Countermeasures That Work:

A Highway Safety Countermeasure Guide For State Highway Safety Offices

Seventh Edition, 2013

U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
www.nhtsa.gov

DISCLAIMER

This publication is distributed by the U.S. Department of Transportation, National Highway Traffic Safety Administration, in the interest of information exchange. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the Department of Transportation or the National Highway Traffic Safety Administration. The United States Government assumes no liability for its contents or use thereof. If trade names, manufacturers' names, or specific products are mentioned, it is because they are considered essential to the object of the publication and should not be construed as an endorsement. The United States Government does not endorse products or manufacturers.

Suggested APA Format Citation:

Goodwin, A., Kirley, B., Sandt, L., Hall, W., Thomas, L., O'Brien, N., & Summerlin, D. (2013, April). *Countermeasures that work: A highway safety countermeasures guide for State Highway Safety Offices*. 7th edition. (Report No. DOT HS 811 727). Washington, DC: National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 811 727		

4. Title and Subtitle	5. Report Date
Countermeasures That Work: A Highway Safety Countermeasure Guide for State Highway Safety Offices, Seventh Edition, 2013	April 2013
	6. Performing Organization Code
7. Author(s) Arthur Goodwin, Bevan Kirley, Laura Sandt, William Hall, Libby Thomas, Natalie O'Brien and Daniel Summerlin	**8. Performing Organization Report No.**
9. Performing Organization Name and Address University of North Carolina Highway Safety Research Center 730 Martin Luther King Jr. Boulevard CB # 3430 Chapel Hill, NC 27599-3430	**10. Work Unit No. (TRAIS)**
	11. Contract or Grant No. DTNH22-11-D-00223, T.O. #1
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration Office of Behavioral Safety Research 1200 New Jersey Avenue SE. Washington, DC 20590	**13. Type of Report and Period Covered** FINAL REPORT
	14. Sponsoring Agency Code

15. Supplementary Notes
Kristie Johnson, Ph.D., served as the Contracting Officer's Technical Representative (COTR) on this project.

16. Abstract

The guide is a basic reference to assist State Highway Safety Offices (SHSOs) in selecting effective, evidence-based countermeasures for traffic safety problem areas. These areas include:

- Alcohol-Impaired and Drugged Driving;
- Seat Belts and Child Restraints;
- Aggressive Driving and Speeding;
- Distracted and Drowsy Driving;
- Motorcycle Safety;
- Young Drivers;
- Older Drivers;
- Pedestrians; and
- Bicycles.

The guide:

- describes major strategies and countermeasures that are relevant to SHSOs;
- summarizes strategy/countermeasure use, effectiveness, costs, and implementation time; and
- provides references to the most important research summaries and individual studies.

17. Key Words	18. Distribution Statement
Alcohol-Impaired Driving, Drugged Driving, Seat Belts, Child Restraints, Aggressive Driving, Speeding, Distracted Driving, Drowsy Driving, Motorcycle Safety, Young Drivers, Older Drivers, Pedestrians, Bicycles, Unsafe Driving	Document is available to the public from the National Technical Information Service www.ntis.gov

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21 No. of Pages	22. Price
Unclassified	Unclassified	388	

Table of Contents

Preface to the Seventh Edition, 2013 ix

Introduction 1
Purpose of the Guide 1
How to Use the Guide 1
Abbreviations, Acronyms, and Initialisms Used 3

1. Alcohol-Impaired and Drugged Driving
Overview 1-1
Strategies to Reduce Impaired Driving 1-4
Resources 1-5
Countermeasures That Work 1-7
Deterrence 1-10
1. Deterrence Laws 1-12
1.1 Administrative License Revocation or Suspension 1-12
1.2 Open Containers 1-14
1.3 High-BAC Sanctions 1-15
1.4 BAC Test Refusal Penalties 1-16
1.5 Alcohol-Impaired Driving Law Review 1-18
2. Deterrence: Enforcement 1-19
2.1 Publicized Sobriety Checkpoint Programs 1-19
2.2 Publicized Saturation Patrol Programs 1-21
2.3 Preliminary Breath Test Devices 1-22
2.4 Passive Alcohol Sensors 1-23
2.5 Integrated Enforcement 1-24
3. Deterrence: Prosecution and Adjudication 1-25
3.1 DWI Courts 1-25
3.2 Limits on Diversion and Plea Agreements 1-27
3.3 Court Monitoring 1-29
3.4 Sanctions 1-30
4. Deterrence: DWI Offender Treatment, Monitoring, and Control 1-32
4.1 Alcohol Problem Assessment and Treatment 1-32
4.2 Alcohol Interlocks 1-34
4.3 Vehicle and License Plate Sanctions 1-37
4.4 DWI Offender Monitoring 1-39
4.5 Lower BAC Limits for Repeat Offenders 1-40
5. Prevention, Intervention, Communications and Outreach 1-41
5.1 Alcohol Screening and Brief Interventions 1-42
5.2 Mass Media Campaigns 1-44
5.3 Responsible Beverage Service 1-46

5.4 Alternative Transportation 1-48
5.5 Designated Drivers 1-49
6. Underage Drinking and Alcohol-Related Driving 1-50
6.1 Minimum Drinking Age 21 Laws 1-51
6.2 Zero-Tolerance Law Enforcement 1-53
6.3 Alcohol Vendor Compliance Checks 1-55
6.4 Other Minimum Drinking Age 21 Law Enforcement 1-57
6.5 Youth Programs 1-59
7. Drugged Driving 1-61
7.1 Enforcement of Drugged Driving 1-63
7.2 Drugged Driving Laws 1-65
7.3 Education Regarding Medications 1-67
Alcohol-Impaired and Drugged Driving References 1-69

2. Seat Belts and Child Restraints

Overview 2-1
Seat Belts for Adults – Trends and Laws 2-4
Child Restraints and Seat Belts for Children – Trends and Laws 2-4
Strategies to Increase Child Restraint Use and Seat Belt Use for Adults and Older Children 2-6
Resources 2-6
Countermeasures That Work 2-8
Countermeasures Targeting Adults 2-11
1. Seat Belt Use Laws 2-11
1.1 State Primary Enforcement Belt Use Laws 2-11
1.2 Local Primary Enforcement Belt Use Laws and Ordinances 2-13
1.3 Increased Belt Use Law Penalties: Fines and Driver's License Points 2-14
2. Seat Belt Law Enforcement 2-16
2.1 Short-Term, High-Visibility Belt Law Enforcement 2-16
2.2 Combined Enforcement, Nighttime 2-19
2.3 Sustained Enforcement 2-21
3. Communications and Outreach 2-22
3.1 Communications and Outreach Supporting Enforcement 2-22
3.2 Communications and Outreach Strategies for Low-Belt-Use Groups 2-23
Countermeasures Targeting Children and Youth 2-26
4. Child/Youth Occupant Restraint Laws 2-26
4.1 Strengthening Child/Youth Occupant Restraint Laws 2-26
5. Child Restraint/Booster Seat Law Enforcement 2-28
5.1 Short-Term, High-Visibility Child Restraint/Booster Law Enforcement 2-28
6. Communications and Outreach 2-30
6.1 Communications and Outreach Strategies for Older Children 2-30
6.2 Communications and Outreach Strategies for Booster Seat Use 2-31
7. Other Strategies 2-32
7.1 School Programs 2-33
7.2 Child Restraint Distribution Programs 2-34
7.3 Inspection Stations 2-35

Seat Belts and Child Restraints References 2-35

3. Aggressive Driving and Speeding

Overview 3-1
Strategies to Reduce Aggressive Driving and Speeding 3-3
Resources 3-5
Countermeasures That Work 3-6
1. Laws 3-8
1.1 Speed Limits 3-8
1.2 Aggressive Driving and Other Laws 3-10
2. Enforcement 3-12
2.1 Automated Enforcement 3-12
2.2 High Visibility Enforcement 3-16
2.3 Other Enforcement Methods 3-19
3. Penalties and Adjudication 3-22
3.1 Penalty Types and Levels 3-22
3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School 3-25
4. Communications and Outreach 3-27
4.1 Communications and Outreach Supporting Enforcement 3-27
Speed and Aggressive-Driving References 3-28

4. Distracted and Drowsy Driving

Overview 4-1
Strategies to Reduce Distracted and Drowsy Driving 4-4
Resources 4-5
Countermeasures That Work 4-7
1. Laws and Enforcement 4-9
1.1 Graduated Driver Licensing Requirements for Beginning Drivers 4-9
1.2 Cell Phone and Text Messaging Laws 4-10
1.3 High Visibility Cell Phone and Text Messaging Enforcement 4-13
1.4 General Driver Drowsiness and Distraction Laws 4-15
2. Communications and Outreach 4-16
2.1 Communications and Outreach on Drowsy Driving 4-16
2.2 Communications and Outreach on Distracted Driving 4-18
3. Other Countermeasures 4-20
3.1 Employer Programs 4-20
3.2 Education Regarding Medical Conditions and Medications 4-21
Distracted and Drowsy Driving References 4-23

5. Motorcycle Safety

Overview 5-1
Strategies to Improve Motorcycle Safety 5-3
Resources 5-4
Countermeasures That Work 5-5
1. Motorcycle Helmets 5-7
1.1 Universal Coverage State Motorcycle Helmet Use Laws 5-7
1.2 Motorcycle Helmet Use Promotion Programs 5-10

1.3 Motorcycle Helmet Law Enforcement: Noncompliant Helmets 5-11
2. Alcohol Impairment 5-13
2.1 Alcohol-Impaired Motorcyclists: Detection, Enforcement and Sanctions 5-13
2.2 Alcohol-Impaired Motorcyclists: Communications and Outreach 5-15
3. Motorcycle Rider Licensing and Training 5-17
3.1 Motorcycle Rider Licensing 5-17
3.2 Motorcycle Rider Training 5-20
4. Communications and Outreach 5-22
4.1 Communications and Outreach: Conspicuity and Protective Clothing 5-22
4.2 Communications and Outreach: Other Driver Awareness of Motorcyclists 5-24
Motorcycle Safety References 5-25

6. Young Drivers
Overview 6-1
Strategies to Reduce Crashes Involving Young Drivers 6-3
Resources 6-5
Countermeasures That Work 6-6
1. Graduated Driver Licensing 6-8
1.1 Graduated Driver Licensing 6-8
1.2 GDL Learner's Permit Length, Supervised Hours 6-10
1.3 GDL Intermediate License Nighttime Restrictions 6-11
1.4 GDL Intermediate License Passenger Restrictions 6-12
1.5 GDL Cell Phone Restrictions 6-13
1.6 GDL Belt Use Requirements 6-14
1.7 GDL Intermediate License Violation Penalties 6-15
2. Driver Education 6-16
2.1 Pre-Licensure Driver Education 6-16
2.2 Post-Licensure or Second-Tier Driver Education 6-19
3. Parents 6-20
3.1 Parental Role in Teaching and Managing Young Drivers 6-20
4. Traffic Law Enforcement 6-23
4.1 Enforcement of GDL and Zero-Tolerance Laws 6-23
Young Driver References 6-25

7. Older Drivers
Overview 7-1
Strategies to Reduce Crashes and Injuries Involving Older Drivers 7-4
Resources 7-6
Countermeasures That Work 7-7
1. Communications and Outreach 7-9
1.1 Formal Courses for Older Drivers 7-9
1.2 General Communications and Education 7-11
2. Licensing 7-13
2.1 License Screening and Testing 7-13

2.2 Referring Older Drivers to Licensing Agencies 7-15
2.3 License Restrictions 7-18
2.4 Medical Advisory Boards 7-20
2.5 License Renewal Policies: In-Person Renewal, Vision Test 7-22
3. Traffic Law Enforcement 7-24
3.1 Law Enforcement Roles 7-24
Older Driver References 7-25

8. Pedestrians

Overview 8-1
Strategies to Increase Pedestrian Safety 8-5
Resources 8-6
Countermeasures That Work 8-8
1. Pre-School-Age Children 8-10
1.1 Children's Safety Clubs 8-10
1.2 Child Supervision 8-12
2. School-Age Children 8-13
2.1 Elementary-Age Child Pedestrian Training 8-13
2.2 Safe Routes to School 8-16
2.3 Child School Bus Training 8-18
3. Impaired Pedestrians 8-19
3.1 Impaired Pedestrians: Communications and Outreach 8-19
3.2 "Sweeper" Patrols of Impaired Pedestrians 8-20
4. All Pedestrians 8-22
4.1 Pedestrian Safety Zones 8-22
4.2 Reduce and Enforce Speed Limits 8-24
4.3 Conspicuity Enhancement 8-26
4.4 Targeted Enforcement 8-27
4.5 Driver Training 8-29
4.6 Pedestrian Gap Acceptance Training 8-30
Pedestrian Safety References 8-31

9. Bicycles

Overview 9-1
Strategies to Reduce Bicycle Crashes and Injuries 9-5
Resources 9-6
Countermeasures That Work 9-8
1. Children 9-10
1.1 Bicycle Helmet Laws for Children 9-11
1.2 Safe Routes to School 9-13
1.3 Bicycle Education for Children 9-15
1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos 9-17
2. Adults 9-19
2.1 Bicycle Helmet Laws for Adults 9-19
2.2 Bicycle Safety Education for Bike Commuters 9-20
3. All Bicyclists 9-21

3.1 Active Lighting and Rider Conspicuity 9-21
3.2 Promote Bicycle Helmet Use with Education 9-24
3.3 Enforcement Strategies 9-26
3.4 Bicyclist Passing Laws 9-28
4. Drivers and Bicyclists 9-29
4.1 Driver Training 9-29
4.2 *Share the Road* Awareness Programs 9-31
Bicycle Safety References 9-32

Preface to the Seventh Edition, 2013

This edition of *Countermeasures That Work* was prepared by the University of North Carolina Highway Safety Research Center. Researchers who contributed to this edition include Arthur Goodwin, Bevan Kirley, Laura Sandt, William Hall, Libby Thomas, Natalie O'Brien, and Daniel Sumerlin. The original *Countermeasures That Work* was prepared in 2005 by James H. Hedlund, Ph.D., of Highway Safety North, with the assistance of Barbara Harsha, executive director of the Governors Highway Safety Association. The chapters on pedestrian and bicycle safety were added in the Second Edition by William A. Leaf of Preusser Research Group.

All chapters have been revised and updated for this edition. Information and research studies through May 31, 2012, have been reviewed and included as appropriate. Data has been updated to include information from NHTSA's Traffic Safety Facts 2010 annual report. Although no new chapters have been added to this edition, several new countermeasures have been introduced:

- The underage drinking and alcohol-impaired driving section of Chapter 1 has been expanded to include two new countermeasures on alcohol vendor compliance checks and other MLDA-21 law enforcement.
- Chapter 2 includes a new countermeasure on strengthening child/youth occupant restraint laws.
- Chapter 4 includes a new countermeasure on cell phone/text messaging enforcement.
- Chapter 8 includes a new countermeasure on pedestrian gap acceptance training.
- Chapter 9 includes two new countermeasures on bicycle safety education for bike commuters and bicyclist passing laws.

We dedicate this edition of *Countermeasures That Work* to Mary Ellen Tucker, MLSc. Mary Ellen passed away during 2012 after 19 years of dedicated service as HSRC's librarian. Over the years, Mary Ellen performed a central role on updates to *Countermeasures That Work*.

User Suggestions and Future Editions

NHTSA will update this guide biennially and may expand it with additional problem areas and countermeasures as appropriate. In particular, NHTSA is considering adding sections on drugs other than alcohol and pupil transportation to the next edition. Users are invited to provide their suggestions and recommendations for the guide:

- How can it be improved, in form and content?
- Specific comments on information in the guide.
- Additional problem areas to include.
- Additional countermeasures to include for the current problem areas.
- Additional key references to include.

Please send your suggestions and recommendations to:

Countermeasures That Work
NHTSA
Office of Behavioral Safety Research, NTI-130
1200 New Jersey Avenue SE.
Washington, DC 20590

or by e-mail to kristie.johnson@dot.gov

Introduction

Purpose of the Guide

This guide is a basic reference to assist State Highway Safety Offices in selecting effective, science-based traffic safety countermeasures for major highway safety problem areas. The guide:

- describes major strategies and countermeasures that are relevant to SHSOs;
- summarizes their use, effectiveness, costs, and implementation time; and
- provides references to the most important research summaries and individual studies.

The guide is not intended to be a comprehensive list of countermeasures available for State use or a list of expectations for SHSO implementation. For a description of an optimal State countermeasure program, SHSOs should refer to the *Highway Safety Program Guidelines*, which delineate the principal components of each of the major program areas.

States should identify problem areas through systematic data collection and analysis and are encouraged to continue to apply innovation in developing appropriate countermeasures. The evaluations summarized in this guide allow SHSOs to benefit from the experience and knowledge gained by others and to select countermeasure strategies that either have proven to be effective or that have shown promise. States choosing to use innovative programs can contribute to the collective knowledge pool by carefully evaluating the effectiveness of their efforts and publishing the findings for the benefit of others.

How to Use the Guide

What's included: The guide contains a chapter for each problem area. Each chapter begins with a brief overview of the problem area's size and characteristics, the main countermeasure strategies, a glossary of key terms, and a few general references. Next, a table lists specific countermeasures and summarizes their effectiveness, costs, use, and implementation time. Each countermeasure is then discussed in approximately one page.

The guide provides an overview and starting point for readers to become familiar with the behavioral strategies and countermeasures in each program area. It has attempted to include countermeasures that have the most evidence of effectiveness as well as those that are used most regularly by SHSOs. Only those countermeasures that could be supported by traditional highway safety grant programs have been considered. In addition, updates to the guide are based only on published research. Unpublished programs and efforts are not included in this edition.

Some countermeasure areas are covered in more depth than others due to the availability of published research. For example, impaired driving has a long and rich research history while other topics, such as driver distraction and drowsiness, have received less attention. This difference in the availability of published research findings is due to a number of factors, including the relative scale of the problem areas, the availability of reliable data on the frequency and characteristics of some safety problems, and the challenge of conducting scientifically valid studies in certain behavioral areas.

References are provided for each countermeasure. When possible, summaries of available research are cited, with Web links where available, so users can find most of the evaluation information in one place. If no summaries are available, one or two key studies are cited. There has been no attempt to list all research, current studies, or program information available on any countermeasure. Readers interested in any problem area or in specific countermeasures are urged to consult the references. Although all Web links in this guide were accurate at the time of publication, please note that Web links may change periodically. For broken links to NHTSA documents, we recommend searching NHTSA's behavioral safety research reports (ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm). For broken links to other reports or documents, refer to the Web site for the agency that produced the report.

What's not included: Since the guide is intended as a tool for SHSO use, it does not include countermeasures for which SHSOs have little or no authority or responsibility, or that cannot be supported under typical highway safety grant programs. For example, the guide does not include vehicle- or roadway-based solutions. Also, it does not include countermeasures that already are in place in every State, such as .08 grams per deciliter blood alcohol concentration laws. Finally, the guide does not include administrative or management topics such as traffic safety data systems and analyses, program planning and assessments, State and community task forces, or comprehensive community traffic safety programs.

What the effectiveness data mean: The effectiveness of any countermeasure can vary immensely from State to State or community to community. *What* is done is often less important than *how* it is done. The best countermeasure may have little effect if it is not implemented vigorously, publicized extensively, and funded satisfactorily. Evaluation studies generally examine and report on high-quality implementation because there is little interest in evaluating poor implementation. Also, the fact that a countermeasure is being evaluated usually gets the attention of those implementing it, so that it is likely to be done well. *The countermeasure effectiveness data presented in this guide probably shows the maximum effect that can be realized with high-quality implementation*. Many countermeasures have not been evaluated well, or at all, as noted in the effectiveness data. Effectiveness ratings are based primarily on demonstrated reductions in crashes; however, changes in behavior and knowledge are taken into account in the ratings when crash information is not available.

NCHRP Guides: The National Cooperative Highway Research Program is developing a series of guides for State Departments of Transportation to use in implementing the American Association of State Highway and Transportation Officials Strategic Highway Safety Plan. This guide draws heavily on the published NCHRP guides and on several draft guides. It differs from the NCHRP guides because it is written for SHSOs, contains only behavioral countermeasures, and is considerably more concise. Readers are urged to consult the NCHRP guides relevant to their interests. They are available at http://safety.transportation.org/guides.aspx.

NCHRP has also developed a framework for estimating the costs and benefits associated with behavioral countermeasures. Each of the countermeasures included in *Countermeasures That Work* was reviewed, and the potential savings of the countermeasures were projected. The subsequent report was designed to help States in selecting countermeasures that will result in the

greatest reduction in crashes, injuries, and fatalities. Readers can find a copy of the report at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_622.pdf.

Cochrane Reviews: In several of the chapters, Cochrane Reviews are cited. The Cochrane Collaboration is a nonprofit organization that produces and disseminates systematic reviews of the effects of healthcare interventions. The database of reviews is published quarterly as part of the Cochrane Library. More information about Cochrane Reviews can be found here: www.cochrane.org/.

Disclaimers: As with any attempt to summarize a large amount of sometimes-conflicting information, this guide is highly subjective. All statements, judgments, omissions, and errors are solely the responsibility of the authors and do not necessarily represent the views of the Governors Highway Safety Association or NHTSA. Users who disagree with any statement or who wish to add information or key references are invited to send their comments and suggestions for future editions (see bottom of page vii for details).

New traffic safety programs and research appear almost weekly. Web sites change frequently. This means that this guide was out of date even before it was published. Readers interested in a specific problem area or countermeasures are urged to contact NHTSA for up-to-date information.

Abbreviations, Acronyms, and Initialisms Used

- AAA: was the American Automobile Association but now the organization uses only the initials
- AAAFTS: AAA Foundation for Traffic Safety
- AAMVA: American Association of Motor Vehicle Administrators
- AARP: was the American Association of Retired Persons but now the organization uses only the initials
- AASHTO: American Association of State Highway and Transportation Officials
- ADTSEA: American Driver and Traffic Safety Education Association
- ALR: administrative license revocation
- ALS: administrative license suspension
- AMA: American Medical Association
- ASA: American Society on Aging
- BAC: blood alcohol concentration, measured in grams per deciliter (g/dL)
- CDC: Centers for Disease Control and Prevention
- CPSC: Consumer Product Safety Commission
- CTIA: Cellular Telecommunications and Internet Association
- DOT: Department of Transportation (Federal or State)
- DWI: driving while impaired or intoxicated, and also often includes DUI, driving under the influence
- DWS: driving while [driver's license is] suspended
- FHWA: Federal Highway Administration
- FMCSA: Federal Motor Carrier Safety Administration

- GDL: graduated driver licensing
- GHSA: Governors Highway Safety Association
- HOS: hours of service
- IIHS: Insurance Institute for Highway Safety
- ITS: Intelligent Transportation Systems
- MAB: medical advisory board
- MSF: Motorcycle Safety Foundation
- NCHRP: National Cooperative Highway Research Program
- NCSDR: National Center for Sleep Disorders Research
- NCUTLO: National Committee on Uniform Traffic Laws and Ordinances
- NHTSA: National Highway Traffic Safety Administration
- NIAAA: National Institute on Alcohol Abuse and Alcoholism (a branch of NIH)
- NIH: National Institutes of Health
- NMSL: National Maximum Speed Limit
- NSC: National Safety Council
- NSF: National Sleep Foundation
- NTSB: National Transportation Safety Board
- SFST: Standardized Field Sobriety Tests
- SHSO: State Highway Safety Office
- SMSA: National Association of State Motorcycle Safety Administrators
- STEP: selective traffic enforcement program
- TIRF: Traffic Injury Research Foundation
- TRB: Transportation Research Board
- UVC: Uniform Vehicle Code

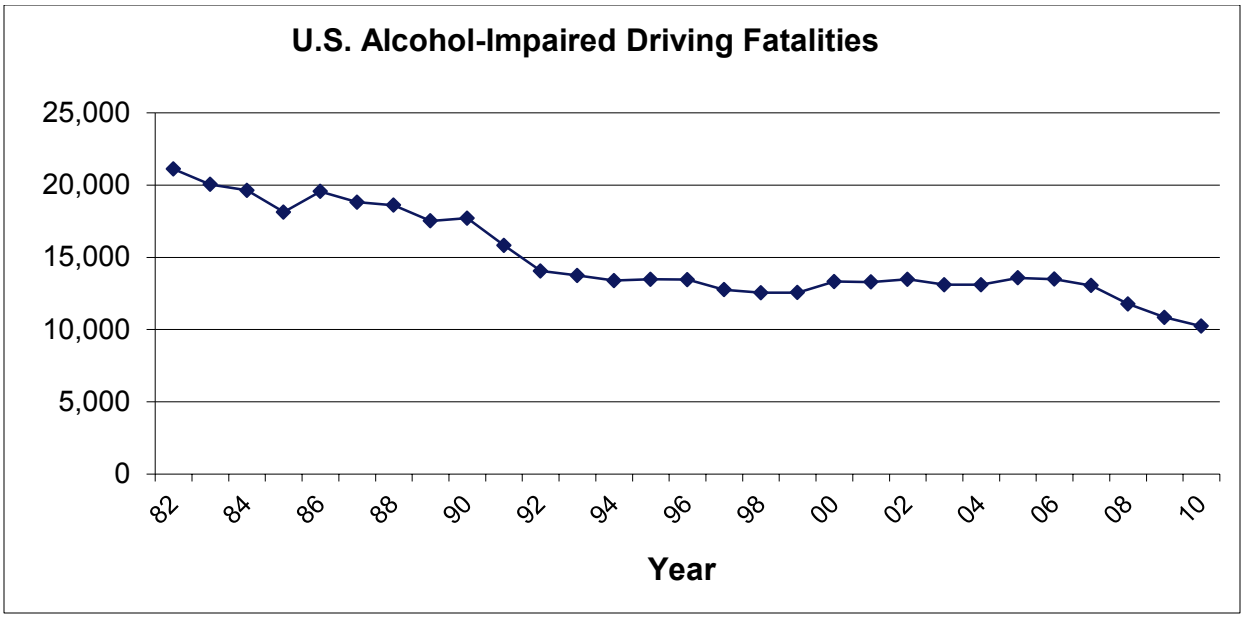
1.Alcohol-Impaired and Drugged Driving

Overview

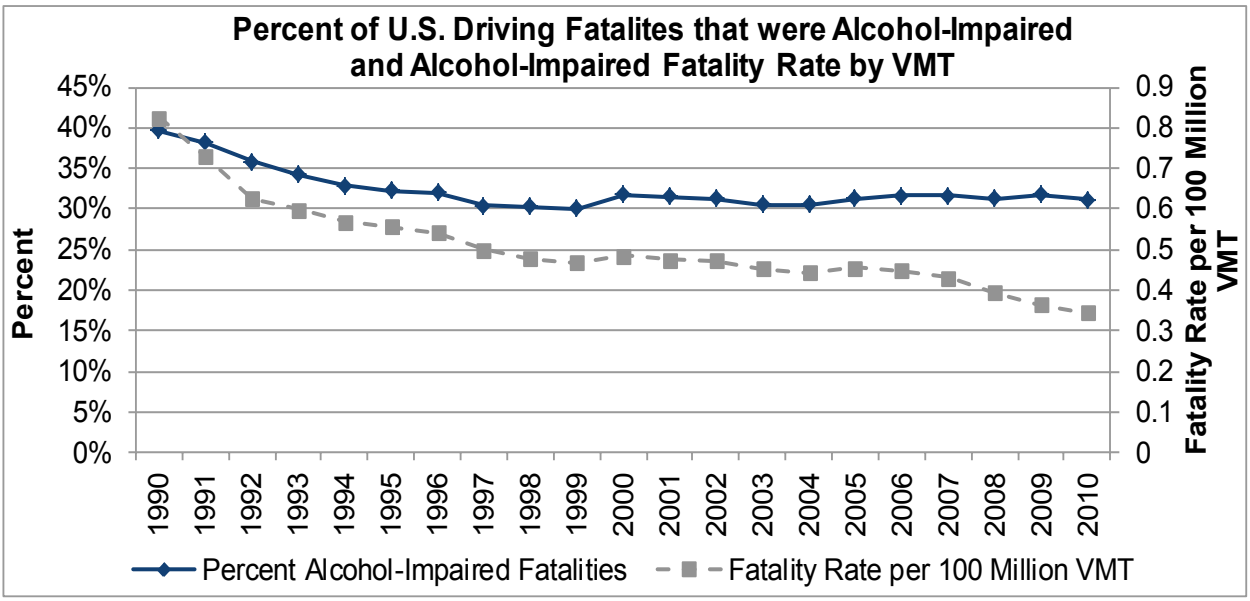
In 2010, 10,228 people were killed in crashes involving alcohol-impaired drivers (defined as drivers with BACs of ≥.08 g/dL), a decrease of 4.9% from the 10,759 fatalities in 2009 (NHTSA, 2012a). Fatalities in crashes involving an alcohol-impaired driver represent almost one-third (31%) of the total motor vehicle fatalities in the United States (NHTSA, 2012a). See NHTSA's most recent *Traffic Safety Facts* (NHTSA, 2012a) for the latest national and State data.

Trends. Alcohol-impaired driving dropped steadily from 1982 to the mid-1990s. A study showed that much of this decrease could be attributed to alcohol-related legislation (e.g., .08 BAC, administrative license revocation, and minimum drinking age laws) and to demographic trends (e.g., the aging of the population and the increased proportion of female drivers) (Dang, 2008). However, during this period there also was substantial public attention to the issue of alcohol-impaired driving, a growth of grassroots organizations such as Mothers Against Drunk Driving and Remove Intoxicated Drivers, increased Federal programs and funding, State task forces, increased enforcement and intensive publicity, all of which combined to help address this critical traffic safety problem.

As the chart shows, alcohol-impaired driving fatalities changed very little between 1992 and 2006, but then began declining in 2007. As shown in the second chart, the rate of alcohol-impaired driving fatalities, based on vehicle miles traveled (VMT) has also declined, but the percentage of fatalities in the United States that involve alcohol-impaired driving (one or more drivers or motorcycle riders with BACs of .08 or more) has remained essentially unchanged during this time (NHTSA, 2012a).



Sources: NHTSA, 2011a and NHTSA, 2012b



Source: NHTSA, 2012a

One age group showed an especially sizeable decrease in alcohol-related traffic fatalities. Between 1996 and 2005, the percentage of fatally injured 16-year-old drivers with positive BACs (i.e., BACs of .01 g/dL or higher) decreased by 16% (Ferguson, Teoh, & McCartt, 2007). It should be noted that most States implemented graduated driver licensing systems (GDL) during this time period. GDL systems have had a substantial impact on reducing the crash risk of young, beginning drivers. (For more information on young drivers and GDL, see Chapter 6.)

Drinking and driving characteristics. Drinking and driving is common, with at least 80 million trips made annually by drivers with BACs of .08 or higher. Arrests are rare, with less than one

arrest for every 50 trips by a driver over .08 BAC (Hedlund & McCartt, 2002). The 2007 National Roadside Survey has shown that 12.4% of drivers on weekend nights have positive BACs, while 2.2% have BACs of .08 or higher (Compton & Berning, 2009; Lacey et al., 2009a). This represents a significant reduction from 1996, when 16.9% of drivers had positive BACs and 4.3% had BACs of .08 or higher.

NHTSA surveyed approximately 7,000 people in 2008 and asked about a variety of attitudes and behaviors related to drinking and driving (Moulton, Peterson, Haddix, & Drew, 2010). Twenty percent reported they had driven within 2 hours of drinking alcohol in the past year. Males were more likely than females to report doing so (27% versus 14%). In another U.S. survey of approximately 337,000 drivers 18 and older, 2.2% admitted to driving after having had too much to drink at least once in the past month (Bergen, Shults, Beck, & Qayad, 2012). Males, college graduates, and unmarried individuals were more likely than their respective counterparts to report driving after drinking too much.

According to the Century Council (2008), impaired drivers may be considered "high risk" if they meet one or more of the following criteria:

- High BACs – half of impaired drivers in crashes or arrests have BACs of .15 or higher.
- Prior convictions – one-third of impaired drivers in crashes or arrests have a prior DWI conviction.
- Problems with alcohol – one-quarter of impaired drivers in surveys have some indication of alcohol problems.

Alcohol-impaired driving fatalities are affected by several external factors, including geography, urbanization, road structure and conditions, and economic activity, as well as by a State's laws and programs. For all of these reasons, both the current level of alcohol-impaired driving and the progress in reducing alcohol-impaired driving vary greatly from State to State. For example, comparing all 50 States and the District of Columbia:

- The proportion of drivers in fatal crashes with BACs of .08 or higher in 2010 ranged from 14% in the lowest State to 32% in the highest (NHTSA, 2012c).
- The proportion of drivers in fatal crashes with BACs of .01 or higher in 2010 ranged from 15% in the lowest State to 38% in the highest (NHTSA, 2012c).

Drugged driving characteristics. There is considerably less research on drugged driving than alcohol-impaired driving. However, two roadside surveys suggest it is not uncommon for drivers to have detectable levels of one or more drugs in their systems. Lacey et al. (2009b) collected oral fluid and blood samples from several thousand drivers across the United States in 2007 at different times of day on weekends. Among nighttime drivers who provided oral fluid and/or blood samples:

- 11.3% tested positive for an illegal drug;
- 3.9% tested positive for a medication (i.e., a prescription or over-the-counter drug); and
- 1.1% tested positive for both an illegal drug and a medication.

Marijuana was the most commonly detected illegal drug, followed by cocaine. Among those drivers who tested positive for an illegal drug, 28% also tested positive for alcohol (Lacey et al., 2009b).

In a roadside survey in Canada, researchers collected oral fluid samples from approximately 1,200 nighttime drivers (Beirness & Beasley, 2010). Similar to the U.S. study, 10% of drivers tested positive for drug use. This was slightly higher than the percentage of drivers who tested positive for alcohol use (8%). Of the drug positive cases, most (88%) involved a single drug, the most common being marijuana or cocaine. Male drivers were more likely than female drivers to test positive for drugs (Beirness & Beasley, 2010). In both the U.S. and Canadian studies, it is important to keep in mind that a positive drug test does not necessarily indicate "impairment." Many drugs can be detected in a blood test long after their effects have diminished. For example, marijuana can be detected for 30 days or longer among heavy users.

Although some countries such as Sweden and Finland have carefully tracked the prevalence of drugged driving (Ojaniemi et al., 2009), little is known about trends in drugged driving in the United States. One study from Washington State found a significant increase in methamphetamine use among fatally injured drivers between 1992 and 2002 (Schwilke, Sampaio dos Santos, & Logan, 2006). In part, this likely reflects larger trends in the drug's popularity.

Research on whether drug use contributes to crashes is limited. A NHTSA study found 18% of all fatally injured drivers in 2009 tested positive for drugs (NHTSA, 2010a). However, not all fatally injured drivers were tested. Additionally, States varied widely in the types of drugs they tested for, and many times the test results were not known. When considering only those fatally injured drivers who were tested with known results, 33% tested positive for drugs (NHTSA, 2010a). Narcotics and cannabinoids (e.g., marijuana) accounted for almost half of the positive test results. In addition, 48% of fatally injured drivers who tested positive for drugs also tested positive for alcohol (ONDCP, 2011). Although drugs are often detected among drivers involved in crashes, this does not necessarily imply drug impairment played a causal role in the crash. At present, the evidence is variable on whether cannabis and benzodiazepines increase crash risk, while relatively few studies have examined the risks associated with stimulants, opioids, and other drugs (Stewart, 2006).

In 2010, the Office of National Drug Control Policy (ONDCP) announced a new initiative to decrease the prevalence of drugged driving 10% by 2015 (ONDCP, 2010). The initiative encourages States to adopt *per se* drug impairment laws, provide increased training to law enforcement on identifying drugged drivers, and further data collection.

Strategies to Reduce Impaired Driving

Four basic strategies are used to reduce alcohol-impaired crashes and drinking and driving:

- Deterrence: enact, publicize, enforce, and adjudicate laws prohibiting alcohol-impaired driving so that people choose not to drive impaired;
- Prevention: reduce drinking and keep drinkers from driving;
- Communications and outreach: inform the public of the dangers of impaired driving and establish positive social norms that make driving while impaired unacceptable; and
- Alcohol treatment: reduce alcohol dependency or addiction among drivers;

In this chapter, deterrence countermeasures are divided into four sections: (1) laws, (2) enforcement, (3) prosecution and adjudication, and (4) offender treatment, monitoring, and control. Prevention, intervention, communications, and outreach countermeasures are combined in a single section. Finally, the Underage Drinking and Alcohol-Impaired Driving section includes deterrence, prevention, and communications measures specific to this age group.

This chapter also briefly considers countermeasures to address drugs other than alcohol. Drugs pose quite different and difficult issues at every step, from estimating their prevalence and effect on driving, to developing effective laws and strategies for enforcement, prevention, and treatment. However, many of the countermeasures to address alcohol-impaired driving may also deter drugged driving.

Many other traffic safety countermeasures help reduce alcohol-impaired and drugged driving-related crashes and casualties but are not discussed in this chapter. A number of vehicular strategies may be helpful in detecting or preventing impaired driving. For example, NHTSA has studied the feasibility of using vehicle-based sensors to detect alcohol-related impairment in drivers (Lee et al., 2010). There are also many environmental countermeasures, such as improved vehicle structures and centerline rumble strips, that may reduce the likelihood of crashes and/or injuries sustained by impaired drivers. However, vehicular and environmental countermeasures are not included in this chapter because State Highway Safety Offices have little or no authority or responsibility for them.

Resources

The agencies and organizations listed below can provide more information on impaired driving and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Impaired Driving - www.nhtsa.gov/Impaired
  - Impaired Driving (Alcohol-Related) Reports - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Impaired+driving+(alcohol-related)+reports
  - Impaired Driving (Drug-Related) Reports - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Impaired+driving+(drug-related)+reports
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention: www.cdc.gov/MotorVehicleSafety/Impaired_Driving/impaired-drv_factsheet.html
- Office of National Drug Control Policy: www.whitehouse.gov/ondcp/drugged-driving
- Governors Highway Safety Association: www.ghsa.org/html/issues/impaireddriving.html
- Insurance Institute for Highway Safety: www.iihs.org/research/topics/alcohol_drugs.html
- National Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/ImpairedDriving.aspx

- American Automobile Association: www.aaapublicaffairs.com/Main/Default.asp?CategoryID=3&SubCategoryID=36
- Mothers Against Drunk Driving: www.madd.org
- Traffic Injury Foundation: www.tirf.ca

For overviews of alcohol-impaired driving prevalence, risks, legislation, research, and recommended strategies, see NHTSA's *Alcohol and Highway Safety: A Review of the State of Knowledge* (Voas & Lacey, 2011) and NCHRP's *A Guide for Reducing Alcohol-related Collisions* (NCHRP, 2005).

Key terms

- BAC: Blood alcohol concentration in the body, expressed in grams of alcohol per deciliter (g/dL) of blood, usually measured with a breath or blood test.
- DUID: Driving Under the Influence of Drugs
- DWI: the offense of driving while impaired by alcohol. In different States the offense may be called driving while intoxicated, driving under the influence (DUI), or other similar terms.
- MADD: Mothers Against Drunk Driving.
- PAS: Passive alcohol sensor, a device to detect alcohol presence in the air near a driver's face, used to estimate whether the driver has been drinking.
- PBT: Preliminary breath test device, a small hand-held alcohol sensor used to estimate or measure a driver's BAC.
- SFST: Standardized Field Sobriety Tests, a battery of three tests (One-Leg Stand, Walk-and-Turn, and Horizontal Gaze Nystagmus) used by law enforcement at the roadside to estimate whether a driver is at or above the legal limit of .08 BAC.
- Illegal *per se* law: A law that makes it an offense to operate a motor vehicle with a BAC at or above a specified level.

Countermeasures That Work

Countermeasures to reduce alcohol-impaired driving are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Deterrence: Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 ALR/ALS	★★★★★	$$$	High	Medium
1.2 Open containers	★★★	$	High	Short
1.3 High-BAC sanctions	★★★	$	Medium	Short
1.4 BAC test refusal penalties	★★★	$	Unknown	Short
1.5 Alcohol-impaired driving law review	★★	$$	Low	Medium

2. Deterrence: Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 High visibility sobriety checkpoints	★★★★★	$$$	Medium	Short
2.2 High visibility saturation patrols	★★★★	$$	High	Short
2.3 Preliminary Breath Test devices (PBTs)†	★★★★	$$	High	Short
2.4 Passive alcohol sensors††	★★★★	$$	Unknown	Short
2.5 Integrated enforcement	★★★	$	Unknown	Short

† Proven for increasing arrests
†† Proven for detecting impaired drivers

3. Deterrence: Prosecution and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 DWI courts†	★★★★	$$$	Low	Medium
3.2 Limits on diversion and plea agreements††	★★★★	$	Medium	Short
3.3 Court monitoring††	★★★	$	Low	Short
3.4 Sanctions	★★	Varies	Varies	Varies

† Proven for reducing recidivism
†† Proven for increasing convictions

4. Deterrence: DWI Offender Treatment, Monitoring, and Control

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Alcohol problem assessment, treatment	★★★★★	Varies	High	Varies
4.2 Alcohol interlocks†	★★★★★	$$	Medium	Medium
4.3 Vehicle and license plate sanctions†	★★★★	Varies	Medium	Medium
4.4 DWI offender monitoring†	★★★★	$$$	Unknown	Varies
4.5 Lower BAC limit for repeat offenders	★★★★	$	Low	Short

† Proven for reducing recidivism

5. Prevention, Intervention, Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
5.1 Alcohol screening and brief intervention	★★★★★	$$	Medium	Short
5.2 Mass-media campaigns	★★★	$$$	High	Medium
5.3 Responsible beverage service	★★	$$	Medium	Medium
5.4 Alternative transportation	★★	$$	Unknown	Short
5.5 Designated drivers	★★	$	Medium	Short

6. Underage Drinking and Alcohol-Impaired Driving

Countermeasure	Effectiveness	Cost	Use	Time
6.1 Minimum drinking age 21 laws	★★★★★	Cost	High	Low
6.2 Zero-tolerance law enforcement	★★★	$	Unknown	Short
6.3 Alcohol vendor compliance checks†	★★★	$$	Unknown	Short
6.4 Other MLDA-21 law enforcement	★★★	$$	Varies	Varies
6.5 Youth programs	★★	Varies	High	Medium

† Proven for reducing sales to underage people

7. Drugged Driving

Countermeasure	Effectiveness	Cost	Use	Time
7.1 Enforcement of drugged driving	★★★	$$	Unknown	Short
7.2 Drugged driving laws	★	Unknown	Medium†	Short
7.3 Education regarding medication	★	Unknown	Unknown	Long

† Use for drug *per se* laws

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

Deterrence

Deterrence means enacting laws that prohibit driving while impaired, publicizing and enforcing those laws, and punishing the offenders. Deterrence works by changing behavior through the fear of apprehension and punishment. If drivers believe that impaired driving is likely to be detected and that impaired drivers are likely to be arrested, convicted and punished, many will not drive while impaired by alcohol. This strategy is called *general deterrence* when it influences the general driving public through well publicized and highly visible enforcement activities and subsequent punishment. In contrast, *specific deterrence* refers to efforts to influence drivers who have been arrested for impaired driving so they will not continue to drive while impaired by alcohol.

Deterrence works when consequences are swift, sure, and severe (with swift and sure being more important in affecting behavior than severe). All States have the basic laws in place to define impaired driving, set illegal *per se* limits at .08 BAC, and provide standard penalties.

Deterrence, however, is far from straightforward, and complexities can limit the success of deterrence measures. For instance:

- Detecting alcohol-impaired drivers is difficult. Alcohol-impaired driving is a common behavior, law enforcement agencies have limited resources, and (except at checkpoints) officers must observe some traffic violation or other aberrant behavior before they can stop a motorist.
- Conviction also may be difficult. DWI laws are extremely complicated (20 pages in some State codes); the evidence needed to define and demonstrate impairment is complex; judges and juries may not impose specified penalties for an action that they do not believe is a "real crime."
- The DWI control system is complex. There are many opportunities for breakdowns in the system that allow impaired drivers to go unpunished.

DWI control system operations and management. The DWI control system consists of a set of laws together with the enforcement, prosecution, adjudication, and offender follow-up policies and programs to support the laws. In this complicated system, the operations of each component affect all the other components. Each new policy, law, or program affects operations throughout the system, often in ways that are not anticipated.

This guide documents 19 specific impaired-driving countermeasures in the deterrence section, in four groups: (1) laws, (2) enforcement, (3) prosecution and adjudication, and (4) offender treatment, monitoring, and control. But the overall DWI control system, including its management and leadership, is more important than any individual countermeasure.

Studies have highlighted the key characteristics of an efficient and effective DWI control system (Hedlund & McCartt, 2002; Robertson & Simpson, 2003):

- Training and education for law enforcement, prosecutors, judges, and probation officers;
- record systems that are accurate, up-to-date, easily accessible, and able to track each DWI offender from arrest through the completion of all sentence requirements;
- adequate resources for staff, facilities, training, equipment, and new technology; and

- coordination and cooperation within and across all components.

A few of the countermeasures discussed in this guide, such as BAC test refusal penalties (Chapter 1, Section 1.4), alcohol-impaired driving law review (1.5), and DWI courts (3.1), are directed at improving DWI system operations. In some instances, the most important action that SHSOs can take to reduce alcohol-impaired driving is to review and improve DWI control system operations, perhaps using a State DWI task force and/or a State alcohol program assessment.

Ulmer, Hedlund, and Preusser (1999) investigated why some States reduced alcohol-related traffic fatalities more than others. They concluded that there is no "silver bullet," no single critical law, enforcement practice, or communications strategy. Once a State has effective laws, high-visibility enforcement, and substantial communications and outreach to support them, the critical factors are strong leadership, commitment to reducing impaired driving, and adequate funding. SHSOs should keep this in mind as they consider the specific countermeasures in this chapter.

1. Deterrence: Laws

1.1 Administrative License Revocation or Suspension (ALR or ALS)

Effectiveness: ★★★★★	Cost: $$$	Use: High	Time: Medium

Administrative license revocation or suspension laws allow law enforcement and driver licensing authorities to revoke or suspend a driver's license if the driver fails or refuses to take a BAC test. The license revocation or suspension occurs very quickly: usually the arresting officer takes the license at the time that a BAC test is failed or refused. The driver typically receives a temporary license that allows the driver time to make other transportation arrangements and to request and receive an administrative hearing or review. In most jurisdictions, offenders may obtain an occupational or hardship license during part or all of the revocation or suspension period (NHTSA, 2007a). NHTSA recommends that ALR laws include a minimum license suspension of 90 days (NHTSA, 2006a). A model ALR law is provided by National Committee on Uniform Traffic Laws and Ordinances (NCUTLO, 2007).

ALR and ALS laws provide for swift and certain penalties for DWI, rather than the lengthy and uncertain outcomes of criminal courts. They also protect the driving public by removing some DWI offenders from the road (but see the discussion of driving with a suspended license, under "other issues," below). More information about ALR laws can be found in the NCHRP Report 500 guide on reducing impaired-driving (NCHRP, 2005, Strategy C1) and NHTSA's *Traffic Safety Facts* on ALR (NHTSA, 2008a).

Use: As of July 2012, 41 States and the District of Columbia had some form of ALR or ALS law (IIHS, 2012). Thirty-five States had a minimum license suspension of at least 90 days, as recommended by NHTSA.

Effectiveness: Many State ALR and ALS laws have been in place for decades, and much of the research examining the effectiveness of these laws is now quite old. For example, a summary of 12 evaluations through 1991 found ALR and ALS laws reduced crashes of different types by an average of 13% (Wagenaar, Zobek, Williams, & Hingson, 2000). A more recent study examining the long-term effects of license suspension policies across the United States concluded that ALR reduces alcohol-related fatal crash involvement by 5%, saving an estimated 800 lives each year (Wagenaar & Maldonado-Molina, 2007).

Costs: ALR laws require funds to design, implement, and operate a system to record and process administrative license actions. In addition, a system of administrative hearing officers must be established and maintained. Some States have recovered ALR system costs through offender fees (Century Council, 2008; NHTSA, 2008a).

Time to implement: Six to 12 months are required to design and implement the system and to recruit and train administrative hearing officers.

Other issues:

- **Two-track system:** Under ALR or ALS laws, drivers face both administrative and criminal actions for DWI. The two systems operate independently. Drivers whose licenses have been suspended or revoked administratively still may face criminal actions that also may include license suspension or revocation. This two-track system has been challenged in some States. All State supreme courts have ruled against these challenges (NHTSA, 2008a).
- **Driving with a suspended license:** Some DWI offenders continue to drive with suspended or revoked licenses (Lenton, Fetherston, & Cercarelli, 2010; McCartt, Geary, & Nissen, 2002). For strategies to reduce driving with a suspended or revoked license, see NCHRP (2003), and Chapter 1, Sections 4.2, 4.3 and 5.4.
- **Delaying license reinstatement:** Many DWI offenders do not reinstate their license when they are eligible to do so. About half (49%) of DWI offenders delay license reinstatement for at least a year, while 30% delay reinstatement for 5 years or more (Voas, Tippetts, & McKnight, 2010). Studies show offenders who delay reinstatement are more likely to recidivate than those who have their license restored (Voas et al., 2010). This suggests it may be important to encourage DWI offenders to reinstate their license once eligible, but with appropriate controls such as ignition interlocks (Chapter 1, Section 4.2) and close monitoring (Section 4.4).
- **Hearings:** An effective ALR system will restrict administrative hearings to the relevant facts: that the arresting officer had probable cause to stop the vehicle and require a BAC test and that the driver refused or failed the test. Such a system will reduce the number of hearings requested, reduce the time required for each hearing, and minimize the number of licenses that are reinstated. When administrative hearings are not restricted in this way they can serve as an opportunity for defense attorneys to question the arresting officer about many aspects of the DWI case. This may reduce the chance of a criminal DWI conviction (Hedlund & McCartt, 2002). Officers often spend substantial time appearing in person at ALR hearings, and cases may be dismissed if an officer fails to appear. Some States use telephonic hearings to solve these problems (Wiliszowski, Jones, & Lacey, 2003).

1.2 Open Containers

Effectiveness: ★★★	Cost: $	Use: High	Time: Short

Open-container laws prohibit the possession of any open alcoholic beverage container and the consumption of any alcoholic beverage by motor vehicle drivers or passengers. These laws typically exempt passengers in buses, taxis, and the living quarters of mobile homes.

In 1998, Congress required States to enact open-container laws or have a portion of their Federal aid highway construction funds redirected to alcohol-impaired driving or hazard elimination activities (NHTSA, 2008b).

Use: As of August 2012, 39 States and the District of Columbia had open-container laws that complied with the Federal requirements (GHSA, 2012a).

Effectiveness: The only study of open-container law effectiveness (Stuster, Burns, & Fiorentino, 2002) examined 4 States that enacted laws in 1999. It found the proportion of alcohol-involved fatal crashes appeared to decline in three of the 4 States during the first 6 months after the laws were implemented, but the declines were not statistically significant. In general, the proportion of alcohol-involved fatal crashes was higher in States with no open-container law than in States with a law (Stuster et al., 2002). Survey data in both law and no-law States show strong public support for open-container laws (NHTSA, 2008b).

Costs: Open-container law costs depend on the number of offenders detected and the penalties applied to them.

Time to implement: Open-container laws can be implemented as soon as appropriate legislation is enacted.

1.3 High-BAC Sanctions

Effectiveness: ★★★	Cost: $	Use: Medium	Time: Short

Almost all States increase the penalties for the standard impaired driving (DWI) offense for repeat offenders. Some States also have increased the penalties for drivers with high BACs, typically .15 or .16 or higher.

High-BAC sanctions are based on the observation that many high-BAC drivers are habitual impaired-driving offenders, even though they may not have a record of previous arrests and convictions. Moreover, drivers with high BACs put themselves and other road users at risk: 58% of impaired drivers involved in fatal crashes in 2010 had BACs of .15 or greater (NHTSA, 2012b). Enhanced sanctions for high-BAC drivers vary by State, and may include mandatory assessment and treatment for alcohol problems, close monitoring or home confinement, installation of an ignition interlock, and vehicle or license plate sanctions (see Chapter 1, Sections 4.1, 4.2, 4.3 and 4.4). NHTSA recommends that sanctions for first-time offenders with high BACs be comparable to those for repeat offenders (NHTSA, 2008c).

Use: As of December 2011, 48 States and the District of Columbia have increased penalties for drivers with high BACs (NCSL, 2012a). Hawaii and Mississippi are the only two States without such laws. (Hawaii's high-BAC provision was repealed in 2010). In 2011, Alabama, Maryland, Texas, and Vermont passed high-BAC legislation (NCSL, 2012a). Alabama's new law requires offenders with a BAC of .15 or higher to have ignition interlocks installed in their vehicles for two years.

Effectiveness: In the only evaluation of high-BAC sanctions to date, McCartt and Northrup (2003, 2004) found that Minnesota's law appears to have increased the severity of case dispositions for high-BAC offenders, although the severity apparently declined somewhat over time. They also found some evidence of an initial decrease in recidivism among high-BAC first offenders (which again dissipated with time). The BAC test refusal rate declined for first offenders and was unchanged for repeat offenders after the high-BAC law was implemented. The authors pointed out that Minnesota's law had a high threshold of .20 BAC, relatively strong administrative and criminal sanctions, and strong penalties for BAC test refusal.

Costs: High-BAC sanctions will produce increased costs if the high-BAC penalties are more costly per offender than the lower-BAC penalties. Over a longer period, if high-BAC sanctions reduce recidivism and deter alcohol-impaired driving, then costs will decrease.

Time to implement: High-BAC sanctions can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Test refusal:** High-BAC sanctions may encourage some drivers to refuse the BAC test unless the penalties for test refusal are at least as severe as the high-BAC penalties. See Chapter 1, Section 1.4.

1.4 BAC Test Refusal Penalties

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

All States have implied consent laws stipulating that people implicitly consent to be tested if they are suspected of impaired driving (NHTSA, 2008d). However, many drivers refuse to provide a breath or blood sample for a BAC test. In 2005, 22% of all drivers arrested for DWI refused the BAC test (Berning et al., 2008), a slight drop from the nationwide average of 25% in 2001 (Zwicker, Hedlund, & Northrup, 2005). A driver's BAC is a critical piece of evidence in an alcohol-impaired driving case. The absence of a BAC test can make it more difficult to convict the impaired driver.

All States have established separate penalties for BAC test refusal, typically involving administrative license revocation or suspension. If the penalties for refusal are less severe than the penalties for failing the test, many drivers will refuse. The Model DWI code sets a more severe penalty for test refusal than for test failure (NCUTLO, 2007).

Reduced test refusal rates will help the overall DWI control system by providing better BAC evidence. Having a driver's BAC may increase DWI and high-BAC DWI convictions, increase the likelihood that prior DWI offenses will be properly identified, and provide the court with better evidence for offender alcohol assessment. For a thorough discussion of issues related to BAC test refusal, see NHTSA's 2008 *Report to Congress* (Berning et al., 2008). See also Voas et al. (2009) for a history of implied consent laws in the United States and a review of the research on breath test refusal.

Use: The relative penalties in each State for failing and refusing a BAC test cannot be categorized in a straightforward manner due to the complexity of State alcohol-impaired driving laws and the differences in how these laws are prosecuted and adjudicated. As of 2008, all States except Nevada imposed administrative sanctions for test refusal (NHTSA, 2008d). See NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* for more detail on each State's laws (NHTSA, 2011b).

Effectiveness: Zwicker et al. (2005) found that test refusal rates appear to be lower in States where the consequences of test refusal are greater than the consequences of test failure. No study has examined whether stronger test refusal penalties are associated with reduced alcohol-impaired crashes.

Costs: There are no direct costs of increasing penalties for BAC test refusal.

Time to implement: Increased BAC test refusal penalties can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Criminalizing test refusal:** As of 2008, BAC test refusal was a criminal offense in 15 States (NHTSA, 2008d; Zwicker et al., 2005, Appendix A). Criminalizing test refusal decreases the likelihood that impaired drivers can avoid penalties by refusing to be tested. It also ensures the driver will be identified as a repeat offender upon subsequent arrests.
- **Warrants:** To reduce breath test refusals and increase the number of drivers successfully prosecuted for DWI, some States issue warrants for drivers who refuse to provide breath tests. Issued by a judge or magistrate, the warrant requires the driver to provide a blood sample, by force if necessary. One study reviewed how warrants are used in 4 States – Arizona, Michigan, Oregon, and Utah (Hedlund & Beirness, 2007). They found that warrants may successfully reduce breath test refusals and result in more pleas, fewer trials, and more convictions. Although warrants require additional time for law enforcement, officers report the chemical evidence obtained from the warrant are of great value and worth the effort to obtain (Haire, Leaf, Presser, & Solomon, 2011).

1.5 Alcohol-Impaired Driving Law Review

Effectiveness: ★★	Cost: $$	Use: Low	Time: Medium

Alcohol-impaired driving laws in many States are extremely complex. They are difficult to understand, enforce, prosecute, and adjudicate, with many inconsistencies and unintended consequences. In many States, a thorough review and revision would produce a system of laws that would be far simpler and more understandable, efficient, and effective.

DWI laws have evolved over the past 30 years to incorporate new definitions of the offense of driving while impaired (illegal *per se* laws), new technology and methods for determining impairment (BAC tests, SFSTs), and new sentencing and monitoring alternatives (electronic monitoring, alcohol ignition interlocks). Many States modified their laws to incorporate these new ideas without reviewing their effect on the overall DWI control system. The result is often an inconsistent patchwork. Robertson and Simpson (2003) summarized the opinions of hundreds of law enforcement officers, prosecutors, judges, and probation officials across the country: "Professionals unanimously support the simplification and streamlining of existing DWI statutes" (p. 18). See also Hedlund and McCartt (2002).

NCUTLO has prepared a model DWI law, which has been incorporated into the Uniform Vehicle Code (NCUTLO, 2007). It addresses BAC testing, BAC test refusals, higher penalties for high-BAC drivers, ALR hearing procedures, and many other issues of current interest. States can use the NCUTLO model as a reference point in reviewing their own laws. In addition, the Traffic Injury Research Foundation has a guidebook to assist policymakers in leading a strategic review of DWI systems, with the goal of streamlining systems and closing loopholes that can be exploited by offenders (Robertson, Vanlaar, & Simpson, 2007). NHTSA also has created several guidebooks, including one to assist States in establishing an Impaired-Driving Statewide Task Force to review key legislation and improve current DWI systems (Fell & Langston, 2009), and another to assist officials and the general public in establishing a task force at a local or regional level (Fell, Fisher, & McKnight, 2011).

Use: No data are available on which States have reviewed and revised their DWI laws.

Effectiveness: To date, no studies have examined the effectiveness of law reviews in reducing alcohol-impaired crashes. The effect of a law review will depend on the extent of inconsistencies and inefficiencies in a State's current laws. A law review can be an important action a State can take to address its alcohol-impaired driving problem, because a thorough law review will examine the function of the entire DWI control system and will identify problem areas. The immediate effect of a law review should be a more efficient and effective DWI control system.

Costs: The review will require substantial staff time. Implementation costs of course will depend on the extent to which the laws are changed.

Time to implement: It can take considerable time to identify qualified stakeholders and establish a task force to conduct the law review.

2. Deterrence: Enforcement

2.1 Publicized Sobriety Checkpoint Programs

Effectiveness: ★★★★★	Cost: $$$	Use: Medium	Time: Short

At a sobriety checkpoint, law enforcement officers stop vehicles at a predetermined location to check whether the driver is impaired. They either stop every vehicle or stop vehicles at some regular interval, such as every third or tenth vehicle. The purpose of checkpoints is to deter driving after drinking by increasing the perceived risk of arrest. To do this, checkpoints should be highly visible, publicized extensively, and conducted regularly, as part of a publicized sobriety checkpoint program. Fell, Lacey, and Voas (2004) provide an overview of checkpoint operations, use, effectiveness, and issues.

Use: Sobriety checkpoints are authorized in 38 States and the District of Columbia (NHTSA, 2008e), but few States conduct them often. According to GHSA (2012b), only 13 States conduct checkpoints on a weekly basis. The main reasons checkpoints are not used more frequently are lack of law enforcement personnel and lack of funding (Fell, Ferguson, Williams, & Fields, 2003).

Effectiveness: CDC's systematic review of 11 high-quality studies found that checkpoints reduced alcohol-related fatal, injury, and property damage crashes each by about 20% (Elder et al., 2002). Similarly, a meta-analysis found that checkpoints reduce alcohol-related crashes by 17%, and all crashes by 10 to 15% (Erke, Goldenbeld, & Vaa, 2009). In recent years, NHTSA has supported a number of efforts to reduce alcohol-impaired driving using publicized sobriety checkpoints. Evaluations of statewide campaigns in Connecticut and West Virginia involving sobriety checkpoints and extensive paid media found decreases in alcohol-related fatalities following the program, as well as fewer drivers with positive BACs at roadside surveys (Zwicker, Chaudhary, Maloney, & Squeglia, 2007; Zwicker, Chaudhary, Solomon, Siegler, & Meadows, 2007). In addition, a study examining demonstration programs in 7 States found reductions in alcohol-related fatalities between 11% and 20% in States that employed numerous checkpoints or other highly visible impaired driving enforcement operations and intensive publicity of the enforcement activities, including paid advertising (Fell, Langston, Lacey, & Tippetts, 2008). States with lower levels of enforcement and publicity did not demonstrate a decrease in fatalities relative to neighboring States. See also NHTSA's Strategic Evaluation States initiative (NHTSA, 2007a; Syner et al., 2008), the *Checkpoint Strikeforce* program (Lacey et al., 2008), and the national Labor Day holiday campaign: *Drunk Driving. Over the Limit. Under Arrest* (Solomon et al., 2008).

Costs: The main costs are for law enforcement time and for publicity. A typical checkpoint using 15 or more officers can cost between $5,000 and $7,000 (Robertson & Holmes, 2011). However, law enforcement costs can be reduced by operating checkpoints with smaller teams of 3 to 5 officers (NHTSA, 2002; NHTSA, 2006b; Stuster & Blowers, 1995). Law enforcement agencies in two rural West Virginia counties were able to sustain a year-long program of weekly low-staff checkpoints. The proportion of nighttime drivers with BACs of .05 g/dL and higher was 70% lower in these counties compared to drivers in comparison counties that did not operate

additional checkpoints (Lacey, Ferguson, Kelley-Baker, & Rider, 2006). NHTSA has a guidebook available to assist law enforcement agencies in planning, operating and evaluating low-staff sobriety checkpoints (NHTSA, 2006b).

Checkpoint publicity can be costly if paid media are used, although publicity can also include earned media.

Time to implement: Sobriety checkpoints can be implemented very quickly if officers are trained in detecting impaired drivers, SFST, and checkpoint operational procedures. See NHTSA (2002) for implementation information.

Other issues:

- **Legality:** Checkpoints currently are permitted in 38 States and the District of Columbia (NHTSA, 2008e). Twelve States do not allow checkpoints, either because there is no statutory provision (AK, MS, and SC) or because checkpoints violate the State's constitution or are prohibited under State law (ID, IA, MI, MN, MT, OR, RI, TX, WA, WI, and WY). States where checkpoints are not permitted may use other enforcement strategies such as saturation patrols (see Chapter 1, Section 2.2).
- **Visibility:** Checkpoints must be highly visible and publicized extensively to be effective. Communication and enforcement plans should be coordinated. Messages should clearly and unambiguously support enforcement. Paid media may be necessary to complement news stories and other earned media, especially in a continuing checkpoint program (NCHRP, 2005, Strategy B1).
- **Arrests:** The primary purpose of publicized sobriety checkpoint programs is to deter impaired driving, not to increase arrests. However, impaired drivers detected at checkpoints should be arrested and arrests should be publicized, but arrests at checkpoints should not be used as a measure of effectiveness. The number of contacts would be a more appropriate measure. A secondary value of publicized sobriety checkpoint programs is checkpoints may also be used to check for valid driver licenses, seat belt use, outstanding warrants, stolen vehicles, and other traffic and criminal infractions.
- **Combining checkpoints with other activities:** To enhance the visibility of their law enforcement operations, some jurisdictions combine checkpoints with other activities, such as saturation patrols. For example, some law enforcement agencies conduct both checkpoints and saturation patrols during the same weekend. Others alternate checkpoints and saturation patrols on different weekends as part of a larger publicized impaired driving enforcement effort.
- **Standardized Field Sobriety Tests:** Officers have used SFSTs for more than 20 years to identify impaired drivers. The SFST is a test battery that includes the horizontal gaze nystagmus test, the walk-and-turn test, and the one-leg-stand test. Research shows the combined components of the SFST are 91% accurate in identifying drivers with BACs above the legal limit of .08 (Stuster & Burns, 1998). However, some police agencies do not require officers to receive SFST training.

2.2 Publicized Saturation Patrol Programs

Effectiveness: ★★★★	Cost: $$	Use: High	Time: Short

A saturation patrol (also called a blanket patrol, "wolf pack," or dedicated DWI patrol) consists of a large number of law enforcement officers patrolling a specific area for a set time to increase visibility of enforcement, as well as to detect and arrest impaired drivers. Like publicized sobriety checkpoint programs, the primary purpose of publicized saturation patrol programs is to deter driving after drinking by increasing the perceived risk of arrest. To do this, saturation patrols should be publicized extensively and conducted regularly, as part of a publicized saturation patrol program. A less-intensive strategy is the "roving patrol" in which individual patrol officers concentrate on detecting and arresting impaired drivers in an area where impaired driving is common or where alcohol-involved crashes have occurred (Stuster, 2000). A "how-to" guide for planning and publicizing saturation patrols and sobriety checkpoints is available from NHTSA (NHTSA, 2002).

Use: A survey conducted by The Century Council (2008) reported that 44 States used saturation patrols.

Effectiveness: A demonstration program in Michigan, where sobriety checkpoints are prohibited by State law, revealed that saturation patrols can be effective in reducing alcohol-related fatal crashes when accompanied by intensive publicity (Fell, Langston, Lacey, & Tippetts, 2008).

Costs: The main costs are for law enforcement time and for publicity. Saturation patrol operations are quite flexible in both the number of officers required and the time that each officer participates in the patrol. As with sobriety checkpoints, publicity can be costly if paid media is used.

Time to implement: Saturation patrols can be implemented within three months if officers are trained in detecting impaired drivers and in SFST. See NHTSA (2002) for implementation information.

Other issues:

- **Legality:** Saturation patrols are legal in all jurisdictions.
- **Publicity:** As with sobriety checkpoints, saturation patrols should be highly visible and publicized extensively to be effective in deterring impaired driving. Communication and enforcement plans should be coordinated. Messages should clearly and unambiguously support enforcement. Paid media may be necessary to complement news stories and other earned media, especially in a continuing saturation patrol program (NCHRP, 2005, Strategy B1).
- **Arrests:** Saturation patrols can be very effective in arresting impaired drivers. For example, law enforcement officers in Minnesota conducted 290 saturation patrols during 2006, in which they stopped 33,923 vehicles and arrested 2,796 impaired drivers (Century Council, 2008). Similar to publicized sobriety checkpoint programs, publicizd saturation patrol programs are also effective in detecting other driving and criminal offenses.

2.3 Preliminary Breath Test Devices (PBTs)

Effectiveness: ★★★★†	Cost: $$	Use: High	Time: Short

† Proven for increasing arrests

A preliminary breath test device is a small hand-held alcohol sensor used to estimate or measure a driver's BAC. Law enforcement officers use PBTs in the field to help establish evidence for a DWI arrest. The driver blows into a mouthpiece and the PBT displays either a numerical BAC level, such as .12, or a BAC range, such as a red light for BACs at or above .08.

Several PBT models are available commercially. They are quite accurate and generally reliable. For a "Conforming Products List" of alcohol testing and screening instruments, including PBTs, see www.gpo.gov/fdsys/pkg/FR-2012-06-14/pdf/2012-14581.pdf.

Use: PBTs are used in 33 States to provide evidence of alcohol use to support DWI arrests (Century Council, 2008). This evidence of alcohol use is admissible in court in approximately half the States, but in most States PBT evidence cannot be used to establish a driver's BAC. California allows officers to use PBT evidence to enforce zero-tolerance laws for drivers under the age of 21; officers at the roadside can issue a citation and seize the driver's license (Ferguson, Fields, & Voas, 2000).

Effectiveness: Law enforcement officers generally agree that PBTs are useful. Sixty-nine percent of the 2,731 law enforcement officers surveyed by Simpson and Robertson (2001) supported greater PBT availability and use. PBTs are especially valuable for two classes of drivers who may appear to perform normally on many tasks: drivers with a high tolerance to alcohol (Simpson & Robertson, 2001) and drivers under 21 who may be in violation of zero-tolerance laws (Ferguson et al., 2000). PBTs also can be useful at crash scenes where a driver is injured and unable to perform a Standardized Field Sobriety Test. There is some evidence that PBT use increases DWI arrests and reduces alcohol-involved fatal crashes (Century Council, 2008).

Costs: PBTs cost from $200 to $600 apiece. Many law enforcement departments have only a limited number of PBTs and many patrol officers do not have regular access to them. Officers surveyed by Simpson and Robertson (2001) estimated that three-fourths of all DWI arrests occur on routine patrols, so DWI detection would be substantially improved if every patrol officer had a PBT.

Time to implement: PBTs can be used as soon as they are purchased and officers are trained in their use and maintenance. PBT instruments must have regular calibration checks. Most law enforcement agencies have the facilities to conduct these checks.

Other issues:

- **The "one test" rule:** Some State statutes allow only one chemical BAC test to be taken from a driver arrested for DWI. These States do not use PBTs because an evidential BAC test cannot be requested if an officer previously has taken a PBT test in the field.
- **Other drugs:** A PBT will not detect the presence of drugs other than alcohol.

2.4 Passive Alcohol Sensors (PAS)

Effectiveness: ★★★★†	Cost: $$	Use: Unknown	Time: Short

† Proven for detecting impaired drivers

A passive alcohol sensor is a device to detect alcohol presence in the air. The sensor usually is integrated into a flashlight or clipboard. Officers hold the flashlight or clipboard near the driver's mouth, where it measures alcohol presence in the air where the driver is breathing. The PAS can be used without the driver's knowledge and without any probable cause because the PAS is considered "an extension of the officer's nose" and records information that is "in plain view" (Preusser, 2000).

Several PAS models are available commercially. They generally are reliable and effective at detecting alcohol in the surrounding air. In one study, both breath samples and PAS measures were obtained from over 12,000 drivers. Results showed that PAS scores were a strong predictor of a driver's BAC status, leading to the conclusion that "the PAS can be an effective tool for officers when deciding whether to initiate a DWI investigation" (Voas, Romano, & Peck, 2006). NHTSA does not maintain a list of PAS models.

Use: PAS units typically are used at the vehicle window after a traffic stop or at a checkpoint. A PAS report of alcohol presence gives the officer probable cause to request further examination with SFSTs or a PBT device. No data are available on how many PAS units are in use.

Effectiveness: The PAS is especially effective at checkpoints, where officers must screen drivers quickly with little or no opportunity to observe the drivers on the road. Evaluations show that officers using a PAS at checkpoints can detect 50% more drivers at BACs of .10 and above than officers not using a PAS (Century Council, 2008; Farmer, Wells, Ferguson, & Voas, 1999; Fell et al., 2004; Voas, 2008). The PAS appears to be especially effective in assisting officers who rarely make arrests for DWI (Fell, Compton, & Voas, 2008).

Costs: PAS units cost from $300 to $700 apiece.

Time to implement: PAS units can be used as soon as they are purchased and officers are trained in their use and maintenance. Training can usually be accomplished quickly.

Other issues:

- **Acceptance by law enforcement:** Officers tend to dislike using the PAS. Common reasons given by officers for not using PAS units are that they require them to be closer to the drivers than they wish to be, they require some portion of officers' attention at a time when they may have other things to be concerned about (including personal safety), or they may keep officers from having a hand free. Other officers believe they can detect the odor of alcohol accurately without assistance from PAS devices (Preusser, 2000).
- **Other drugs:** As with a PBT, a PAS will not detect the presence of drugs other than alcohol.

2.5 Integrated Enforcement

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

Impaired drivers are detected and arrested through regular traffic enforcement and crash investigations as well as through special impaired driving checkpoints and saturation patrols. A third opportunity is to integrate impaired-driving enforcement into special enforcement activities directed primarily at other offenses such as speeding or seat belt nonuse, especially since impaired drivers often speed or fail to wear seat belts. (Such operations can be particularly effective when conducted at night.)

Use: There are no data on how frequently integrated enforcement methods are used.

Effectiveness: Jones, Joksch, Lacey, Wiliszowski, and Marchetti (1995) evaluated a three-site evaluation of integrated impaired driving, speed, and seat belt use enforcement. Sites that combined high publicity with increased enforcement reduced crashes likely to involve alcohol (such as single-vehicle nighttime crashes) by 10% to 35%. They concluded that the results were encouraging but not definitive. The *Massachusetts Saving Lives* comprehensive programs in six communities used integrated enforcement methods. The programs reduced fatal crashes involving alcohol by 42% (Hingson et al., 1996). About half the speeding drivers detected through these enforcement activities had been drinking and about half the impaired drivers were speeding. See also Voas and Lacey (2011), NCHRP (2005, Strategy B2), and Stuster (2000).

Costs: As with other enforcement strategies, the primary costs are for law enforcement time and for publicity.

Time to implement: Impaired driving can be integrated into other enforcement activities within three months if officers are trained in detecting impaired drivers and in SFST.

Other issues:

- **Publicity:** Integrated enforcement activities should be publicized extensively to be effective in deterring impaired driving and other traffic offenses. Paid media may be necessary to complement news stories and other earned media, especially in an ongoing program (NCHRP, 2005, Strategy B2).
- **Priorities:** Integrated enforcement activities send a message to the public and to law enforcement officers alike that traffic safety is not a single-issue activity.
- **Citizen reporting programs:** Six States have dedicated programs where drivers with cell phones can dial a special number to report suspected impaired drivers (Fiorentino, Cure, & Kipper, 2007). Such programs can generate support for law enforcement efforts and increase the perception in the community that impaired drivers will be caught. A study of a grassroots DWI witness reward program in Stockton, California, found a significant decrease in alcohol-related injury/fatality crashes following the program, relative to six comparison communities (Van Vleck & Brinkley, 2009). However, other studies of citizen reporting programs have been inconclusive (e.g., Kelley-Baker et al., 2006).

3. Deterrence: Prosecution and Adjudication

3.1 DWI Courts

Effectiveness: ★★★★†	Cost: $$$	Use: Low	Time: Medium

† Proven for reducing recidivism

A dedicated DWI court provides a systematic and coordinated approach to prosecuting, sentencing, monitoring, and treating DWI offenders. A DWI court's underlying goal is to change offenders' behavior by identifying and treating their alcohol problems and by holding offenders accountable for their actions.

Prosecutors and judges in DWI courts specialize in DWI cases. Probation officers monitor offenders closely and report any probation infraction to the judge immediately for prompt action. Restrictions and monitoring are gradually relaxed as offenders demonstrate responsible behavior. DWI courts follow the model established by almost 2,500 drug courts around the Nation (Huddleston, Marlowe, & Casebolt, 2008; NADCP, 2009; NCHRP, 2005, Strategy D3). See Brunson and Knighten (2005), Practice #1, for a comprehensive overview of DWI courts.

A DWI court can reduce recidivism because judge, prosecutor, probation staff, and treatment staff work together as a team to assure that alcohol treatment and other sentencing requirements are satisfied for offenders on an individual basis. A key feature of a DWI court is that the team meets regularly, giving all parties an opportunity to discuss the status of a case. Judges can then immediately revise restrictions, if appropriate. DWI courts can be more efficient and effective than regular courts because judges and prosecutors closely supervise the offenders and are familiar with the complex DWI laws, evidentiary issues, sentencing options, and the offenders. NHTSA (2003) describes the operation of a DWI court in Albuquerque, New Mexico.

Use: As of June 2012, NDCI reported 208 designated DWI courts in 33 States. In addition, there were 401 hybrid DWI/drug courts, which are drug courts that also take DWI offenders. DWI courts have been growing rapidly – 29 new DWI courts were added in 2011 alone.

Effectiveness: A number of individual program evaluations show that DWI courts can be successful. Low DWI recidivism rates have been found for graduates of DWI courts in Athens (Georgia), Maricopa County (Arizona), Los Angeles County (California), and elsewhere (Marlowe et al., 2009). One study in Michigan found that DWI court participants were 19 times *less* likely to be rearrested for DWI within two years than a comparison group of offenders who were in traditional probation (Michigan Supreme Court & NPC Research, 2008). Another study of three DWI courts in Georgia found that offenders who graduated from the court program had a 9% recidivism rate within the next 4 years, compared to a 24% recidivism rate for a comparison group of offenders processed in traditional courts (Fell, Tippetts, & Langston, 2011).

Evaluations have shown that close monitoring and individualized sanctions for DWI offenders reduce recidivism (see Chapter 1, Section 4.4). When these are incorporated within a comprehensive DWI court program, their effect is likely to be even greater.

Costs: DWI court costs are difficult to estimate and compare with regular courts. Costs may be greater because more probation officers will be needed to reduce caseloads and to provide close monitoring, and because judges must allocate time to meet regularly with probationers and to deal with any probation violations. However, total time offenders spend in jail is reduced, thus saving the justice system time and money (Michigan Supreme Court & NPC Research, 2008). Moreover, DWI courts may reduce long-term system costs substantially if they decrease DWI recidivism as expected. According to one estimate, for every dollar invested in drug courts, taxpayers save up to $3.36 (NADCP, 2009).

Time to implement: DWI courts can be implemented 4 to 6 months after the participating organizations agree on the program structure if enough trained prosecutors, judges, probation officers, and treatment providers are available. Otherwise, planning and implementation may require a year or more.

Other issues:

- **Traffic Safety Resource Prosecutors and Judicial Outreach Liaisons:** DWI cases can be highly complex and difficult to prosecute, yet they are often assigned to the least experienced prosecutors. In one survey, about half of prosecutors and judges said the training and education they received prior to assuming their position was inadequate for preparing them to prosecute and preside over DWI cases (Robertson & Simpson, 2002a). Traffic Safety Resource Prosecutors (TSRPs) are current (or former) prosecutors who specialize in the prosecution of traffic crimes, and DWI cases in particular. They provide training, education, and technical support to other prosecutors and law enforcement agencies within their State. Judicial Outreach Liaisons (JOLs) are current (or former) judges who are experienced in handling DWI cases. Many JOLs have presided over DWI or Drug courts. They share information and provide education to judges and other court personnel about DWI cases. NHTSA has developed a manual to assist new TSRPs (NHTSA, 2007b) and is in the process of developing one for JOLs.

3.2 Limits on Diversion and Plea Agreements

Effectiveness: ★★★★†	Cost: $	Use: Medium	Time: Short

† Proven for increasing convictions

Diversion programs defer sentencing while a DWI offender participates in some form of alcohol education or treatment. In many States, charges are dropped or the offender's DWI record is erased if the education or treatment is completed satisfactorily.

A survey of prosecutors found that of defendants who plead guilty, 67% negotiated a plea agreement resulting in a reduced penalty (Robertson & Simpson, 2002a). Negotiated plea agreements are a necessary part of efficient and effective DWI prosecution and adjudication. However, plea agreements in some States allow offenders to eliminate any record of a DWI offense and to have their penalties reduced or eliminated.

Effective DWI control systems can use a variety of adjudication and sanction methods and requirements. The key feature is that an alcohol-related offense must be retained on the offender's record (Hedlund & McCartt, 2002; NCHRP, 2005; NTSB, 2000; Robertson & Simpson, 2002a). Otherwise, offenders who recidivate will receive less severe penalties than if the original charge had been retained on their record.

Use: As of 2006, 33 States provided for diversion programs in State law or statewide practice, and local courts and judges in some additional States also offer diversion programs (NHTSA 2006c). The Century Council (2008) documented diversion programs restrictions in several States. As of 2010, 12 States had anti-plea-bargaining Statutes limiting plea agreements in certain cases (NHTSA, 2011b).

Effectiveness: The evidence for the effectiveness of diversion programs has been mixed (Voas & Fisher, 2001). Although a few studies have shown diversion programs reduce recidivism, others have shown no benefits. However, there is substantial anecdotal evidence that diversion programs, by eliminating the offense from the offender's record, allow repeat offenders to avoid being identified (Hedlund & McCartt, 2002). Eliminating or establishing limits on diversion programs should remove a major loophole in the DWI control system.

Wagenaar et al. (2000) reviewed 52 studies of plea agreement restrictions applied in combination with other DWI control policies and found they reduced various outcome measures by an average of 11%. However, the effects of plea agreement restrictions by themselves cannot be determined in these studies. The only direct study of plea agreement restrictions was completed over 20 years ago (NHTSA, 1989; NTSB, 2000). It found that plea agreement restrictions reduced recidivism in all three study communities.

Costs: Costs for eliminating/limiting diversion programs can be determined by comparing the per-offender costs of the diversion program and the non-diversion sanctions. Similarly, costs for restricting plea agreements will depend on the relative costs of sanctions with and without the plea agreement restrictions. In addition, if plea agreements are restricted, some charges may be dismissed or some offenders may request a full trial, resulting in significant costs.

Time to implement: Eliminating/limiting diversion programs and restricting plea agreements statewide may require changes to a State's DWI laws. Once legislation is enacted, policies and practices can be changed within three months. Individual prosecutor offices and courts also can change local policies and practices without statewide legislation.

3.3 Court Monitoring

Effectiveness: ★★★★†	Cost: $	Use: Low	Time: Short

† Proven for increasing convictions

In court monitoring programs, citizens observe, track, and report on DWI court or administrative hearing activities. Court monitoring provides data on how many cases are dismissed or pled down to lesser offenses, how many result in convictions, what sanctions are imposed, and how these results compare across different judges and different courts. Court monitoring programs usually are operated and funded by citizen organizations such as MADD, although Mississippi has funded a statewide court monitor (Century Council, 2008).

Use: As of 2006, court monitoring programs were active in at least 13 States (Syner, 2006). It is generally believed that court monitoring has decreased substantially since the mid-1980s, when Probst, Lewis, Asunka, Hershey, and Oram (1987) identified over 300 programs in the United States.

Effectiveness: Shinar (1992) found that court-monitored cases in Maine produced higher conviction rates and stiffer sentences than unmonitored cases. Probst et al. (1987) found that judges, prosecutors, and other officials in 51 communities believed that court monitoring programs helped increase DWI arrests, decrease plea agreements, and increase guilty pleas.

Costs: The main requirement for a court monitoring program is a reliable supply of monitors. Monitors typically are unpaid volunteers from MADD, RID, or a similar organization. Modest funds are needed to establish and maintain court monitoring records and to publicize the results.

Time to implement: Court monitoring programs can be implemented very quickly if volunteer monitors are available. A few weeks will be required to set up the program and train monitors.

3.4 Sanctions

Effectiveness: ★★	Cost: Varies	Use: Varies	Time: Varies

The standard court sanctions for DWI offenses are driver's license suspension or revocation, fines, jail, and community service. All States use some combination of these sanctions. Details of each State's laws may be found in NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2011b). Some States set mandatory minimum levels for some sanctions, which often increase for second and subsequent offenders.

DWI offenders also may have their driver's licenses revoked or suspended administratively and may have sanctions imposed on their vehicles or license plates. See Chapter 1, Section 1.1, Administrative License Revocation or Suspension, and Chapter 1, Section 4.3, Vehicle and License Plate Sanctions, for discussions of these sanctions. See also NHTSA's *Guide to Sentencing DWI Offenders* (NHTSA, 2006d) for an overview of sanctions and sentencing practices for judges and prosecutors, with extensive references. The *Guide* also includes screening and brief intervention, alcohol treatment, and DWI courts.

License suspension or revocation: All States allow post-conviction license actions. As of 2010, 30 States set mandatory minimum lengths for first offenders (NHTSA, 2011b). This suspension or revocation typically runs concurrently with any administrative license action. In most States, offenders may obtain an occupational or hardship license during part or all of the revocation or suspension period.

Although *administrative* license actions are highly effective in reducing crashes (see Chapter 1, Section 1.1), *court-imposed* license actions appear less effective. A study of 46 States found that post-conviction license suspension had no discernible effects on alcohol-related fatal crashes (Wagenaar & Maldonado-Molina, 2007). As discussed in Chapter 1, Section 1.1, some DWI offenders continue to drive with a suspended or revoked license, and many DWI offenders do not reinstate their license when they are eligible to do so. Consequently, long court-imposed license actions may do little to reduce recidivism. Instead, it may be important to encourage DWI offenders to reinstate their licenses, but with appropriate controls such as ignition interlocks (Section 4.2) and close monitoring (Section 4.4).

Fines: Most States impose fines on DWI offenders. As of 2010, 25 States had mandatory minimum fines for first offenders, typically ranging from $250 to $500 (NHTSA, 2011b). In addition to fines, offenders often face substantial costs for license reinstatement, mandated alcohol education or treatment, insurance rate increases, and legal fees. Available evidence suggests that fines appear to have little effect on reducing alcohol-impaired driving. For example, Wagenaar et al. (2008) examined alcohol-related fatal crashes across 32 States and concluded that mandatory fines "do not have clearly demonstrable general deterrent or preventive effects" (p. 992). Another study from Australia found the size of fines was unrelated to recidivism rates among DWI offenders (Weatherburn & Moffatt, 2011). Even though fines may not reduce alcohol-impaired driving, they do help support the system financially.

Jail: All States allow some DWI offenders to be sentenced to jail. As of 2010, 21 States required some jail time for first offenders, though 11 of these States allow community service in lieu of jail. Forty-nine States require jail for third offenders, though even these offenders can substitute community service in 9 States (NHTSA, 2011b).

Jail is the most severe and most contentious of the DWI sanctions. Jail is expensive: estimated to be $20,267 in Ohio per inmate per year, for example (Century Council, 2008). Judges and prosecutors may be reluctant to use limited jail space for DWI offenders rather than "real" criminals. Offenses with mandatory jail terms may be pled down, or judges simply may ignore the mandatory jail requirement (Robertson & Simpson, 2002b).

Research on the effectiveness of jail is equivocal at best (Voas & Lacey, 2011, pp. 215-216; NTSB, 2000). Very short (48-hour) jail sentences for first offenders may be effective (NTSB, 2000) and the threat of jail may be effective as a deterrent (as is done in DWI and Drug Courts), but other jail policies appear to have little effect. Wagenaar et al. (2000) reviewed 18 studies and concluded: "The balance of the evidence clearly suggests the ineffectiveness of mandatory jail sentence policies" (p. 12). In fact, they find "numerous studies that indicate that [mandatory jail] might be a counterproductive policy" (p. 12) that increases alcohol-related crashes.

Community service: Many States allow community service as part of a DWI offender's sentence and 11 States allow community service in lieu of mandatory jail for first-time offenders (NHTSA, 2011b). Community service can provide benefits to society if offenders perform useful work, but even if appropriate jobs can be found there are costs for program operation, offender supervision, and liability. The effects of community service programs on alcohol-impaired driving have not been evaluated (Century Council, 2008).

Victim Impact Panels: DWI offenders are often required to attend a Victim Impact Panel, in which offenders hear from individuals whose lives have been permanently altered by an impaired driver. Each year, an estimated 400,000 offenders attend Victim Impact Panels, conducted by more than 200 MADD chapters across the U.S. (Voas & Lacey, 2011). Although Victim Impact Panels are intuitively appealing, most studies suggest they do not reduce recidivism (Crew & Johnson, 2011; deBaca, Lapham, Liang, & Skipper, 2001; Shinar & Compton, 1995; Wheeler, Rogers, Tonigan, & Woodall, 2004).

4. Deterrence: DWI Offender Treatment, Monitoring, and Control

4.1 Alcohol Problem Assessment and Treatment

Effectiveness: ★★★★★	Cost: Varies	Use: High	Time: Varies

It is widely recognized that many DWI first offenders and most repeat offenders are dependent on alcohol or have alcohol use problems. They likely will continue to drink and drive unless their alcohol problems are addressed. A DWI arrest provides an opportunity to identify offenders with alcohol problems and to refer them to treatment as appropriate. However, treatment should not be provided in lieu of other sanctions or as part of a plea bargain or diversion program that eliminates the record of a DWI offense (see Chapter 1, Section 3.2).

Alcohol problem assessment can take many forms, from a brief paper-and-pencil questionnaire to a detailed interview with a treatment professional. Alcohol treatment can be even more varied, ranging from classroom alcohol education programs to long-term inpatient facilities. For brief overviews of alcohol assessment and treatment programs and further references see Century Council (2008), Dill and Wells-Parker (2006), Voas and Lacey (2011), NCHRP (2005, Strategy C4), and Robertson, Simpson, and Parsons (2008).

Use: All States have provisions under State law for alcohol treatment (NHTSA, 2011b). However, the nature of the treatment – and to whom it applies – varies greatly. Some States mandate treatment, especially for repeat offenders, but usually treatment is at the court's discretion.

Effectiveness: Even the best of the many assessment instruments currently in use is subject to error. Chang, Gregory, and Lapham (2002) found that none correctly identified more than 70% of offenders who were likely to recidivate. However, the assessment process itself can have therapeutic benefits. See Chapter 1, Section 5.1 on alcohol screening and brief interventions.

Wells-Parker, Bangert-Drowns, McMillan, and Williams (1995) reviewed the studies evaluating treatment effectiveness. They found that, on average, treatment reduced DWI recidivism and alcohol-related crashes by 7 to 9%. Treatment appears to be most effective when combined with other sanctions and when offenders are monitored closely to assure that both treatment and sanction requirements are met (Century Council, 2008; Dill & Wells-Parker, 2006).

Costs: Treatment expenses vary widely depending on program type. However, several studies suggest alcohol abuse treatment can be cost effective. For example, a study from California found every dollar spent on treatment potentially saved taxpayers up to $7 (Gerstein et al., 1994). Offenders can bear some of the costs of both assessment and treatment, though provisions must be made for indigent offenders.

Time to implement: Implementation time also varies depending on program type. The simplest can be implemented in several months, while others may take years.

Other issues:

- **Treatment options:** There are many effective treatment options for alcohol problems including cognitive-behavioral therapy, group counseling, pharmacological interventions (e.g., naltrexone, acamprosate), and brief interventions (see Chapter 1, Section 5.1). It is important that treatment be tailored to the individual. Also, combining therapies can result in better outcomes because DWI offenders usually have a range of diverse and complex problems (Dill & Wells-Parker, 2006).
- **DWI Courts:** Alcohol problem assessment and treatment are an integral part of DWI courts. In addition, a DWI court can sanction offenders who fail to complete assigned treatment programs. See Chapter 1, Section 3.1.
- **Other mental health issues:** Alcohol assessment and treatment provide an opportunity to address other problems that may underlie or contribute to problems with alcohol. One study found that more than 60% of DWI repeat offenders have experienced other psychiatric disorders in addition to alcohol-related problems, such as post-traumatic stress disorder, anxiety disorders, and bipolar disorder (Shaffer et al., 2007). This is substantially higher than the rate of about 30% for the general population.

4.2 Alcohol Interlocks

Effectiveness: ★★★★★†	Cost: $$	Use: Medium	Time: Medium

† Proven for reducing recidivism

An alcohol ignition interlock prevents a vehicle from starting unless the driver provides a breath sample with a BAC lower than a pre-set level, usually .02. Interlocks typically are used as a condition of probation for DWI offenders, to prevent them from driving while impaired by alcohol after their driver's licenses have been reinstated.

Interlocks are highly effective in allowing a vehicle to be started by sober drivers but not by alcohol-impaired drivers. A post-start retest requires the driver to remain sober while driving. A data recorder logs the driver's BAC at each test and can be used by probation officers to monitor the offender's drinking and driving behavior. Marques and Voas (2010) provide an overview of interlock use, effectiveness, operational considerations, and program management issues. Marques (2005), Beirness and Robertson (2005), and Robertson, Vanlaar, and Beirness (2006) summarize interlock programs in the United States and other countries and discuss typical problems and solutions. See also Brunson and Knighten (2005), Practice #5, NCHRP (2003, Strategy C2), and papers from the 11th Annual International Alcohol Interlock Symposium (TIRF, 2011). NHTSA offers an ignition interlock toolkit to assist policymakers, highway safety professions, and advocates (Sprattler, 2009). In addition, NHTSA has published a report, Case Studies of Ignition Interlock Programs, featuring State ignition interlock programs (Fieldler, Brittle, & Stafford, 2012). TIRF offers an alcohol interlock curriculum for practitioners (TIRF, 2010).

Use: All 50 States and the District of Columbia allow interlocks to be used for some DWI offenders (IIHS, 2012). In 14 States interlocks are mandatory for all convicted offenders, including first offenders (NCSL, 2012b). Connecticut, Kansas, and Missouri became the most recent States to pass such requirements. In addition, a pilot program in 4 California counties (including Los Angeles) requires all convicted offenders to install interlocks. In total, nearly 30 States considered legislation pertaining to interlocks in 2011 (NCSL, 2012a).

Despite widespread laws, a relatively small percentage of eligible offenders have an interlock installed. However, interlock use has more than doubled in the past 5 years, from 101,000 in 2006 to 279,000 in 2012 (Roth, 2012). Use of interlocks is substantially higher when they are required as a prerequisite to license reinstatement. For example, among DWI offenders in Florida who were subject to the State's interlock requirement, 93% installed interlocks once they qualified for reinstatement (Voas, Tippetts, Fisher, & Grosz, 2010). Use of interlocks is also higher when interlocks are offered as an alternative to home confinement via electronic monitoring (Roth, Marques, & Voas, 2009). Through a combination of these measures, New Mexico currently installs interlocks in the vehicles of half of all convicted DWI offenders – the highest level of penetration of any State (Marques, Voas, Roth, & Tippetts, 2010).

Effectiveness: A review of 15 studies of interlock effectiveness found that offenders who had interlocks installed in their vehicles had recidivism rates that were 75% lower than drivers who did not have interlocks installed (Elder et al., 2011). Findings were similar for first offenders and

repeat offenders. After interlocks were removed, however, the effects largely disappeared, with interlock and comparison drivers having similar recidivism rates. Although only three studies have examined the effects of interlocks on crashes, the limited evidence suggests that alcohol-related crashes decrease while interlocks are installed in vehicles (Elder et al., 2011). One limitation of interlock research is that study participants often are not randomly assigned to interlock or no-interlock groups, so there may be important pre-existing differences between groups. However, the preponderance of evidence suggests that interlocks are a highly effective method for preventing alcohol-impaired driving – and possibly crashes – while they are installed.

Costs: Presently, offenders pay approximately $65 to $90 per month for interlocks, not including installation fees which can range from $100 to $250 (Marques & Voas, 2010). Offenders usually pay these costs; however, some States, such as Illinois and New Mexico, have indigent funds to reduce the costs for low income offenders.

Time to implement: Interlock programs may require enabling legislation. Once authorized, interlock programs require 4 to 6 months to implement a network of interlock providers.

Other issues:

- **Barriers to use:** Interlocks have demonstrated their effectiveness in controlling impaired driving while they are installed. In light of this success, their limited use may be due to several factors, such as lengthy license suspension periods, offenders who delay license reinstatement, judges who lack confidence in the interlock technology or who fail to enforce "mandatory" interlock requirements, interlock costs, and localities that lack enough interlock providers. In an effort to increase the number of offenders who drive interlock-equipped vehicles, some States have made the alternatives to interlocks more undesirable. For example, pilot programs in Indiana and New Mexico found that roughly two-thirds of offenders chose to have interlocks installed when the alternative was house arrest with electronic monitoring (Marques et al., 2010; Voas, Blackman, Tippetts, & Marques, 2001). Other States allow offenders to shorten (or eliminate) the license suspension period if they are willing to operate an interlock-installed vehicle. For a discussion of barriers to interlock use, see Beirness and Marques (2004), Beirness, Clayton, and Vanlaar (2008), Beirness and Robertson (2005), and NCHRP (2003, Strategy C2).
- **Compliance with interlocks:** Some offenders have relatively high rates of breath test failures and other violations, typically near the beginning of their participation in an interlock program (Vanlaar, Robertson, Schaap, & Vissers, 2010). Offenders are becoming familiar with the equipment, and in some cases may be testing the limits of the devices. Presently, few jurisdictions use the compliance data collected by interlocks to identify offenders who may be at high risk for recidivism. The data could also be used to require an extension of the interlock period for those with poor compliance, or even to inform treatment options (Marques et al., 2010). To improve compliance with interlocks, it is important to closely monitor offenders during their participation in an interlock program. One study found that offenders who were closely monitored (e.g., their data was reviewed weekly and they received letters documenting their progress) had fewer initial breath test failures and other indicators of non-compliance than offenders who

received standard monitoring through the State licensing office (Zador, Ahlin, Rauch, Howard, & Duncan, 2011).

- **First-time offenders:** There are special issues concerning interlocks and first-time offenders. In many States, first offenders are not monitored by the criminal justice system. Consequently, it can be difficult to respond to violations and to ensure that first-time offenders complete the interlock program. Despite challenges in closely monitoring first-time offenders, evidence suggests interlocks effectively reduce recidivism among this group while the interlock is installed (Marques et al., 2010; McCartt, Leaf, Farmer, & Eichelberger, 2012). For more information about issues in implementing interlock programs with first-time offenders, see Robertson, Homes, and Vanlaar (2010).
- **Public support:** There is strong support for ignition interlocks among the general public. In a national survey, 84% of respondents approved of requiring interlocks in the vehicles of convicted DWI offenders (McCartt, Wells, & Teoh, 2010). Moreover, almost two-thirds (64%) of respondents favored having alcohol detection technology in *all* vehicles. The general public also believes strongly that interlocks work. In a NHTSA survey, respondents were asked about the effectiveness of eight strategies to reduce or prevent impaired driving. Interlocks ranked highest in the percentage who rated the strategy "very effective" (63%) (Moulton et al., 2010).

4.3 Vehicle and License Plate Sanctions

Effectiveness: ★★★★†	Cost: Varies	Use: Medium	Time: Short

† Proven for reducing recidivism

In recent years many States have implemented sanctions affecting a DWI offender's license plate or vehicle. These sanctions are intended to prevent the offender from driving the vehicle while the sanctions are in effect, and also to deter impaired driving by the general public. Vehicle and plate sanctions include:

- Special license plates for drivers whose licenses have been revoked or suspended. The plates allow family members and other people to drive the offender's vehicle but permit law enforcement to stop the vehicle to verify that the driver is properly licensed.
- License plate impoundment. Officers seize and impound or destroy the license plate.
- Vehicle immobilization. Vehicles are immobilized on the offender's property with a "boot" or "club."
- Vehicle impoundment. Vehicles are stored in a public impound lot.
- Vehicle forfeiture. Vehicles are confiscated and sold at auction.

NHTSA (2008f) and Voas, Fell, McKnight, and Sweedler (2004) give an overview of vehicle and license plate sanctions and are the basic references for the information provided below. See also Brunson and Knighten (2005), Practice #4, and NCHRP (2003), Strategies B1, B2, and C1. All vehicle and license plate sanctions require at least several months to implement.

Use, effectiveness, and costs:

- Special license plates: Permitted in Georgia, Hawaii, Michigan, Minnesota, New Jersey, and Ohio (Voas, McKnight, Falb, & Fell, 2008). Ohio requires special plates for all first-time offenders with a BAC of .17 and above and for all repeat offenders. Effectiveness and costs have not been evaluated in any State. In the 1990s Oregon and Washington adopted a version of this strategy by allowing arresting officers to place a "zebra stripe" sticker on the license plate at the time of arrest. Oregon's program proved effective in reducing DWI recidivism but Washington's did not. Use has been discontinued in both States (NCHRP, 2003, Strategy B1; NHTSA 2008f).
- License plate impoundment: Used in 17 States (McKnight, Watson, Voas, & Fell, 2008). In Minnesota, license plate impoundment administered by the arresting officer was shown to reduce both recidivism and driving with a suspended license, especially among the youngest offenders (Leaf & Preusser, 2011; Rogers, 1995). Since plate impoundment does not involve the courts, it occurs quickly, consistently, and efficiently (NCHRP, 2003, Strategy B2; NHTSA, 2008f; NTSB, 2000). Fourteen States allow for impounding a vehicle's registration (McKnight et al., 2008).
- Vehicle immobilization: Laws in 16 States allow vehicle immobilization (Voas et al., 2008). An evaluation in Ohio found that immobilization reduced recidivism (Voas, Tippetts, & Taylor, 1998). Costs are minimal compared to impoundment or forfeiture (NCHRP, 2003, Strategy C1; NTSB, 2000).
- Vehicle impoundment: 27 States and the District of Columbia allow for vehicle impoundment and some use it extensively (Voas et al., 2008). Vehicle impoundment reduces recidivism while the vehicle is in custody and to a lesser extent after the vehicle

has been released. The strategy is costly, as storage fees can be $20 daily and owners may abandon low-value vehicles rather than pay substantial storage costs (NCHRP, 2003, Strategy C1; NTSB, 2000). In California, impoundment programs are administered largely by towing contractors and supported by fees paid when drivers reclaim their vehicles or by the sale of unclaimed vehicles. An evaluation of California's impoundment law found both first-time and repeat offenders whose vehicles were impounded had fewer subsequent arrests for driving with a suspended license and fewer crashes (De Young, 1997).

- Vehicle forfeiture: Thirty-five States have provisions allowing vehicle forfeiture for impaired driving and/or driving with a suspended license (Voas et al., 2008); however, there is little information on its use or effectiveness. Vehicle forfeiture programs must pay storage costs until the vehicles are sold or otherwise disposed (NCHRP, 2003, Strategy C1; NTSB, 2000).

Other issues:

- **To whom are vehicle sanctions applied:** Most vehicle sanctions have been applied to repeat offenders rather than first offenders, although some States also apply vehicle sanctions to high-BAC first offenders (e.g., a BAC of .15 or higher). If someone other than the offender owns the vehicle, the vehicle owner should be required to sign an affidavit stating they will not allow the offender to drive the vehicle while the suspension is in effect (NHTSA, 2008f).
- **Administrative issues:** All license plate and vehicle sanctions require an administrative structure to process the license plates or vehicles. Laws should permit officers to impound vehicles or license plates at the time of arrest so offenders do not have the opportunity to transfer vehicle ownership (NHTSA, 2008f).

4.4 DWI Offender Monitoring

Effectiveness: ★★★★†	Cost: $$$	Use: Unknown	Time: Varies

† Proven for reducing recidivism

The most successful methods for controlling convicted DWI offenders and reducing recidivism have the common feature that they monitor offenders closely. Close monitoring can be accomplished at various levels and in various ways, including a formal intensive supervision program, home confinement with electronic monitoring, and dedicated detention facilities. South Dakota's 24/7 Sobriety Project is one example of an intensive supervision program. Participants are multiple offenders who are required to use no alcohol or drugs as a condition of remaining in the community and avoiding incarceration. The program includes daily breath testing, SCRAM ankle bracelets that monitor for alcohol consumption, and random drug testing. If an offender tests positive for alcohol or drugs, they are taken into custody and appear before a judge within 24 hours. The goal of the program is to ensure that sanctions are swift and certain.

For overviews of DWI offender monitoring and further references, see Century Council (2008) and NCHRP (2005, Strategy D4). See also Wiliszowski, Fell, McKnight, and Tippetts (2011) for more information about intensive supervision programs and descriptions of eight different programs (including South Dakota's 24/7 Sobriety Project). DWI courts and alcohol ignition interlocks, which are discussed in Chapter 1, Sections 3.1 and 4.2, also assist in monitoring offenders closely. Guidelines for community supervision of DWI offenders are available from NHTSA (Dunlap, Mullins, & Stein, 2008).

Use: There are no data showing how extensively these programs are used.

Effectiveness: Intensive supervision programs, home confinement with electronic monitoring, and dedicated detention facilities all have been evaluated in individual settings and show substantial reductions in DWI recidivism. Recidivism was reduced by one-half in an intensive supervision program in Oregon (Lapham, Kapitula, C'de Baca, & McMillan, 2006) and by one-third in an electronic monitoring program in Los Angeles County, California (Brunson & Knighten, 2005; Jones, Wiliszowski, & Lacey, 1996). A dedicated detention facility in Baltimore County had a 4% recidivism rate one year after program completion, compared to a normal recidivism rate of 35% for offenders (Century Council, 2008).

Costs: All close monitoring programs are more expensive than the standard high-caseload and low-contact probation but less expensive than jail. Electronic monitoring fees typically range from $3 to $15 per day (NCHRP, 2005, Strategy D3). New Mexico estimated that intensive supervision costs $2,500 per offender per year compared to $27,500 per offender per year for jail (Century Council, 2008). Dedicated detention facility costs can approach jail costs: $37 per day in the Baltimore County dedicated detention facility compared to $45 per day for jail (Century Council, 2008). Offenders can bear some program costs, especially for the less expensive alternatives (Century Council, 2008).

Time to implement: All close monitoring programs require many months to plan and implement. Dedicated facilities require years to plan and build.

4.5 Lower BAC Limits for Repeat Offenders

Effectiveness: ★★★★	Cost: $	Use: Low	Time: Short

All States now have an illegal *per se* BAC limit of .08. All States also have a BAC limit of .02 or lower for drivers under the age of 21. These laws reinforce the minimum drinking age 21 laws in all States that prohibit people under 21 from purchasing or possessing alcohol in public. As of 2001, 5 States also lowered the BAC limit for people convicted of DWI, to emphasize that they should not be driving after drinking even moderate amounts (Jones & Rodriguez-Iglesias, 2004).

Use: It is currently not known how many States have established lower BAC limits for drivers with one or more DWI offenses.

Effectiveness: In 1988, Maine established a .05 g/dL BAC limit for 1 year after a first DWI offense and for 10 years after a subsequent offense. Violators received an administrative license suspension. In 1995, this BAC limit was lowered to .00. Hingson, Heeren, and Winter (1998) evaluated the 1988 law and concluded that it reduced the proportion of repeat offender drivers in fatal crashes by 25%. Jones and Rodriguez-Iglesias (2004) evaluated the overall effects of both laws, using data from 1988-2001. They also concluded that the laws contributed to a reduction in the proportion of repeat offenders in fatal crashes, primarily due to a reduction in drivers at BACs of .10 and higher.

Costs: Implementation and operation costs are minimal. Jones and Rodriguez-Iglesias (2004) found that Maine's laws had little or no effect on the operations of the DWI control system.

Time to implement: Lower BAC limit laws can be implemented as soon as legislation is enacted.

5. Prevention, Intervention, Communications, and Outreach

Prevention and intervention.

Prevention and intervention strategies seek to reduce drinking, or to prevent driving by people who have been drinking. Prevention and intervention work through laws, policies, and programs that:

- control hours, locations, and promotions of alcohol sales;
- implement responsible alcohol service practices;
- control alcohol purchase and use through increased alcohol taxes and restrictions on consumption in public locations such as parks and sports facilities; or
- provide alternatives to driving for people who have been drinking.

Prevention and intervention measures are especially important for those under 21. These are discussed in the Youth section that follows.

Many prevention and intervention measures fall under the authority of a State's alcohol control board rather than the SHSO. However, the SHSO can be a critical partner in many prevention and intervention activities. Only countermeasures directly associated with drinking and driving are discussed in this section. For information regarding more general countermeasures directed at alcohol see Grube and Stewart (2004), Toomey and Wagenaar (1999), and Alcohol Epidemiology Program (2000).

Communications and outreach.

Communications and outreach strategies seek to inform the public of the dangers of driving while impaired by alcohol and to promote positive social norms of not driving while impaired. As with prevention and intervention, education through various communications and outreach strategies is especially important for youth under 21. Education may occur through formal classroom settings, news media, paid advertisements and public service announcements, and a wide variety of other communication channels such as posters, billboards, Web banners, and the like.

Communications and outreach strategies are a critical part of many deterrence and prevention strategies. This section discusses only stand-alone communications and outreach countermeasures.

5.1 Alcohol Screening and Brief Interventions

Effectiveness: ★★★★★	Cost: $$	Use: Medium	Time: Short

Alcohol screening uses a few questions to estimate the level and severity of alcohol use and to determine whether a person may be at risk of alcohol misuse or dependence (SAMHSA, 2007). Brief interventions are short, one-time encounters with people who may be at risk of alcohol-related injuries or other health problems. Brief interventions focus on the awareness of the problem and motivation toward behavior change (SAMHSA, 2007). The combination of alcohol screening and brief intervention is most commonly used with injured patients in emergency departments or trauma centers. Patients are screened for alcohol use problems and, if appropriate, are counseled on how alcohol can affect injury risk and overall health. Patients also may be referred to a follow-up alcohol treatment program. Brief interventions take advantage of a "teachable moment" when a patient can be shown that alcohol use can have serious health consequences. Dill, Wells-Parker, and Soderstrom (2004) provide a summary of alcohol screening and brief intervention studies. Also, NHTSA and the American Public Health Association (APHA) have produced an alcohol and brief intervention guide for public health practitioners (Guard & Rosenblum, 2008), and NHTSA offers a toolkit to assist in conducting screening and brief intervention on college campuses (Quinn-Zobeck, 2007).

Use: Approximately one-half of trauma centers screen patients for alcohol problems and one-third use some form of brief intervention (NCHRP, 2005, Strategy A4; Schermer et al., 2003). Alcohol screening and brief interventions also are used in colleges, primary care medical facilities, and social service settings (NCHRP, 2005, Strategy A4).

Effectiveness: Many studies show that alcohol screening and brief intervention in medical facilities can reduce drinking and self-reported driving after drinking (D'Onofrio & Degutis, 2002; Moyer, Finney, Swearingen, & Vergun, 2002; Wilk, Jensen, & Havighurst, 1997). Dill et al. (2004) reviewed 9 studies that evaluated alcohol screening and brief intervention effects on injury. These studies generally found that alcohol screening and brief intervention reduced both drinking and alcohol-related traffic crashes and injuries.

Costs: Alcohol screening and brief intervention in medical facilities require people with special training to administer the intervention. However, several studies show the intervention is cost effective, and substantially reduces future health care costs (e.g., hospital and ER visits) (Guard & Rosenblum, 2008).

Time to implement: Procedures for alcohol screening and brief intervention are readily available from APHA (Guard & Rosenblum, 2008), the American College of Emergency Physicians (ACEP, 2006), and the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2005), and can be implemented as soon as staff is identified and trained.

Other issues:

- **Alcohol exclusion laws:** An alcohol exclusion law (Uniform Accident and Sickness Policy Provision Law or UPPL) allows insurance companies to deny payment to hospitals for treating patients who are injured while impaired by alcohol or a non-prescription drug

(NHTSA, 2008g). These laws may cause hospitals to be reluctant to determine the BAC of an injured driver and may limit the use of alcohol screening (although screening does not measure the patient's BAC). As of July 2012, alcohol exclusion laws were in effect in 37 States (GHSA, 2012a), though the extent to which insurance companies deny payment is, at best, sporadic.

5.2 Mass Media Campaigns

Effectiveness: ★★★	Cost: $$$	Use: High	Time: Medium

A mass media campaign consists of intensive communications and outreach activities regarding alcohol-impaired driving that use radio, television, print, and other mass media, both paid and/or earned. Mass media campaigns are a standard part of every State's efforts to reduce alcohol-impaired driving. Some campaigns publicize a deterrence or prevention measure such as a change in a State's DWI laws or a checkpoint or other highly visible enforcement program. Others promote specific behaviors such as the use of designated drivers, illustrate how impaired driving can injure and kill, or simply urge the public not to drink and drive. Campaigns vary enormously in quality, size, duration, funding, and every other way imaginable. Effective campaigns identify a specific target audience and communications goal and develop messages and delivery methods that are appropriate to, and effective for, the audience and goal (Williams, 2007).

Use: Most States use some form of alcohol-impaired driving mass media campaign every year. Mass media campaigns are an essential part of many deterrence and prevention countermeasures that depend on public knowledge to be effective.

Effectiveness: Most mass media campaigns are not evaluated. Elder et al. (2004) studied the few available high-quality evaluations. The campaigns being evaluated were carefully planned, well-funded, well-executed, achieved high levels of audience exposure (usually by using paid advertising), had high-quality messages that were pre-tested for effectiveness, and were conducted in conjunction with other impaired-driving activities. These mass media campaigns were associated with a 13% reduction in alcohol-related crashes. Levy, Compton, and Dienstfrey (2004) documented the costs and media strategy of a high-quality national media campaign and its effects on driver knowledge and awareness.

Costs: High-quality and effective mass media campaigns are expensive. Funds are needed for market research, design, pre-testing, and production. Paid advertising expenses depend on the media chosen and the media markets needed to reach the target audience.

Time to implement: A high-quality mass media campaign will require at least 6 months to research, plan, produce, and distribute.

Other issues:

- **Campaign quality:** Poor-quality or stand-alone campaigns that are not tied to program activities are unlikely to be effective. Similarly, although public service announcements are a relatively inexpensive way to deliver messages about impaired driving, they are likely to be aired infrequently, reach small audiences, miss the target audience and have little or no effect. To be successful, mass media campaigns must be carefully pre-tested, communicate information not previously known, be long-term, and have substantial funding (Williams, 2007).

- **Comprehensive media strategy:** Mass media campaigns should be planned as part of an overall communications and outreach strategy that supports specific impaired driving activities, such as enforcement.
- **Social norms campaigns:** Social norms marketing campaigns are a more recent approach to reducing alcohol-related crashes. They are built on the premise that an individual's behavior is influenced by his or her perceptions of how most people behave. A study in Montana demonstrates the potential effectiveness of this approach. Surveys of young adults 21 to 34 years old in Montana revealed that only 20% had driven in the previous month after consuming two or more alcoholic drinks, although more than 90% thought their peers had done so. Based on this finding, a paid media campaign was developed with the normative message, "MOST Montana Young Adults (4 out of 5) Don't Drink and Drive." By the end of the campaign, there was a 13.7% decrease in young adults who reported driving after drinking relative to a comparison community (Linkenbach & Perkins, 2005).
- **Social media:** NHTSA and some States have begun using social networking sites to reach the general public with messages concerning alcohol-impaired driving. Although sites such as Facebook, Twitter, and YouTube can effectively and inexpensively reach large numbers of people, there are no evaluations of alcohol-impaired driving campaigns that use this approach. Similar to mass media campaigns and other types of communication described above, social media is unlikely to be effective as a stand-alone strategy; however, it may be a useful approach when combined with other communications to support specific impaired driving activities.

5.3 Responsible Beverage Service

Effectiveness: ★★	Cost: $$	Use: Medium	Time: Medium

Responsible beverage service covers a range of alcohol sales policies and practices that prevent or discourage restaurant and bar patrons from drinking to excess or from driving while impaired by alcohol. Server training programs teach servers how to recognize the signs of intoxication and how to prevent intoxicated patrons from further drinking and from driving. Management policies and programs include limits on cheap drinks and other promotions, support for designated driver programs, strong commitment to server training, and strong support for servers who refuse alcohol to intoxicated patrons. NCHRP (2005, Strategy A2) provides an overview of responsible beverage service. See also Wagenaar and Tobler (2007) and Voas and Lacey (2011; pp. 131-137) for reviews and discussion of the research literature on this issue.

Beginning in the early 1980s, a major effort was undertaken to encourage alcohol servers to comply with laws prohibiting the sale of alcoholic beverages to visibly intoxicated patrons. Since that time, many "server intervention" programs have been developed as a means of securing more responsible behavior on the part of servers. Some States have mandatory programs that require at least some alcohol retail employees to attend a server training course. Other States have voluntary programs that provide incentives for retailers to participate (e.g., liability protection or insurance discounts). The quality of server training programs can vary considerably. Wagenaar and Tobler (2007) note that many server training laws "are not optimally designed, do not ensure quality training, and do not ensure all servers are consistently trained, or retained periodically" (p. 158).

Server training programs are the only segment of responsible beverage service for adults that has been documented and evaluated well. Activities directed at people under 21 are discussed separately in Chapter 1, Sections 6.1 through 6.4.

Use: As of 2005, 17 States had some form of mandatory server training program in place; another 15 States had voluntary programs (Wagenaar & Tobler, 2007).

Effectiveness: The findings on the effectiveness of server training have been mixed. In their systematic review, Shults et al. (2001) found five high-quality evaluations of server training programs. They concluded that "intensive, high-quality, face-to-face server training, when accompanied by strong and active management support, is effective in reducing the level of intoxication in patrons" (p. 80). When server training programs are not intensive and are not supported, they are unlikely to result in greater refusals of service to intoxicated patrons.

Few studies have examined the effect of server training on alcohol-impaired crashes. An evaluation of a statewide server training program in Oregon found a 23% reduction in single-vehicle nighttime injury crashes following the program (Holder & Wagenaar, 1994). However, Molof and Kimball (1994) reviewed the same Oregon program and observed no decline in alcohol-related fatalities.

Costs: A typical alcohol server course takes about 4 to 8 hours. Course costs can be borne by the servers themselves, their employers, or the State.

Time to implement: Server training courses are offered by several private vendors and can be implemented in a few weeks. A statewide requirement for server training or more general responsible beverage service policies would require time to enact any necessary legislation, establish policies, and provide for program administration.

Other issues:

- **Program quality:** The quality of responsible beverage service programs can vary enormously, from excellent to abysmal. Management support can vary from enthusiastic to nonexistent. Shults et al. (2001) clearly limit their conclusions to high-quality programs with strong management support. The Alcohol Epidemiology Program (2000) cites several server training program evaluation studies that found no effect and notes that these programs may have been poorly supported or implemented.
- **Responsible beverage service is more than server training:** Grube and Stewart (2004) emphasize that management policy and its implementation may be at least as important as server training in determining responsible beverage service program effectiveness.
- **Dram shop laws:** More than half of States have laws that allow individuals injured by an intoxicated driver to recover damages from the licensed establishment that served or sold the alcohol (NCHRP, 2005). The potential threat of legal liability can provide strong encouragement to retailers to adopt responsible beverage service policies and practices. Research shows the implementation of dram shop laws is associated with reductions in alcohol-related crashes and fatalities (Voas & Lacey, 2011).
- **Enforcement of responsible beverage service:** Enforcement of alcohol service laws is key, but largely lacking. Mosher et al. (2009) identified three main reasons for this: (1) a lack of societal and political will to address violations; (2) limited resources for enforcement operations; and (3) statutory provisions that make collection of evidence overly burdensome. As a result, action against licensed establishments has historically been limited to case law action involving serious crashes. Although alcohol enforcement by police is almost exclusively directed toward drivers, research has demonstrated that enforcement of alcohol service laws can help ensure alcohol retailers follow responsible serving practices. For example, an enforcement program in Michigan resulted in a three-fold increase in refusals of service to “pseudo-patrons” who simulated intoxication (McKnight & Streff, 1994).

5.4 Alternative Transportation

Effectiveness: ★★	Cost: $$	Use: Unknown	Time: Short

Alternative transportation describes methods by which people can get to and from places where they drink without having to drive. Alternative transportation supplements normal public transportation provided by subways, buses, taxis, and other means.

Ride service programs transport drinkers home from, and sometimes to and between, drinking establishments using taxis, private cars, buses, tow trucks, and even police cars. Some will drive the drinker's car home along with the drinker. Most operate only for short periods of the year, such as the Christmas and New Year's holidays. Many are free; some charge users a minimal fee; some are operated commercially on a for-profit basis. Ride service programs are relatively inexpensive and easy for communities to implement. Although it can be difficult to measure the effectiveness of these programs, they can play a role in a community's efforts to reduce drinking and driving. For an overview, see Decina, Foss, Tucker, Goodwin, and Sohn (2009) and NCHRP (2003, Strategy E1).

Use: During the 1980s, 325 programs were in operation in 44 States and the District of Columbia (Harding, Apsler, & Goldfein, 1987). There is limited information on ride service programs currently in operation, although some data is available on the NHTSA Buzzed Driving Facebook page: www.facebook.com/buzzeddrivingisdrunkdriving.

Effectiveness: Three studies have evaluated ride service programs. The first examined one year-round and one holiday program. Both functioned smoothly and delivered rides but neither demonstrated any effect on crashes (Molof et al., 1995). The second study examined a year-round program in Aspen, Colorado, and concluded that it reduced injury crashes in the surrounding county by 15% (Lacey, Jones, & Anderson, 2000). Finally, a program in Wisconsin that provided rides to and from bars using older luxury vehicles resulted in a 17% decline in alcohol-related crashes during the first year (Rothschild, Mastin, & Miller, 2006). The program became largely self-sustaining through fares and tavern contributions. These three programs and others are summarized in Decina et al. (2009). After reviewing select programs, Decina et al. (2009) concluded that a model alternative transportation program (i.e., one that reduces alcohol-related crashes) should be continually available, free to users, and convenient and easy to use.

Costs: The major ride service program costs are for the rides that are provided. Short-term ride service programs can be operated largely with donated rides. Year-round programs need enough steady funding to accommodate demand (NCHRP, 2003, Strategy E1).

Time to implement: Short-term ride service programs can be established and operated informally in a few weeks. Longer-term programs need to establish long-term strategies for funding and managing the program.

5.5 Designated Drivers

Effectiveness: ★★	Cost: $	Use: Medium	Time: Short

Designated drivers are individuals who agree not to drink so they can drive their friends who have been drinking. Formal designated driver programs in drinking establishments provide incentives such as free soft drinks for people who agree to be designated drivers. Usually, though, designated driver arrangements are completely informal.

The designated driver concept has been questioned on two grounds: (1) designated drivers may still drink, though perhaps less than the passengers; and (2) it may encourage passengers to drink to excess. In a national roadside survey, Fell, Voas, and Lange (1997) found self-identified designated drivers were more likely to have a positive BAC in comparison to all drivers on the road. Also, some designated drivers had very high BACs, especially those coming from bars. Apparently some groups of drinkers had selected the designated driver near the *end* of a night of drinking. To be effective, Voas and Lacey (2011) argue the designated driver must be chosen before the drinking begins, and must be willing to abstain (or substantially limit) his or her drinking.

Use: The designated driver concept is widely understood and accepted. Surveys show that designated driver use is common. In NHTSA's general population survey of 7,000 people, 44% said they had served as a designated driver during the past year, and 33% reported riding with a designated driver (Moulton et al., 2010).

Effectiveness: Because designated drivers are informally determined and somewhat imprecisely defined, it's no surprise there is little data on the impact of designated drivers on crashes. CDC's systematic review found insufficient evidence to determine the effectiveness of designated driver programs (Ditter et al., 2005). A review from Australia concluded that designated driver programs can successfully increase awareness and use of designated drivers, but evidence for changes in alcohol-related crashes is inconclusive (Nielson & Watson, 2009). However, the authors note the lack of supporting evidence "does not necessarily mean that such programs should be discouraged. On the contrary, it highlights the need for them to be better implemented and evaluated" (Nielson & Watson, 2009, p.36).

Costs: The only costs associated with informal designated driver programs are for publicity. Designated drivers can be promoted independently or can be included with other impaired driving publicity. Establishments that operate formal designated driver programs have minimal costs for the drinks provided and for publicity.

Time to implement: Designated driver promotion can be implemented in a few weeks and formal programs can be established equally quickly.

6. Underage Drinking and Alcohol-Impaired Driving

Teenagers drink and drive less often than adults, but they are more likely to crash when they do drink and drive (Williams, 2003). Teenagers are inexperienced with both driving and drinking. Consequently, they have a higher crash risk at all BAC levels than adult drivers (Mayhew et al., 1986; Zador, Krawchuck, & Voas, 2000). Alcohol-related crashes among teenagers are typically associated with driving at nighttime, on weekends, and with passengers (Bingham, Shope, Parow, & Raghunathan, 2009).

Many of the countermeasures described in previous sections of this chapter apply not only to adults, but to teenagers as well. However, there are some countermeasures to reduce drinking and alcohol-related crashes that are directed specifically to those under 21.

Since 1988, minimum-drinking-age laws in all States prohibit youth under 21 from purchasing alcohol or consuming it in public. These laws influence all youth impaired-driving strategies. For people 21 and older, drinking is legal but driving while impaired by alcohol is not. With a BAC limit of .08, drivers know they should not drive after drinking "too much," but are faced with mixed messages at low levels of alcohol, because lower BAC's are not illegal *per se*. The message for those under 21 is unambiguous: they should not be drinking at all, and certainly should not be driving after drinking.

Zero-tolerance laws in all States reinforce this message by setting a maximum BAC limit of .02 or less for drivers under 21. This effectively prohibits driving after drinking *any* amount of alcohol. Presently, zero-tolerance laws are not actively publicized or enforced by many States. In addition, compliance checks of alcohol vendors can reduce the availability of alcohol to those under 21, though again this strategy is not used as widely as it could be. There are many other policies and programs reinforcing the no-drinking message that are directed primarily at adults (beer keg registration, social host liability) or take place in schools or youth organizations (Students Against Destructive Decisions clubs, alcohol-free prom and graduation parties). Youth receive education and information about alcohol and alcohol-impaired driving in schools and colleges, through licensing agencies, and through media directed to youth.

The minimum-drinking-age laws and the no-drinking message for youth mean that youth impaired-driving activities must work hand-in-hand with activities to control youth drinking. With the exception of zero-tolerance law enforcement and alcohol vendor compliance checks, many of the countermeasures discussed below require cooperative activities between traditional highway safety organizations, such as law enforcement and motor vehicle departments, and community, health, and educational organizations with a broader social agenda than traffic safety.

6.1 Minimum Legal Drinking Age 21 Laws

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Low

The primary strategy to reduce underage drinking, as well as drinking and driving, has been restricting access to alcohol via minimum purchase age laws. Since July 1988, the minimum legal drinking age (MLDA) has been 21 in all States. There is strong evidence that MLDA-21 laws reduce drinking, driving after drinking, and alcohol-related crashes and injuries among youth (Hingson et al., 2004; McCartt, Hellinga, & Kirley, 2010; Shults et al., 2001; Wagenaar & Toomey, 2002). In fact, MLDA-21 laws reduced youth drinking and driving more than youth drinking alone (using the measurements of self-reporting and testing of impaired drivers in fatal crashes). Drinking and driving has become less socially acceptable among youth, and more youth have separated their drinking from their driving (Hedlund et al., 2001).

The specific laws implementing MLDA 21 for alcohol vendors, adults, and youth differ substantially from State to State. See Alcohol Epidemiology Program (2000) and Century Council (2005) for State-by-State summaries of some of the key provisions.

Use: The minimum age to purchase alcohol is 21 in all 50 States and the District of Columbia. Surprisingly, in a 2008 survey of the general public conducted by NHTSA, only 71% of respondents believed there was a minimum legal drinking age in the U.S. Of those who said there was a minimum legal drinking age, 86% correctly identified the legal drinking age as 21 (Moulton et al., 2010).

Effectiveness: Several reviews point to the effectiveness of MLDA-21 laws. Shults et al. (2001) identified 33 published studies examining the effects of changing the legal drinking age. Overall, changes to the MLDA affected alcohol-related crashes by 10% to 16%, with crashes decreasing when the MLDA was raised, and increasing when it was lowered. Wagenaar and Toomey (2002) reviewed 79 high-quality studies examining the relationship between the legal minimum drinking age and crashes. Of these studies, 58% found fewer crashes associated with a higher MLDA, whereas none found fewer crashes associated with a lower MLDA. These findings prompted McCartt et al. (2010) to conclude: "The highway safety benefits of MLDA-21 have been proven, and the cause and effect relationship between MLDA and highway crashes is clear. Deaths go up when the drinking age is lowered, and they go down when it is raised" (p. 180). NHTSA estimates that MLDA-21 laws have saved 28,230 lives since 1975, and an estimated 550 lives in 2010 alone (NHTSA, 2012c).

Costs: There are no direct costs of MLDA-21 laws. Costs may be needed for enforcement of MLDA-21 laws. (See Chapter 1, Sections 6.2 and 6.3).

Time to implement: MLDA-21 laws can be implemented as soon as appropriate legislation is enacted.

Other issues:

- **Repealing MLDA-21 laws:** Since 2007, 9 States have considered legislation allowing at least some people under the age of 21 to purchase and consume certain types of alcoholic

beverages (McCartt et al., 2010). To date, none of these bills have passed. Perhaps the most notable (and highly publicized) effort to lower the MLDA was a statement signed by approximately 120 college and university presidents in 2008 suggesting the MLDA be lowered to 18. This group questioned the validity of MLDA-21 research, and advocated for education in place of laws to reduce drinking among young people. Many organizations, including NHTSA, have opposed lowering the legal drinking age. There has been more research on the minimum legal drinking than perhaps any other alcohol-control policy (Wechsler & Nelson, 2010). Most traffic safety experts have concluded that MLDA-21 laws are effective, and they recommend strengthening enforcement of MLDA-21 laws and establishing policies to support them. For further discussion of this issue, see Wechsler and Nelson (2010) and McCartt et al. (2010).

6.2 Zero-Tolerance Law Enforcement

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Zero-tolerance laws set a maximum BAC of .02 or less for drivers under 21. Violators have their driver's licenses suspended or revoked. There is strong evidence that zero-tolerance laws reduce alcohol-related crashes and injuries (Voas & Lacey, 2011; NCHRP, 2005, Strategy B3; Shults et al., 2001). Fell, Fisher, Voas, Blackman, and Tippetts (2009) estimate that zero-tolerance laws save 159 lives each year.

However, zero-tolerance laws often are not actively enforced or publicized (Hedlund et al., 2001; Voas & Lacey, 2011). Studies have found that young drivers are not arrested in proportion to their involvement in alcohol-related crashes (Hingson, Assailly, & Williams, 2004). One exception is the State of Washington, where a study found that arrests for alcohol violations among 16- to 20-year-old drivers increased by about 50% after the zero-tolerance law went into effect (McCartt, Blackman, & Voas, 2007). Enforcement may be greater in Washington because the law allows officers to request a test for alcohol based on suspicion of either a DWI or zero-tolerance offense. In other States where drivers can only be tested if DWI is suspected, zero-tolerance laws may be more difficult to enforce.

Use: Zero-tolerance laws have been in effect in all States since 1998. The degree to which zero-tolerance laws are enforced in States is unknown.

Effectiveness: An early study in Maryland found that alcohol-involved crashes for drivers under 21 dropped by 21% in 6 counties after the zero-tolerance law was implemented. After the law was publicized extensively, these crashes dropped by an additional 30% (Blomberg, 1992). No other studies have examined the effect of increasing enforcement and publicity for an existing zero-tolerance law. Lacey, Jones, and Wiliszowski (2000) documented how zero-tolerance laws are administered and enforced in 4 States. Highly publicized enforcement has proven effective in increasing compliance with many traffic safety laws and reducing crashes and injuries: see for example checkpoints (Chapter 1, Section 2.1) and seat belt use mobilizations (Chapter 2, Section 2.1).

Costs: Zero-tolerance laws can be enforced on regular patrol or on special patrols directed at times and areas when young impaired drivers may be present. Enforcement will require moderate costs for appropriate training, publicity, and perhaps equipment (see Other Issues).

Time to implement: Enforcement programs can be implemented within 3 or 4 months, as soon as appropriate training, publicity, and equipment are in place.

Other issues:

- **Zero-tolerance-law provisions:** Zero-tolerance laws are far easier to enforce if the offense is an administrative rather than criminal violation, and if law enforcement officers can use PBTs at the roadside to determine if the law has been violated and to seize the driver's license if it has (Jones & Lacey, 2001). Some State laws require the same probable cause as for a standard DWI arrest, or even require a full DWI arrest,

before a BAC test for a zero-tolerance-law violation can be administered. In these States, the zero-tolerance law is not enforced independently of the standard DWI law, and in fact young drivers may not be aware of the zero-tolerance law (Hingson et al., 2004).

- **PBT and PAS:** Preliminary breath test devices (PBTs) are important to effective and efficient enforcement in States that allow PBT use for zero-tolerance laws. A passive alcohol sensor (PAS) can help officers detect violators who have consumed alcohol. See Chapter 1, Sections 2.3 and 2.4.
- **Holding juveniles in custody:** A complication of enforcing zero-tolerance laws is deciding how and where to hold young offenders once they are taken into custody. NHTSA helped produce an implementation guide for developing a juvenile holdover program (NHTSA, 2001).

6.3 Alcohol Vendor Compliance Checks

Effectiveness: ★★★†	Cost: $$	Use: Unknown	Time: Short

† Proven for reducing sales to underage people

In all 50 States, alcohol venders are required to verify the age of young customers to be sure they are at least 21. However, several studies suggest young people can obtain alcohol without much difficulty. Across various studies, young buyers successfully purchased alcohol in 44% to 97% of attempts without showing identification (NCHRP, 2005, Strategy A3). To reduce the likelihood that alcohol vendors sell alcohol to underage people, law enforcement officers can conduct frequent compliance checks. In a compliance check or "sting," law enforcement officers watch as underage people attempt to purchase alcohol and cite the server or vendor for an MLDA-21 violation if a sale is made. Vendors can include on-premise retailers (e.g., bars and restaurants) or off-premise outlets (e.g., convenience stores or liquor stores).

An effective compliance check program works primarily through deterrence. The goal is to increase the perception among vendors they will be caught if they sell alcohol to underage people. To maximize deterrence, compliance checks should:

- Be conducted frequently and on an unscheduled basis. The vendor should not know when a compliance check will occur.
- Be conducted at *all* vendors, not just a sample of vendors in the community. One study showed the benefits of compliance checks did not generalize to vendors who were not checked (Wagenaar, Toomey, & Erickson, 2005).
- Be well-publicized. Both vendors and the community should know that compliance checks are taking place. This will discourage young people from trying to obtain alcohol, and encourage vendors to put policies and procedures in place that prevent the sale of alcohol to underage customers.
- Be sustained over time. The effects of compliance checks decay over a few months, so an ongoing program is needed to maintain deterrence (Wagenaar et al., 2005).

A manual describing how to conduct compliance checks is available from the University of Minnesota at www.epi.umn.edu/alcohol/manual/manual.pdf. Another good resource is the Department of Justice's Reducing Alcohol Sales to Underage Purchasers, available at www.udetc.org/documents/AlcoholSales.pdf.

Use: Although many jurisdictions conduct compliance checks of alcohol retailers at least occasionally, few jurisdictions do so frequently.

Effectiveness: Several studies document that well-publicized and vigorous compliance checks reduce alcohol sales to youth; for example, a review of 8 high quality studies found that compliance checks reduced sales to underage people by an average of 42% (Elder et al., 2007). The effect of compliance checks on motor vehicle crashes has not been studied.

Costs: Compliance checks require time from law enforcement or alcohol beverage control staff. These costs can be supported, in part, though alcohol license fees or fines collected from non-compliant vendors.

Time to implement: Compliance checks can be implemented within three months if officers are trained in proper procedures.

Other issues:

- **Penalties for violations:** To increase the likelihood that penalties will be quickly and consistently enforced, all penalties for violations should be administrative in nature (NCHRP, 2005, Strategy A3). Also, the penalties must be substantial enough to deter alcohol vendors from selling to underage people. Some States employ graduated penalties for vendors who fail compliance checks, where both fines and suspension periods increase with each violation (NCHRP, 2005, Strategy A3).

6.4 Other Minimum Legal Drinking Age 21 Law Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Varies	Time: Varies

MLDA-21 law enforcement is very limited in many communities (Hedlund et al., 2001). Enforcement can take several forms, as summarized by Stewart (1999):

- Actions directed at alcohol vendors: compliance checks to verify that vendors will not sell to youth (see Chapter 1, Section 6.3).
- Actions directed at youth: "use-and-lose" laws that confiscate the driver's license of an underage drinker, "Cops in Shops" directed at underage alcohol purchasers, law enforcement "party patrols" using party dispersal techniques, and penalties for using false identification.
- Actions directed at adults: beer keg registration laws, enforcement of laws prohibiting purchasing alcohol for youth, shoulder tap operations, and programs to limit parties where parents provide alcohol to youth.

While these enforcement strategies have been used frequently, few have been evaluated. Several strategies are briefly described below, along with any supporting research evidence.

"Use and lose" laws: These laws allow confiscation of the driver's license or postpone licensure for a period of time for youth who violate a State's MLDA-21 law. In the only study to date, Ulmer et al. (2001) investigated "use and lose" law implementation and effects in Missouri and Pennsylvania. Missouri suspended the driver's licenses of most youth arrested for DWI but rarely suspended the licenses of youth who violated the MLDA-21 law by drinking but not driving. Pennsylvania, in contrast, applied the "use and lose" law to violations of the MLDA-21 both for youth arrested while driving and youth arrested while not driving. Pennsylvania's "use and lose" license suspensions appeared to reduce subsequent traffic violations and crashes. "Use and lose" laws can be implemented quickly and inexpensively once enacted. To be effective, they should be publicized extensively. As of 2006, 29 States had "use and lose" laws and another 10 States and the District of Columbia had "use and lose" authority that may be applied in varying circumstances (NHTSA, 2006c).

Keg registration laws: These laws link beer keg purchasers to an identification number on the keg, which provides a method of identifying adults who supply beer to parties attended by youth. As of 2000, 12 States and the District of Columbia had keg registration laws (Alcohol Epidemiology Program, 2000). In the only study on the effectiveness of these laws, keg registration was shown to be associated with reduced traffic fatality rates in 97 U.S. communities (Cohen, Mason, & Scribner, 2001). However, the authors could not conclude that key registration *caused* the lower fatality rates.

Media campaigns: Ohio has conducted a statewide media campaign, *Parents Who Host Lose the Most*, since 2000. The campaign informs parents and youth about Ohio's underage drinking laws and attempts to discourage parents from providing alcohol to underage drinkers at parties. Telephone surveys in 2006 showed that about 55% of parents and youth had heard messages about underage drinking (Applied Research Center, 2008). About two-thirds of those who had heard a message said that it prompted a conversation between parents and their teenagers about

drinking. In comparison with surveys conducted in 2001, there was a 42% decrease among youth who reported knowing of parents who host parties where alcohol is served to teens.

Underage Drinking Tipline: In 2006 Kansas launched a statewide underage drinking tipline, 866-MustB21. The toll-free tipline operates 24 hours a day, 7 days a week, for citizens to report parties involving underage drinking, plans to purchase alcohol for underage people, and willingness of retailers to sell alcohol to underage people. The effect of the tipline has not been evaluated. Nebraska introduced a statewide underage drinking tipline in 2009, using the same phone number as Kansas.

Social Host Liability: Under social host laws, adults who provide alcohol to people under 21 – or who allow underage drinking to occur on their property – can be held accountable if the young person is subsequently involved in a crash. This liability might discourage adults (parents, older siblings, and friends) from purchasing alcohol for underage people or hosting an underage party. Conducting source investigations, in which law enforcement teams identify the providers of the alcohol, can be resource intensive and time consuming (Curtis & Ramirez, 2011). Moreover, the few research studies that have examined the effect of social host liability laws have obtained conflicting findings (Voas & Lacey, 2011). Nonetheless, comprehensive and well-publicized efforts to hold providers accountable appear to be promising. Social host laws, and their accompanying penalties, vary from State to State. A description of each State's social host laws may be found in NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws* (NHTSA, 2011b). Another good resource is available from the Alcohol Policy Information System (APIS) at http://alcoholpolicy.niaaa.nih.gov/prohibitions_against_hosting_underage_drinking_parties.html.

Comprehensive community programs: Several comprehensive community initiatives have reduced youth drinking and alcohol-related problems (Hingson et al., 2004; Shults et al., 2009). These initiatives typically bring together several community government departments, such as schools, health, and law enforcement, with alcohol sellers, parents, youth, and citizen organizations. They may include school-based programs, law enforcement, media, and other intervention strategies. They require strong leadership and organization. They may take many months to plan and implement. Costs depend on the activities included. A recent example is a campaign conducted in Huntington, West Virginia, that included checkpoints to look for violations of the MLDA-21 law, checks of alcohol outlets to reduce sales to minors, and publicity for program activities. Roadside surveys conducted before and during the program showed a 93% drop in 16- to 20-year-old drivers having BACs greater than .05 g/dL (IIHS, 2008). NHTSA has produced a guide on how communities can prevent underage drinking, available at: www.nhtsa.gov/people/injury/alcohol/Community%20Guides%20HTML/Guides_index.html

6.5 Youth Programs

Effectiveness: ★★	Cost: Varies	Use: High	Time: Medium

States and communities have conducted extensive youth drinking-and-driving-prevention programs over the past 25 years. These programs seek to motivate youth not to drink, not to drink and drive, and not to ride with a driver who has been drinking. Although some programs use scare tactics, many employ positive messages and methods: providing positive role models that discourage alcohol use, promoting positive norms that do not involve alcohol, and encouraging youth activities that do not involve or lead to alcohol use.

The best-known youth program is associated with SADD, founded in 1981 as Students Against Driving Drunk, then renamed Students Against Destructive Decisions. SADD currently has an estimated 10,000 chapters in the United States, with a total of 350,000 active student members (SADD, 2012). Some States conduct similar activities under different names, such as Students Taking a New Direction (STAND) in Colorado and Stopping Automobile Fatalities Through Youth Efforts (SAFTYE) in Washington State. One specific activity, operated either by a youth program or independently, is Project Graduation, which provides alcohol-free prom and graduation parties for high school students. See Hedlund et al. (2001) for brief examples of State programs.

A more recent type of approach focuses on "social norms" or "normative feedback." Social norms programs are based on studies showing that students often overestimate alcohol use among their peers. By providing students with accurate information about drinking, social norms programs reduce the pressure that light- or non-drinkers feel to drink, and help heavier drinkers realize their drinking is atypical (Perkins 2002, 2003). Although many social norms programs focus on alcohol or other substance use, a few have addressed drinking and driving. Examples of social norms programs can be found at the National Social Norms Institute (www.socialnorms.org).

Use: Youth programs of some type are conducted in most, if not all, States.

Effectiveness: CDC's systematic review found there was insufficient evidence to determine the effectiveness of youth programs (Elder et al., 2005). Two studies have attempted to evaluate SADD's activities and effects. One study, in two schools, found that neither school implemented the model SADD program well and found no evidence of effects on any drinking and driving measure. The second study, in 6 schools, found that SADD activities affected drinking and driving attitudes as well as self-reported drinking and driving (Hedlund et al., 2001).

One study has examined the long-term effects of a social norms program on drinking and driving. Breath samples were taken from students at a large public university as they returned home late at night. Following the social norms program, there was a marginally significant decrease in drivers who registered a positive BAC, from 15.3% to 10.8%. Among drivers who had been drinking, self-reported number of drinks consumed and measured BACs decreased, as did the number of drinking-drivers who reported having five or more drinks at one sitting on the night of the survey (Goodwin, 2004).

Costs: Youth program costs can vary substantially depending on the size and nature of the individual activities. States have spent substantial funds, both Federal and non-Federal, on youth drinking-and-driving programs. These funds have been used for a variety of youth education, enforcement, and program activities.

Time to implement: With model programs available and organizations such as SADD and MADD available for assistance, youth programs can be started easily in 6 months.

Other Issues:

- **Other programs aimed at youths:** There are a wide variety of programs that are directed at youths. To increase the perceived risks of drinking and driving, many schools have employed fatal vision goggles, peer-to-peer programs, role plays, or drunk-driving crash reenactments (e.g., "Every 15 Minutes"). Although popular, the vast majority of these programs have not been evaluated or demonstrated to be effective. The few existing studies suggest these types of programs may produce changes in knowledge or attitudes, but have little or no effect on behaviors (Hover, Hover, & Young, 2000; Jewell & Hupp, 2005). Broader community-based programs have had much greater success at reducing drinking and driving among youth (see Chapter 1, Section 6.4).

7. Drugged Driving

The impairing effects of alcohol and the dangers of drinking and driving are well-documented. By contrast, there is considerably less research investigating the potentially impairing effects of drugs on drivers. Compton, Vegega, and Smither (2009) and Stewart (2006) summarize some of the challenges in studying, measuring, and creating countermeasures to address drugged driving:

- There is a wide range of drugs, both licit and illicit, that can potentially impair driving. Moreover, the list of drugs in common usage is constantly changing.
- Although the relationship between BAC and driving impairment is clear and well-documented, the relationship between blood levels of drugs and driving impairment has not been established for drugs other than alcohol.
- Alcohol can be measured reliably through breath tests, but other types of drugs can only be measured through more intrusive tests of bodily fluids such as blood, urine, or saliva.
- Alcohol leaves the body in a predictable pattern, whereas other drugs are eliminated at many rates; hence, timing is critical when conducting a drug test. In addition, blood levels of certain drugs can accumulate with repeated administrations, and can be detected well after impairment has ceased.
- It is not unusual for drivers to take more than one impairing drug at the same time or to combine drugs with alcohol. Although individual drugs, taken at normal doses, may not impair driving, drug effects may be synergistic when taken together and substantially increase the risk of a crash.

Despite these challenges, a growing body of research suggests that many illicit, prescription, and over-the-counter drugs may impair a driver's ability to operate a vehicle (for reviews, see Couper & Logan, 2004; Jones, Shinar, & Walsh, 2003, and Kelly, Darke, & Ross, 2004). Much of this research has involved laboratory or experimental studies using driving simulators, although some epidemiological studies have examined the effect of drugs on crash prevalence and risk. See Compton et al. (2009) for a discussion of this research.

In most cases, the research investigating the effect of drugs on driving has had variable results. Several studies suggest that a benzodiazepine user is at increased risk of being involved in a crash (Movig et al., 2004; Rapoport et al., 2009), although some studies have not found these results. The risk appears to depend on the type of benzodiazepine used, the dose, the time since last use, and whether the drug was combined with alcohol (Dassanayake, Michie, Carter, & Jones, 2011; Leung, 2011). The findings for marijuana also have been variable, although a recent meta-analysis concluded marijuana doubles the risk of crash (Asbridge, Hayden, & Cartwright, 2012). Generally, the risk appears highest when marijuana has been used recently, and especially when marijuana is combined with alcohol (Beirness & Simpson, 2006; Sewell, Poling, & Sofuoglu, 2009). The relationship between antihistamines and motor vehicle crashes is also ambiguous (Moskowitz & Wilkinson, 2004). A small connection has been found between first-generation antihistamines and crashes, but second-generation antihistamines appear to cause less sedation. Fewer studies have examined the crash risks associated with stimulants (e.g., amphetamines and cocaine) and other types of drugs.

Compton et al. (2009) describe four basic issues that must be addressed to better understand the extent of the problem of drug-impaired driving:

- What drugs impair driving ability?
- What drug dose levels are associated with impaired driving?
- How frequently are impairing drugs being used by drivers?
- What drugs are associated with higher crash rates?

In sum, there are still sizeable gaps in our understanding of the effects of drugs on driving. In their review of drug-impaired driving, Jones et al. (2003) concluded: "The role of drugs as a causal factor in traffic crashes involving drug-positive drivers is still not understood…. Current research does not enable one to predict with confidence whether a driver testing positive for a drug, even at some measured level of concentration, was actually impaired by that drug at the time of crash" (p. 96). Perhaps the one consistent finding across studies is the risk of driver impairment increases substantially when drugs are combined with alcohol.

Similar to alcohol-impaired driving, drugged driving is primarily addressed through a combination of laws, enforcement, and education. Relatively few countermeasures have been developed to address drugged driving, and there has been little evaluation of drugged-driving countermeasures. Much more research is needed to better understand the nature and degree of traffic safety risk posed by drugs, as well as the effectiveness of potential countermeasures to address this issue.

7.1 Enforcement of Drugged Driving

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Enforcement of drugged driving laws can be difficult. Typically, drugged driving is only investigated when a driver is obviously impaired but the driver's BAC is zero (or low). If a driver has a BAC over the legal limit, there is often no reason to probe for drugs since in many States drugged driving carries no additional penalties.

Although several devices are available that allow officers to screen suspects for illegal drug use at point-of-contact, none have been proven to be accurate and reliable (Compton et al., 2009). Instead, a number of law enforcement agencies employ drug recognition experts (DREs) to assist in investigating potential drug-impaired driving cases. DREs use a standardized procedure to observe a suspect's appearance, behavior, vital signs, and performance on psychophysical and physiological tests to determine whether and what type of drug or drug category may have been used. If drug intoxication is suspected, a blood or urine sample is collected and submitted to a laboratory for confirmation.

Use: As of July 2012, 49 States and the District of Columbia had Drug Evaluation and Classification (DEC) programs, which are designed to train officers to become DREs (GHSA, 2010c). These programs have prepared nearly 1,000 instructors and trained more than 6,000 officers (Compton & Berning, 2009).

During 2011, there were 23.653 drug evaluations conducted by approximately 6,100 DREs (Sobriety Testing Resource Center, 2012). This is equivalent to less than 6 evaluations per DRE. This suggests drugged driving arrests are not as common in comparison to arrests for alcohol-impaired driving. However, it should be noted that the number of drugged driving arrests cannot be known as many States only record "impaired driving" arrests, and do not separate alcohol from drug arrests.

Effectiveness: Several studies have shown DRE judgments of drug impairment are corroborated by toxicological analysis in 85% or more of cases (NHTSA, 1996). However, one experimental laboratory study found DREs' ability to distinguish between impaired and non-impaired individuals was moderate to poor for several types of drugs including marijuana, codeine, and amphetamines (Shinar, Schechtman, & Compton, 2000). The study showed DREs tended to rely on just one or two "pivotal" cues to identify specific drug impairment. To date, there have been no studies examining the effectiveness of enforcement in reducing drugged driving or crashes.

Costs: As with other enforcement strategies, the primary costs are for law enforcement time and training. The time to conduct a DRE evaluation can be 2 to 3 hours. Training includes 72 hours of classroom instruction and approximately 50 hours of field work.

Time to implement: Drugged driving enforcement can be integrated into other enforcement activities within three months; however, time will be needed to train DREs in detecting drug impairment. DRE training consists of 9 days of classroom instruction, and DRE candidates are

also required to perform a number of supervised field evaluations in order to become certified (Compton et al., 2009).

7.2 Drugged Driving Laws

Effectiveness: ★	Cost: Unknown	Use: Medium†	Time: Short

†Use for drug *per se* laws

Although most States have laws that prohibit the use of impairing drugs by drivers, there is a great deal of variability in how States approach this issue. In some States, impairment-based statutes stipulate that prosecution must prove the driver was impaired (for example, by driving recklessly or erratically). Other States have *per se* laws in which it is illegal to operate a motor vehicle if there is any detectable level of a prohibited drug in a driver's system. Hence, a positive drug test is sufficient for conviction. This is equivalent to "zero tolerance."

Lacey, Brainard, and Snitow (2010) conducted interviews with law enforcement officers, prosecutors, and other traffic safety professionals in States with *per se* laws. Most were supportive of such laws. Although they did not believe *per se* laws made enforcement easier, they reported these laws had a positive effect on the prosecution and conviction of drugged drivers. Moreover, discussions with officers and prosecutors in States *without* per se laws also revealed relatively high conviction rates, with few cases reaching trial (Lacey, Brainard, & Snitow, 2010).

NHTSA's Report to Congress includes a model drugged driving law (Compton et al., 2009). Because the relationship between blood levels of drugs and driving impairment has not been established for drugs other than alcohol, the model law does not include a *per se* provision. However, NHTSA recommends States include enhanced penalties for drivers who are under the influence of multiple drugs (including alcohol). In addition, NHTSA recommends State statutes provide separate and distinct sanctions for alcohol-impaired driving and drugged driving (Compton et al., 2009).

For a detailed discussion of issues related to drugged driving laws, see DuPont et al. (2012). The authors make a number of recommendations including: improvement of drug testing technology, enactment of laws requiring drug testing of all drivers in injury crashes, and adding drug use to underage zero-tolerance laws.

Use: As of July 2012, 19 States have *per se* laws that forbid the presence of any prohibited drug while a driver is in control of a vehicle (GHSA, 2012c). In addition, 2 States (North Carolina and South Dakota) have *per se* laws that apply only to those younger than 21, and 5 States (California, Colorado, Idaho, Kansas, and West Virginia) have made it illegal for a drug addict or habitual drug user to drive a vehicle (Lacey, Brainard, & Snitow, 2010). More information about the drugged driving laws in each State can be found in Lacey et al. (2010) and Walsh (2009).

Effectiveness: Lacey et al. (2010) tried to determine whether drug *per se* laws increased drugged driving arrests and convictions. However, they were hampered by the fact that States do not record drug-impaired offenses separately from alcohol-impaired offenses. To date, there have been no evaluations of the effect of drugged driving laws on the prevalence of drug-impaired driving or crashes.

Costs: The costs of drugged driving laws will depend on the number of offenders detected and the penalties applied to them.

Time to implement: Drugged driving laws can be implemented as soon as appropriate legislation is enacted, although time will be needed to train law enforcement officers, prosecutors, and judges about the new legislation and to inform the general public.

7.3 Education Regarding Medications

Effectiveness: ★	Cost: Unknown	Use: Unknown	Time: Long

Some medications prescribed by a doctor can pose a risk for drivers. It is important that physicians, pharmacists, and patients receive information about the potential risk of motor vehicle crashes associated with certain medications. Perhaps the simplest way to achieve this would be through clear warning labels on packages. France uses a warning label system that has four categories:

- 0. No warning.
- I. Be careful: Read the patient leaflet carefully before driving.
- II. Be very careful: Seek advice from a physician or pharmacist before driving.
- III. Danger – Do not drive: Seek medical advice before driving again.

Entire classes of drugs may be classified in a particular category. For example, all hypnotic drugs are classified as category III. Any labeling scheme would need to be systematic. Presently in the United States, labeling is inconsistent and dependent on the individual pharmacy/pharmacist.

The International Council on Alcohol, Drugs, and Traffic Safety (ICADTS) has developed a categorization system for medicinal drugs that can affect driving performance (ICADTS, 2007). The list was intended for physicians and pharmacists so they could better identify medications that could impair driving skills and look for safer alternatives when possible. In 2008 and 2009, NHTSA convened an expert panel to develop a list of medications (or classes of medications) that may be “safe” for driving; however, the panel found inadequate information about specific medications to develop such a list (Kay & Logan, 2011).

The effects of medications on driving are a particular concern with older drivers. LeRoy and Morse (2008) examined the association between multiple medication use and motor vehicle crashes among people 50 and older. The study found a large percentage of older people (64%) take medications that can potentially impair driving, and those taking three or more impairing medications were 87% more likely to be involved in a crash.

For recent reviews on medications and road safety, see de Gier (2006) and Vandrevala, Helman, Turner, and Stone (2010).

Use and Effectiveness: There is little information available on how frequently this countermeasure is used in the United States, or how effective it has been in raising awareness, increasing knowledge, or changing behavior. NHTSA has worked with Walgreens, the country's largest drugstore chain, to develop a curriculum for pharmacists on medication-impaired driving. The curriculum includes modules that cover potentially driver-impairing prescription drugs, laws relating to medication use and DUI, and the role of pharmacists in counseling patients regarding medications and driving risk. A pilot test with 640 pharmacists showed the curriculum was effective in increasing pharmacists’ knowledge of medication-related impaired driving (Lococo & Tyree, 2007).

Costs: Targeted education to physicians and pharmacists (through drug categorization systems) and to drivers (through warning labels) would be needed. The former would likely be the most costly.

Time to implement: Targeted communications could require a year or more to plan, produce, and distribute.

Alcohol-Impaired and Drugged Driving References

American College of Emergency Physicians. (2006). *Alcohol Screening and Brief Intervention in the ED*. Washington, DC: Author. Available at www.acep.org/practres.aspx?id=34358

Alcohol Epidemiology Program. (2000). *Alcohol Policies in the United States: Highlights from the 50 States*. Minneapolis, MI: University of Minnesota, School of Public Health. Available at www.impacteen.org/generalarea_PDFs/Alcohol%20Policies%20in%20the%20United%20States.PDF

Applied Research Center. (2008). *Executive Summary of "Parents Who Host, Lose the Most: Don't Be a Party to Teenage Drinking" Campaign Survey.* Middletown, OH: Applied Research Center, Miami University Middletown. Available at www.drugfreeactionalliance.org/files/PWHExecSummary2006.pdf

Asbridge, M., Hayden, J. A., & Cartwright, J. L. (2012). Acute cannabis consumption and motor vehicle collision risk: systematic review of observational studies and meta-analysis. *BMJ: British Medical Journal*, *344*:e536, doi: 10.1136/bmj.e536.

Beirness, D. J., & Beasley, E. E. (2010). A roadside survey on alcohol and drug use among drivers in British Columbia. *Traffic Injury Prevention*, *11*, 215-221.

Beirness, D. J., Clayton, A., & Vanlaar, W. (2008). *An Investigation of the Usefulness, the Acceptability and Impact on Lifestyle of Alcohol Ignition Interlocks in Drink-Driving Offenders*. (Road Safety Research Report No. 88). London, England: Department for Transport. Available at www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme3/investigation.pdf

Beirness, D. J., & Robertson, R. D. (2005). *Alcohol Interlock Programs: Enhancing Acceptance, Participation and Compliance.* Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/PDF_publications/Hilton_Head_Proceedings.pdf

Beirness, D. J., & Simpson, H. M. (2006). Role of cannabis and benzodiazepines in motor vehicle crashes. In: *Drugs and Traffic: A Symposium*. Transportation Research Circular, Number E-C096, pp. 12-21. Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/circulars/ec096.pdf

Bergen, G., Shults, R. A., Beck, L. F., & Qayad, M. (2012). Self-reported alcohol-impaired driving in the U.S., 2006 and 2008. *American Journal of Preventive Medicine*, *42*, 142-149.

Berning, A., Compton, R., Vegega, M., Beirness, D., Hedlund, J., Jones, R., & Nichols, J. (2008). *Refusal of Intoxication Testing: A Report to Congress*. (Report No. DOT HS 811 098). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811098.pdf

Bingham, C. R., Shope, J. T., Parow, J. E., & Raghunathan, T. E. (2009). Crash types: Markers of increased risk of alcohol-involved crashes among teen drivers. *Journal of Studies on Alcohol and Drugs*, *70*, 528-535.

Blomberg, R. D. (1992). *Lower BAC limits for youth: evaluation of the Maryland .02 law*. (Report No. DOT HS 807 859). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25800/25857/DOT-HS-807-859.pdf

Brunson, W., & Knighten, P., editors. (2005). *Strategies for Addressing the DWI Offender: 10 Promising Sentencing Practices.* (Report No. DOT HS 809 850). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/enforce/PromisingSentence/images/10Promising.pdf

The Century Council. (2008). *Hardcore Drunk Driving: A Sourcebook of Promising Strategies, Laws & Programs*. Washington, DC: Author. Available at www.centurycouncil.org/drunk-driving/hardcore-drunk-driving-sourcebook

The Century Council. (2005). *Underage Drinking: A Resource Guide to State Laws.* Washington, DC: Author.

Chang, I., Gregory, C., & Lapham, S. C. (2002). *Review of Screening Instruments and Procedures for Evaluating DWI (Driving While Intoxicated/Impaired) Offenders*. Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/DWIScreeningReport.pdf

Cohen, D. A., Mason, K., & Scribner, R. A. (2001). The population consumption model, alcohol control practices, and alcohol-related traffic fatalities. *Preventive Medicine*, *34*, 187.

Compton, R., & Berning, A. (2009). *Results of the 2007 National Roadside Survey of Alcohol and Drug Use by Drivers.* (Report No. DOT HS 811 175). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811175.pdf

Compton, R., Vegega, M., & Smither, D. (2009). *Drug-Impaired Driving: Understanding the Problem and Ways to Reduce It: A Report to Congress*. (Report No. DOT HS 811 268). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811268.pdf

Couper, F. J., & Logan, B. K. (2004). *Drugs and Human Performance Fact Sheets*. (Report No. DOT HS 809 725). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/job185drugs/drugs_web.pdf

Crew, B. K., & Johnson, S. E. (2011). Do victim impact programs reduce recidivism for operating a motor vehicle while intoxicated? Findings from an outcomes evaluation. *Criminal Justice Studies*, *24*, 153-163.

Curtis, S. C., & Ramirez, R. L. (2011). *Source Investigations: A Tool to Combat Impaired Driving*. (Report No. DOT HS 811 519). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811519.pdf

Dang, J. N. (2008, May). *Statistical Analysis of Alcohol-related Driving Trends, 1982-2005.* (Report No. DOT HS 810 942). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/810942.pdf

Dassanayake, T., Michie, P., Carter, G., & Jones, A. (2011). Effects of benzodiazepines, antidepressants, and opioids on driving. A systematic review and meta-analysis of epidemiological and experimental evidence. *Drug Safety*, *34*, 125-156.

Decina, L. E., Foss, R. D., Tucker, M. E., Goodwin, A., and Sohn, J. (2009). *Alternative Transportation Programs: A Countermeasure for Reducing Impaired Driving*. (Report No. DOT HS 811 188). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811188.pdf

DeBaca, J. C., Lapham, S. C., Liang, H. C., & Skipper, B. J. (2001). Victim impact panels: Do they impact drunk drivers? A follow-up of female and male first-time and repeat offenders. *Journal of Studies on Alcohol*, *62*, 615-620.

De Gier, H. (2006). Medicinal drugs: Critical review of present knowledge and statements for discussion. In: *Drugs and Traffic: A Symposium*. Transportation Research Circular, Number E-C096, pp. 68-77. Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/circulars/ec096.pdf

Dill, P. L., & Wells-Parker, E. (2006). Court-mandated treatment for convicted drinking drivers. *Alcohol Research & Health. 29*, 41-8. Available at pubs.niaaa.nih.gov/publications/arh291/41-48.htm

Dill, P. L., Wells-Parker, E., & Soderstrom, C. A. (2004). The emergency care setting for screening and intervention for alcohol use problems among injured and high-risk drivers: a review. *Traffic Injury Prevention, 5*, 278-291.

Ditter, S. M., Elder, R. W., Shults, R. A., Sleet, D. A., Compton, R., & Nichols, J. L. (2005). Effectiveness of designated driver programs for reducing drinking and driving and alcohol-involved crashes: A systematic review, *American Journal of Preventive Medicine, 28(5S),* 280-287.

D'Onofrio, G., & Degutis, L. C. (2002). Preventive care in the emergency department: screening and brief intervention for alcohol problems in the emergency department: a systematic review. *Academic Emergency Medicine, 5*, 627-638.

De Young, N. J. (1997). An evaluation of the specific deterrent effect of vehicle impoundment on suspended, revoked and unlicensed drivers in California. (Report No. DOT HS 808 727).

Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25900/25940/DOT-HS-808-727.pdf

Dunlap, K. L., Mullins, T. G., & Stein, M. (2008). *Guidelines for Community Supervision of DWI Offenders*. (Report No. DOT HS 810 940). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810940.pdf

DuPont, R. L., Voas, R. B., Walsh, J. M., Shea, C., Talpins, S. K., & Neil, M. M. (2012). The need for drugged driving *per se* laws: a commentary. *Traffic Injury Prevention*, *13*, 31-42.

Elder, R. W., Lawrence, B., Janes, G., Brewer, R. D., Toomey, T. L., Higson, R. W., Naimi, T. S., Wing, S. G., & Fielding, J. (2007). Enhanced enforcement of laws prohibiting sale of alcohol to minors. Systematic review of effectiveness for reducing sales and underage drinking. *Transportation Research Circular: Traffic Safety and Alcohol Regulation*, Number E-C123, 181-187. Available at onlinepubs.trb.org/onlinepubs/circulars/ec123.pdf

Elder, R. W., Nichols, J. L., Shults, R.A., Sleet, D. A., Barrios, L. C., Compton, R., & the Task Force on Community Preventive Services. (2005). Effectiveness of school-based programs for reducing drinking and driving and Riding with Drinking Drivers. *American Journal of Preventive Medicine, 28(5S),* 288-297. Available at www.thecommunityguide.org/mvoi/mvoi-AJPM-evrev-school-based.pdf

Elder, R. W., Shults, R. A., Sleet, D. A., Nichols, J. L., Zaza, S., & Thompson, R. S. (2002). Effectiveness of Sobriety Checkpoints for Reducing Alcohol-Involved Crashes. *Traffic Injury Prevention, 3,* 266-274.

Elder, R. W., Shults, R. A., Sleet, D. A., Nichols, J. L., Thompson, R. S., Rajab, W., & the Task Force on Community Preventive Services. (2004). Effectiveness of mass media campaigns for reducing drinking and driving and alcohol-involved crashes. *American Journal of Preventive Medicine, 27*, 57-65. Available at www.thecommunityguide.org/mvoi/massmedia_ajpm.pdf

Erke, A., Goldenbeld, C., & Vaa, T. (2009). The effects of drink-driving checkpoints on crashes – A meta-analysis. *Accident Analysis and Prevention*, *41*, 914-923.

Farmer, C. M., Wells, J. K., Ferguson, S. A., & Voas, R. B. (1999). Field evaluation of the PAS III Passive Alcohol Sensor. *Traffic Injury Prevention*, *1*, 55-61.

Fell, J. C., Compton, C., & Voas, R. B. (2008). A note on the use of passive alcohol sensors during routine traffic stops. *Traffic Injury Prevention*, *9*, 534-538.

Fell, J. C., Ferguson, S. A., Williams, A. F., & Fields, M. (2003). Why are sobriety checkpoints not widely adopted as an enforcement strategy in the United States? *Accident Analysis and Prevention, 35*, 897-902.

Fell, J. C., Fisher, D. A., & McKnight, A. S. (2011). *A Guide for Local Impaired-Driving Task Forces, Vol. I: Final Report*. (Report No. DOT HS 811 460A). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811460a.pdf

Fell, J. C., Fisher, D. A., Voas, R. B., Blackman, K., & Tippetts, A. S. (2009). The impact of underage drinking laws on alcohol-related fatal crashes of young drivers. *Alcoholism: Clinical and Experimental Research*, *33*, 1208-1219.

Fell, J. C., Lacey, J. H., & Voas, R. B. (2004). Sobriety checkpoints: Evidence of effectiveness is strong, but use is limited. *Traffic Injury Prevention, 5*, 220-227.

Fell, J. C., & Langston, E. A. (2009). *A Guide for Statewide Impaired-Driving Task Forces*. (Report No. DOT HS 811 203). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811203.pdf

Fell, J. C., Langston, E. A., Lacey, J. H., & Tippetts, A. S. (2008). *Evaluation of Seven Publicized Enforcement Demonstration Programs to Reduce Impaired Driving: Georgia, Louisiana, Pennsylvania, Tennessee, Texas, Indiana, and Michigan*. (Report No. DOT HS 810 941). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810941.pdf

Fell, J. C., Tippetts, A. S., & Langston, E. A. (2011). *An Evaluation of the Three Georgia DUI Courts*. (Report No. DOT HS 811 450). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811450.pdf

Fell, J., Voas, R. B., & Lange, J. E. (1997). Designated driver concept: Extent of use in the USA. *Journal of Traffic Medicine, 25*(3–4), 109-114.

Ferguson, S. A., Teoh, E. R., & McCartt, A. T. (2007). Progress in teenage crash risk during the last decade. *Journal of Safety Research, 38*, 137-145.

Ferguson, S. A., Fields, M., & Voas, R. B. (2000). Enforcement of zero-tolerance laws in the United States. In *Proceedings of the 15th International Conference on Alcohol, Drugs and Traffic Safety.* Stockholm, Sweden. Available at www.icadts.org/proceedings/2000/icadts2000-108.pdf

Fieldler, K., Brittle, C., & Stafford, S. (2012). Case Studies of Ignition Interlock Programs. (Report No. DOT HS 811 594). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811594.pdf

Fiorentino, D., Cure, M., & Kipper, J. (2007). *Programs Across the United States that Aid Motorists in the Reporting of Impaired Drivers to Law Enforcement*. (Report No. DOT HS 810 750). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/810750.pdf

Gerstein, D., Johnson, R., Harwood, H., Fountain, D., Suiter, N., & Malloy, K. (1994). *Evaluating Recovery Services: The California Drug and Alcohol Treatment Assessment (CALDATA).* Sacramento, CA: California Department of Alcohol and Drug Problems.

GHSA. (2012a). *Drunk Driving Laws.* (2012, July). Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/impaired_laws.html

GHSA. (2012b). *Sobriety Checkpoint Laws.* (2012, July). Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/checkpoint_laws.html

GHSA. (2012c). *Drug Impaired Driving Laws*. (2012, July). Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/dre_perse_laws.html

Goodwin, A. H. (2004). A social norms approach to reduce drinking-driving among university students. In *Proceedings of the 17th International Conference on Alcohol, Drugs and Traffic Safety. Glasgow, Scotland.* Available at www.icadts.org/T2004/pdfs/O42.pdf

Grube, J., & Stewart, K. (2004). Preventing impaired driving using alcohol policy. *Traffic Injury Prevention*, *5*, 199-207.

Guard, A., & Rosenblum, L . (2008). *Alcohol screening and brief intervention: A guide for public health practitioners*. Washington DC: National Highway Traffic Safety Administration. Available at http://www.apha.org/NR/rdonlyres/B03B4514-CCBA-47B9-82B0-5FEB4D2DC983/0/SBImanualfinal4_16.pdf

Haire, E. R., Leaf, W. A., Presser, D. F., & Solomon, M. G. (2011). *Use of Warrants to Reduce Breath Test Refusals: Experiences From North Carolina*. (Report No. DOT HS 811 461). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811461.pdf

Harding, W., Apsler, R., & Goldfein, J. (1987). *A directory of ride service programs*. (Report No. DOT HS 807 146). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25700/25760/DOT-HS-807-146_001.pdf

Hedlund, J. H., & Beirness, D. J. (2007). *Use of Warrants for Breath Test Refusals: Case Studies*. (Report No. DOT HS 810 852). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810852.pdf

Hedlund, J. H., & McCartt, A. T. (2002). *Drunk Driving: Seeking Additional Solutions.* Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/DrunkDriving-SeekingAdditionalSolutions.pdf

Hingson, R. W., Assailly, J., & Williams, A. F. (2004). Underage drinking: Frequency, consequences, and interventions. *Traffic Injury Prevention, 5*, 228-236.

Hingson, R., Heeren, T., & Winter, M. (1998). Effects of Maine's 0.05% legal blood alcohol level for drivers with DWI convictions. *Public Health Reports, 113*, 440-446.

Hingson, R., McGovern, T., Howland, J., Heeren, T., Winter, M., & Zakocs, R. (1996). Reducing alcohol-impaired driving in Massachusetts: the Savings Lives Program. *American Journal of Public Health*, *86*, 791-797.

Holder, H. D., & Wagenaar, A. C. (1994). Mandated server training and reduced alcohol-involved traffic crashes: A time series analysis of the Oregon experience. *Accident Analysis and Prevention, 26*, 89-97.

Hover, A. R., Hover, B. A., & Young, J. C. (2000). Measuring the effectiveness of a community-sponsored DWI intervention for teens. *American Journal of Health Studies*, *16*, 171-176.

Huddleston, C. W., III, Marlowe, D.B., & Casebolt, R. (2008). *Painting the Current Picture: A National Report Card on Drug Courts and Other Problem-Solving Court Programs in the United States, Vol. II, No. 1*. Alexandria, VA: National Drug Court Institute. Available at www.ndci.org/sites/default/files/ndci/PCPII1_web%5B1%5D.pdf

International Association of Chiefs of Police. (2009).*The 2009 Annual Report. The Drug Recognition Expert Section of the International Association of Chiefs of Police*. Alexandria, VA: Author. Available at www.decp.org/oversight/2009AnnualReport.pdf

ICADTS. (2007). *Categorization System for Medicinal Drugs Affecting Driving Performance*. Available at www.icadts.nl/reports/medicinaldrugs1.pdf

Insurance Institute for Highway Safety. (2008). *Campaign Spurs Big Drop in Night Drinking, Driving*. Status Report, 43(6), 4-5. Arlington, VA: Author. Available at www.iihs.org/externaldata/srdata/docs/sr4306.pdf

IIHS. (2012). *DUI/DWI laws.* (2012, July). Arlington, VA: Author. Available at www.iihs.org/laws/dui.aspx

Jewell, J., & Hupp, S. D. A. (2005). Examining the effects of fatal vision goggles on changing attitudes and behaviors related to drinking and driving. *The Journal of Primary Prevention*, *26*, 553-565.

Jones, R. K., Joksch, H. C., Lacey, J. H., Wiliszowski, C., & Marchetti, L. (1995). *Summary Report: Field Test of Combined Speed, Alcohol, and Safety Belt Strategies*. (Report No. DOT HS

808 242). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25900/25919/DOT-HS-808-242.pdf

Jones, R. K., & Rodriguez-Iglesias, C. (2004). *Evaluation of Lower BAC Limits for Convicted OUI Offenders in Maine.* (Report No. DOT HS 809 827). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/alcohol/Maine-BAC-Limits/index.htm

Jones, R. K., Shinar, D., & Walsh, J. M. (2003). *State of Knowledge of Drug-Impaired Driving*. (Report No. DOT HS 809 642. Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/StateofKnwlegeDrugs/StateofKnwlegeDrugs/pages/TOC.html

Jones, R. K., Wiliszowski, C., & Lacey, J. H. (1996). *Evaluation of alternative programs for repeat DWI offenders.* (Report No. DOT HS 808 493). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/pub/hs808493.pdf

Kay, G. G., & Logan, B. K. (2011). *Drugged Driving Expert Panel Report: A Consensus Protocol for Assessing the Potential of Drugs to Impair Driving*. (Report No. DOT HS 808 493). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811438.pdf

Kelly, E., Darke, S., & Ross, J. (2004). A review of drug use and driving: Epidemiology, impairment, risk factors and risk perceptions. *Drug and Alcohol Review*, *23*, 319-344.

Kelley-Baker, T., Lacey, J., Brainard, K., Kirk, H., & Taylor, E. (2006). *Citizen Reporting of DUI*—Extra Eyes *to Identify Impaired Driving*. (Report No. DOT HS 810 647). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/alcohol/ExtraEyes/

Lacey, J., Brainard, K., & Snitow, S. (2010). *Drug Per Se Laws: A Review of Their Use in States*. (Report No. DOT HS 811 317). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/impaired_driving/pdf/811317.pdf

Lacey, J. H., Ferguson, S. A., Kelley-Baker, T., & Rider, R. P. (2006). Low-manpower checkpoints: can they provide effective DUI enforcement for small communities? *Traffic Injury Prevention, 7,* 213-218.

Lacey, J. H., Kelley-Baker, T., Brainard, K., Tippetts, S., & Lyakhovich, M. (2008). *Evaluation of the* Checkpoint Strikeforce *Program*. (Report No. DOT HS 811 056). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811056.pdf

Lacey, J. H., Kelley-Baker, T., Furr-Holden, D., Voas, R. B., Romano, E., Torres, P., Tippetts, A. S., Ramirez, A., Brainard, K., & Berning, A. (2009a). *2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Alcohol Results*. (Report No. DOT HS 811 248). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811248.pdf

Lacey, J. H., Kelley-Baker, T., Furr-Holden, D., Voas, R. B., Romano, E., Ramirez, A., Brainard, K., Moore, C., Torres, P., & Berning, A. (2009b). *2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Drug Results*. (Report No. DOT HS 811 249). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811249.pdf

Lacey, J. H., Jones, R. K., & Anderson, E. W. (2000). *Evaluation of a Full-Time Ride Service Program: Aspen, Colorado's* Tipsy Taxi *Service*. (Report No. DOT HS 809 155). Washington, DC: National Highway Traffic Safety Administration.

Lacey, J. H., Jones, R. K., & Wiliszowski, C. H. (2000). *Zero-Tolerance Laws for Youth: Four States' Experience.* (Report No. DOT HS 809 803). Washington, DC: National Highway Traffic Safety Administration.

Lapham, S. C., Kapitula, L. R., C'de Baca, J., & McMillan, G. P. (2006). Impaired-driving recidivism among repeat offenders following an intensive court-based intervention. *Accident Analysis and Prevention, 38*, 162-169.

Leaf, W. A., & Preusser, D. F. (2011). *Evaluation of Minnesota's Vehicle Plate Impoundment Law for Impaired Drivers*. (Report No. DOT HS 811 351). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811351.pdf

Lee, J. D., Fiorentino, D., Reyes, M. L., Brown, T. L., Omar, A., Fell, J., Ward, N., & Dufour, R. (2010). *Assessing the Feasibility of Vehicle-Based Sensors to Detect Alcohol Impairment*. (Report No. DOT HS 811 358). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2010/811358.pdf

Lenton, S., Fetherston, J., & Cercarelli, R. (2010). Recidivist drink drivers' self-reported reasons for driving whilst unlicensed – A qualitative study. *Accident Analysis and Prevention*, *42*, 637-644.

LeRoy, A. A., & Morse, M. L. (2008). *Multiple Medications and Vehicle Crashes: Analysis of Databases*. (Report No. DOT HS 810 858). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810858.pdf

Leung, S. Y. (2011). Benzodiazepines, opioids and driving: an overview of the experimental research. *Drug and Alcohol Review*, *30*, 281-286.

Levy, M., Compton, R., & Dienstfrey, S. (2004). Public Perceptions of the July 2003 "You Drink & Drive. You Lose" Crackdown: Telephone Surveys Show the Media Campaign Reaches Target Audience. (Traffic Safety Facts: Research Note. Report No. DOT HS 809 708). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/RN-public04/RN%20PublicPercep/images/Public_Perceptions.pdf%20

Linkenbach, J., & Perkins, H. W. (2005). Montana's MOST of Us Don't Drink and Drive Campaign: A Social Norms Strategy to Reduce Impaired Driving Among 21-34-Year-Olds. (Report No. DOT HS 809 869). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/alcohol/SocialNorms_Strategy/pages/TOC.htm

Lococo, K., & Tyree, R. (2007). *Medication Related Impaired Driving*. MedScape Education. Available at: http://www.medscape.org/viewprogram/31244

Marlowe, D. B., Festinger, D. S., Arabia, P. L., Croft, J. R., Patapis, N. S., et al. (2009). A systematic review of DWI court program evaluations. *Drug Court Review*, *6(2)*, 1-52. Available at www.ndci.org/sites/default/files/ncdc/DCR%2C%20Vol.%206%2C%20No.%202.pdf

Marques, P. R., ed. (2005). *Alcohol Ignition Interlock Devices Vol. II: Research, Policy, and Program Status 2005*. Ann Arbor, MI: International Council on Alcohol, Drugs and Traffic Safety. Available at www.icadts.org/reports/AlcoholInterlockReport2.pdf

Marques, P. R., & Voas, R. B. (2010). *Key Features for Ignition Interlock Programs*. (Report No. DOT HS 811 262). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/impaired_driving/pdf/811262.pdf

Marques, P. R., Voas, R. B., Roth, R., & Tippetts, A. S. (2010). *Evaluation of the New Mexico Ignition Interlock Program*). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811410.pdf

Mayhew, D. R., Donelson, A. C., Beirness, D. J., & Simpson, H. M. (1986). Youth alcohol and relative risk of crash involvement. *Accident Analysis and Prevention*, *18*, 273-287.

McCartt, A. T., Blackman, K., & Voas, R. B. (2007). Implementation of Washington State's Zero Tolerance Law: Patterns of Arrests, Dispositions, and Recidivism. *Traffic Injury Prevention*, *8*, 339-345.

McCartt, A. T., Geary, L. L., & Nissen, W. J. (2002). *Observational Study of the Extent of Driving While Suspended for Alcohol-Impaired Driving.* (Report No. DOT HS 809 491). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/observation_study/index.htm%20

McCartt, A. T. Leaf, W. A., Farmer, C. M., & Eichelberger, A. H. (2012). *Washington State's Alcohol Ignition Interlock Law: Effects on Recidivism Among First-time DUI Offenders*. Arlington, VA: Insurance Institute for Highway Safety. Available at www.iihs.org/research/topics/pdf/r1168.pdf

McCartt, A. T., & Northrup, V. S. (2003). *Enhanced Sanctions for Higher BACs: Evaluation of Minnesota's High-BAC Law*. (Report No. DOT HS 809 677). Washington, DC: National Highway Traffic Safety Administration Available at www.nhtsa.dot.gov/people/injury/alcohol/EnhancedSanctions/

McCartt, A. T., Hellinga, L. A., & Kirley, B. B. (2010). The effects of minimum legal drinking age 21 laws on alcohol-related driving in the United States. *Journal of Safety Research*, *41*, 173-181.

McCartt, A. T., & Northrup, V. S. (2004). Effects of enhanced sanctions for high-BAC DWI drivers on case dispositions and rates of recidivism, *Traffic Injury Prevention, 5,* 270-277.

McCartt, A. T., Wells, J. K., & Teoh, E. R. (2010). Attitudes toward in-vehicle advanced alcohol detection technology. *Traffic Injury Prevention*, *11*, 156-164.

McKnight, A. J., & Streff, F. M. (1994). The effect of enforcement upon service of alcohol to intoxicated patrons of bars and restaurants. *Accident Analysis and Prevention, 26*, 79-88.

McKnight, A. S., Watson, D. E., Voas, R. B., & Fell, J. C. (2008). *Update of Vehicle Sanction Laws and Their Application: Volume II – Vehicle Sanctions by State.* (Report No. DOT HS 811 028B). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811028b.pdf

Michigan Supreme Court and NPC Research (2008). *Michigan DUI Courts Outcome Evaluation: Final Report Executive Summary*. Lancing, MI: Michigan Supreme Court State Court Administrative Office. Available at www.npcresearch.com/Files/MI_DUI_Outcome_Evaluation_EXECUTIVE_SUMMARY_Re-Release_March_2008.pdf

Molof, M., Dresser, J., Ungerleider, S., Kimball, C., & Schaefer, J. (1995). *Assessment of year-round and holiday ride service programs*. (Report No. DOT HS 808 203). Washington, DC: National Highway Traffic Safety Administration.

Molof, M. J., & Kimball, C. (1994). *A Study of the Implementation and Effects of Oregon's Mandatory Alcohol Server Training Program*. Eugene, OR: Oregon Research Services Inc.

Mosher, J., Hauck, A., Carmona, M., Treffers, R., Reitz, D., et al. (2009). *Legal Research Report: Laws Prohibiting Alcohol Sales to Intoxicated Persons*. (Report No. DOT HS 811 142).

Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811142.pdf

Moskowitz, H., & Wilkinson, C. J. (2004). *Antihistamines and Driving-Related Behavior: A Review of the Evidence for Impairment*. (Report No. DOT HS 809 714). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/antihistamines/Antihistamines%20Web/images/Antihistamines%20text.pdf

Moulton, B. E., Peterson, A., Haddix, D., & Drew, L. (2010). *National Survey of Drinking and Driving Attitudes and Behaviors: 2008. Volume II: Findings Report.* (Report No. DOT HS 811 343). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811343.pdf

Movig, K. L. L., Mathijssen, M. P. M., Nagel, P. H. A., van Egmond, T., de Gier, J. J., et al. (2004). Psychoactive substance use and the risk of motor vehicle accidents. *Accident Analysis and Prevention*, *36*, 631-636.

Moyer, A., Finney, J. W., Swearingen, C. E., & Vergun, P. (2002). Brief interventions for alcohol problems: a meta-analytic review of controlled investigations in treatment-seeking and non-treatment-seeking populations. *Addiction, 97*, 279-292.

NADCP. (2009). *The Facts on Drug Courts.* Alexandria, VA: National Association of Drug Court Professionals. Available at www.nadcp.org/sites/default/files/nadcp/Facts%20on%20Drug%20Courts%20.pdf

NCHRP, Vol. 2. (2003). *A Guide for Addressing Collisions Involving Unlicensed Drivers and Drivers with Suspended or Revoked Licenses.* Washington, DC: Transportation Research Board. trb.org/publications/nchrp/nchrp_rpt_500v2.pdf

NCHRP, Vol. 16. (2005). *A Guide for Reducing Alcohol-related Collisions*. Washington, DC: Transportation Research Board. trb.org/publications/nchrp/nchrp_rpt_500v16.pdf

NCSL. (2012a). *Traffic Safety and Public Health: State Legislative Action 2011*. Denver, CO: National Conference of State Legislatures. Available at www.ncsl.org/documents/transportation/2011trafficsafety.pdf

NCSL. (2012b). *State Ignition Interlock Laws*. Denver, CO: National Conference of State Legislatures. Available at www.ncsl.org/issues-research/transport/state-ignition-interlock-laws.aspx

NCUTLO. (2007). *2007 Model DUI Law*. Alexandria, VA: National Committee on Uniform Traffic Laws and Ordinances. Available at www.ncutlo.org/2007dui.htm

NDCI. (2011). *Painting the Current Picture: A National Report on Drug Courts and Other Problem-Solving Court Programs in the United States*. Alexandria, VA: National Drug Court Institute. Available at www.ndci.org/sites/default/files/nadcp/PCP%20Report%20FINAL.PDF

NHTSA. (1989). *An Evaluation of the Elimination of Plea Bargaining for DWI Offenders*. (Report No. DOT HS 807 435). Washington, DC: Author.

NHTSA. (2001). *An Implementation Guide for Juvenile Holdover Programs*. Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/alcohol/juvenile/index.html

NHTSA. (2002). *Saturation Patrols and Sobriety Checkpoints: A How-to Guide for Planning and Publicizing Impaired Driving Enforcement Efforts*. (Report No. DOT HS 809 063). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/alcohol/saturation_patrols/index.html

NHTSA. (2003). *Criminal Justice Summit on Impaired Driving.* (Report No. DOT HS 809 605). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/enforce/CrimJustSum-HTML/

NHTSA. (2006a). *Uniform Guidelines for State Highway Safety Programs*. Washington, DC: Author. Available at www.nhtsa.dot.gov/nhtsa/whatsup/tea21/tea21programs/pages/ImpairedDrivingPDF.pdf

NHTSA. (2006b). *Low-Staffing Sobriety Checkpoints.* (Report No. DOT HS 810 590). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/enforce/LowStaffing_Checkpoints/images/LowStaffing.pdf

NHTSA. (2006c). Office of Impaired Driving and Occupant Protection, personal communication, July 21, 2006.

NHTSA. (2006d). *A Guide to Sentencing DWI Offenders. Second Edition, 2005.* (Report No. DOT HS 810 555). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/alcohol/dwioffenders/A%20Guide2.pdf

NHTSA. (2007a). *Evaluation of the National Impaired Driving High-Visibility Enforcement Campaign: 2003-2005*. (Report No. DOT HS 810 789). Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/YDYDYL_2001-05.pdf

NHTSA. (2007b). *Traffic Safety Resource Prosecutor's Manual*. (Report No. DOT HS 810 706). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/enforce/ProsecutorsManual/index.htm

NHTSA. (2008a). *Traffic Safety Facts, Laws: Administrative License Revocation*. (Report No. DOT HS 810 878). Washington, DC: Author.

NHTSA. (2008b). *Traffic Safety Facts, Laws: Open Container Laws*. (Report No. DOT HS 810 882W). Washington, DC: Author.

NHTSA. (2008c). *Traffic Safety Facts, Laws: High BAC Laws*. (Report No. DOT HS 810 883). Washington, DC: Author. Available at www.dmv.ne.gov/highwaysafety/pdf/altsfacts2.pdf

NHTSA. (2008d). *Traffic Safety Facts, Laws: Blood Alcohol Concentration Test Refusal Laws*. (Report No. DOT HS 810 884W). Washington, DC: Author.
Available at
www.safercar.gov/staticfiles/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/810884.pdf

NHTSA. (2008e). *Traffic Safety Facts, Laws: Sobriety Checkpoints.* (Report No. DOT HS 810 881W). Washington, DC: Author.

NHTSA. (2008f). *Traffic Safety Facts, Laws: Vehicle and License Plate Sanctions*. (Report No. DOT HS 810 880). Washington, DC: Author.

NHTSA. (2008g). *Traffic Safety Facts, Laws: Alcohol Exclusion Laws*. (Report No. DOT HS 810 885). Washington, DC: Author. Available at
www.safercar.gov/staticfiles/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/810885.pdf

NHTSA. (2009). *Traffic Safety Facts: 2008 Traffic Safety Annual Assessment – Highlights.* (Report No. DOT HS 811 172). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811172.PDF

NHTSA. (1996). *Drug Evaluation and Classification Program*. Washington, DC:
Author. Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/drepp.pdf

NHTSA. (2010a). *Traffic Safety Facts: Crash Stats. Drug Involvement of Fatally Injured Drivers*. (Report No. DOT HS 811 383). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811415.pdf

NHTSA. (2011a). *Traffic Safety Facts 2009.* (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.PDF

NHTSA. (2011b). *Digest of Impaired Driving and Selected Beverage Control Laws, 25*th *Edition.* (Report No. DOT HS 811 456). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/pdf/811456.pdf

NHTSA. (2012a). *Traffic Safety Facts 2010.* (Report No. DOT HS 811 659). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811659.PDF

NHTSA (2012b). *Traffic Safety Facts, 2010 Data: Alcohol-Impaired Driving*. (Report No. DOT HS 811 606). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811606.pdf

NHTSA. (2012c). *Traffic Safety Facts, 2010 Data: State Alcohol-Impaired Driving Estimates.* (Report No. DOT HS 811 612). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811612.pdf

NHTSA. (2012d). *Traffic Safety Facts, 2010 Data: Young Drivers.* (Report No. DOT HS 811 622). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811622.pdf

NIAAA. (2005). *A Pocket Guide for Alcohol Screening and Brief Intervention.* Rockville, MD: National Institute on Alcohol Abuse and Alcoholism. Available at pubs.niaaa.nih.gov/publications/Practitioner/PocketGuide/pocket_guide.htm

Nielson, A. L., & Watson, B. (2009). The effectiveness of designated driver programs. *Journal of the Australasian College of Road Safety*, *May 2009*, 32-37.

NTSB. (2000). *Actions to Reduce Fatalities, Injuries, and Crashes Involving the Hard Core Drinking Driver*. NTSB/SR-00/01). Washington, DC: National Transportation Safety Board. Available at www.ntsb.gov/publictn/2000/sr0001.pdf

Ojaniemi K. K., Lintonen, T. P., Impinen, A. OLillsunde, P. M., & Ostamo, A. I. (2009). Trends in driving under the influence of drugs: A register-based study of DUID suspects during 1977-2007. *Accident Analysis and Prevention*, *41*, 191-196.

ONDCP. (2010). *National Drug Control Strategy, 2010*. Washington, DC: Office of National Drug Control Policy. Available at www.whitehouse.gov/ondcp/2012-national-drug-control-strategy

ONDCP. (2011). *Drug Testing and Drug-Involved Driving of Fatally Injured Drivers in the United States: 2005-2009*. Washington, DC: Author. Available at www.whitehouse.gov/sites/default/files/ondcp/issues-content/fars_report_october_2011.pdf

Perkins, H. W. (2002). Social norms and the prevention of alcohol misuse in collegiate contexts. *Journal of Studies on Alcohol, 14*(S), 164-172.

Perkins, H. W. (2003). *The Emergence and Evolution of the Social Norms Approach to Substance Abuse Prevention*. In H. W. Perkins (Ed). The social norms approach to preventing school and college age substance abuse: A handbook for educators, counselors, clinicians. San Francisco: Jossey-Bass.

Preusser, D. F., Ulmer, R. G., & Preusser, C. W. (1992). *Evaluation of the Impact of the Drug Evaluation and Classification Program on Enforcement and Adjudication*. (Report No. DOT HS 808 058). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25800/25838/DOT-HS-808-058.pdf

Probst, J., Lewis, J., Asunka, K., Hershey, J., & Oram, S. (1987). *Assessment of Citizen Group Court Monitoring Programs*. (Report No. DOT HS 807 113). Washington, DC: National Highway Traffic Safety Administration.

Quinn-Zobeck, A. (2007). *Screening and Brief Intervention Tool Kit for College and University Campuses*. (Report No. DOT HS 810 751). Washington, DC: National Highway Traffic Safety Administration.

Ramirez, R., Nguyen, D., Cannon, C., Carmona, M, & Freisthler, B. (2008). *A Campaign to Reduce Impaired Driving Through Retail-Oriented Enforcement in Washington State*. (Report No. DOT HS 810 913). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810913.pdf

Rapoport, M. J., Lanctot, K. L., Steiner, D. L., Bedard, M., Vingilis, E., et al. (2009). Benzodiazepine use and driving: A meta-analysis. *Journal of Clinical Psychiatry*, *70*, 663-673.

Robertson, R. D., & Holmes, E. A. (2011). *Effective Strategies to Reduce Drunk Driving: Sobriety Checkpoints*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/PDF_publications/2011_DWI_WG_Sobriety_Checkpoints_8.pdf

Robertson, R. D., Holmes, E., & Vanlaar W. G. M. (2010). *The Implementation of Alcohol Interlocks for First Offenders: A Case Study*. Ottawa, ON: Traffic Injury Research Foundation. Available at http://tirf.ca/publications/PDF_publications/CC_2010_Report_web.pdf

Robertson, R. D., & Simpson, H. M. (2002a). *DWI System Improvements for Dealing with Hard Core Drinking Drivers: Prosecution*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=33

Robertson, R. D., & Simpson, H. M. (2002b). *DWI System Improvements for Dealing with Hard Core Drinking Drivers: Sanctioning*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=41

Robertson, R. D., & Simpson, H. M. (2003). *DWI System Improvement: Stopping the Revolving Door*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=60

Robertson, R. D., Simpson H. M., & Parsons P. (2008). *Screening, Assessment and Treatment of DWI Offenders: A Guide for Justice Professionals and Policy Makers*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/publications_show.php?pub_id=223

Robertson, R. D., Vanlaar, W. G. M., & Beirness, D. J. (2006). *Alcohol Interlock Programs: A Global Perspective*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=89

Robertson, R., Vanlaar, W., & Simpson, H. (2007). *10 Steps to a Strategic Review of the DWI System: A Guidebook for Policymakers*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=106

Rogers, A. (1995). Effects of Minnesota's license plate impoundment law on recidivism of multiple DWI violators. *Journal of Safety Research*, *26*, 125-126.

Roth, R. (2012). *2012 Survey of Currently Installed Interlocks in the U.S*. Sante Fe: NM. Available at www.rothinterlock.org/2012surveyofcurrentlyinstalledinterlocksintheus.pdf

Roth, R., Marques, P. R., & Voas, R. B. (2009). A note on the effectiveness of the house-arrest alternative for motivating DWI offenders to install ignition interlocks. *Journal of Safety Research*, *40*, 437-441.

Rothschild, M. L., Mastin, B., & Miller, T. W. (2006). Reducing alcohol-impaired driving crashes through the use of social marketing. *Accident Analysis and Prevention, 38*, 1218-1230.

SADD. (2012). *SADD by the Numbers*. Marlborough, MA: Students Against Destructive Decisions. Available at www.sadd.org/numbers.htm

SAMHSA. (2007). *Screening, Brief Intervention, Referral, and Treatment*. Washington, DC: Substance Abuse and Mental Health Services Administration. Available at www.sbirt.samhsa.gov/

Schermer, C. R., Gentilello, L. M., Hoyt, D. B., Moore, E. E., Moore, J. B., Rozycki, G., & Feliciano, D. V. (2003). National survey of trauma surgeons' use of alcohol screening and brief intervention. *The Journal of Trauma: Injury, Infection, and Critical Care*, *55*, 849-856.

Schwilke, E. W., Sampaio dos Santos, M. I., & Logan, B. K. (2006). Changing patterns of drug and alcohol use in fatally injured drivers in Washington State. *Journal of Forensic Sciences*, *51*, 1191-1198.

Sewell, R. A., Poling, J., & Sofuoglu, M. (2009). The effect of cannabis compared with alcohol on driving. *The American Journal on Addictions*, *18*, 185-193.

Shaffer, H. J., Nelson, S. E., LaPlante, D. A., LaBrie, R. A., Albanese, M., & Caro, G. (2007). The epidemiology of psychiatric disorders among repeat DUI offenders accepting a treatment-sentencing option. *Journal of Consulting and Clinical Psychology*, *75*, 795-804.

Shinar, D. (1992). Impact of court monitoring on the adjudication of driving while intoxicated (DWI). *Accident Analysis and Prevention, 24*, 167-179.

Shinar, D., & Compton, R. P. (1995). Victim Impact Panels: Their impact on DWI recidivism. *Alcohol, Drugs and Driving*, *11*, 73-87.

Shinar, D., Schechtman, E., & Compton, R. P. (2000) *Signs and symptoms predictive of drug impairment.* In: *15th International Conference on Alcohol, Drugs & Traffic Safety.* May 22-26, 2000. Stockholm, Sweden. International Council on Alcohol, Drugs & Traffic Safety. Available at www.icadts.org/proceedings/2000/icadts2000-045.pdf

Shults, R. A., Elder R. W., Nichols, J. L., Sleet, D. A., Compton, R., et al. (2009). Effectiveness of multicomponent programs with community mobilization for reducing alcohol-impaired driving. *American Journal of Preventive Medicine, 37*, 360-371.

Shults, R. A., Elder, R. W., Sleet, D. A., Nichols, J. L., Alao, M. O., et al. (2001). Review of evidence regarding interventions to reduce alcohol-impaired driving. *American Journal of Preventive Medicine, 21(4S*), 66-84. Available at www.thecommunityguide.org/mvoi/mvoi-AJPM-evrev-alchl-imprd-drvng.pdf

Simpson, H.M., and Robertson, R.D. (2001). *DWI System Improvements for Dealing with Hard Core Drinking Drivers: Enforcement*. Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=163

Solomon, M. G., Hedlund, J. H., Haire, E. R., Chaffe, R. H. B., & Cosgrove, L. A. (2008). *The 2006 National Labor Day Impaired Driving Enforcement Crackdown:* Drunk Driving. Over the Limit. Under Arrest. (Report No. DOT HS 811 039). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811039.pdf

Sprattler, K., (2009). *Ignition Interlocks – What You Need to Know: A Toolkit for Policymakers, Highway Safety Professionals, and Advocates*. (Report No. DOT HS 811 246). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/impaired_driving/pdf/811246.pdf

Stewart, K. (1999). *Strategies to Reduce Underage Alcohol Use: Typology and Brief Overview*. Washington, DC: Office of Juvenile Justice and Delinquency Prevention, Department of Justice. Available at www.udetc.org/documents/strategies.pdf

Stewart, K. (2006). Overview and summary. In: *Drugs and Traffic: A Symposium*. Transportation Research Circular, Number E-C096, pp. 2-10. Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/circulars/ec096.pdf

Stuster, J. W. (2000). Increasing the opportunity to examine impaired drivers, in *Issues and Methods in the Detection of Alcohol and Other Drugs*. (TRB Circular E-C020, pp. D10-D14). Washington, DC: Transportation Research Board. Available at onlinepubs.trb.org/Onlinepubs/circulars/ec020.pdf

Stuster, J. W., & Blowers, P. (1995). *Experimental Evaluation of Sobriety Checkpoint Programs*. (Report No. DOT HS 808 287). Washington, DC: National Highway Traffic Safety Administration.

Stuster, J., & Burns, M. (1998). *Validation of the Standardized Field Sobriety Test Battery at BAC's Below 0.10 Percent.* (Report No. DOT HS 808 839). Washington, DC: National Highway Traffic Safety Administration.

Stuster, J., Burns, M. & Fiorentino, D. (2002). *Open Container Laws and Alcohol Involved Crashes: Some Preliminary Data*. (Report No. DOT HS 809 426). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/alcohol/OpenContainer/HS809426.pdf%20

Syner, J. (2006). Personal communication.

Syner, J., Jackson, B., Dankers, L., Naff, B., Hancock, S., & Siegler, J. (2008). *Strategic Evaluation States Initiative – Case Studies of Alaska, Georgia, and West Virginia*. (Report No. DOT HS 810 923). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810923.pdf

TIRF. (2010). *Alcohol Interlock Curriculum for Practitioners*. Ottawa, Ontario: Traffic Injury Research Foundation. Available at http://aic.tirf.ca/section1/index.php

TIRF. (2011). *Alcohol Interlocks: Harmonizing Policies and Practices*. Ottawa, Ontario: Traffic Injury Research Foundation.

Toomey, T. L., & Wagenaar, A. C. (1999). Policy options for prevention: the case of alcohol, *Journal of Public Health Policy, 20*, 192-13.

Ulmer, R. G., Hedlund, J. H., & Preusser, D. F. (1999). *Determine why alcohol-related fatalities decreased in five states*. Final report. Washington, DC: National Highway Traffic Safety Administration.

Ulmer, R. G., Shabanova, V. I., & Preusser, D. F. (2001). *Evaluation of Use and Lose Laws*. (Report No. DOT HS 809 285). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/pub/alcohol-laws/eval-of-law/

Vandrevala, T., Helman, S., Turner, C., & Stone, B. (2010). *Medication and Road Safety: A Scoping Study*. (Road Safety Research Report No. 116). London: Department of Transport. Available at www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme3/report16review.pdf

Vanlaar, W., Robertson, R., Schaap, D., & Vissers, J. (2010). *Understanding Behavioural Patterns of Interlocked Offenders to Inform the Efficient and Effective Implementation of Interlock Programs: How Offenders on an Interlock Learn to Comply*. Ottawa, Ontario: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/document_request.php?docid=204

Van Vleck, V. N. L., & Brinkley, G. L. (2009). Alert eyes and DWIs: An indirect evaluation of a DWI witness reward program in Stockton, CA. *Accident Analysis and Prevention*, *41*, 581-587.

Voas, R. B. (2008). A new look at NHTSA's evaluation of the 1984 Charlottesville sobriety checkpoint program: Implications for current checkpoint issues. *Traffic Injury Prevention*, *9*, 22-30.

Voas, R. B., Blackman, K. O., Tippetts, A. S., & Marques, P. R. (2001). Motivating DUI offenders to install interlocks: avoiding jail as an incentive. *Alcoholism: Clinical and Experimental Research*, *25*, 102A.

Voas, R. B., Fell, J. C., McKnight, A.S., & Sweedler, B. M. (2004). Controlling impaired driving through vehicle programs: an overview. *Traffic Injury Prevention, 5*, 292-298.

Voas, R. B., & Fisher, D. A. (2001). Court procedures for handling intoxicated drivers. *Alcohol Research and Health World*, *25*, 32-42.

Voas, R. B., Kelley-Baker, T., Romano, E., & Vishnuvajjala, R. (2009). Implied-consent laws: A review of the literature and examination of current problems and related statutes. *Journal of Safety Research*, *40*, 77-83.

Voas, R. B., & Lacey, J. H. (2011). *Alcohol and Highway Safety 2006: A Review of the State of Knowledge*. (Report No. DOT HS 811 374). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811374.pdf

Voas, R. B., McKnight, A. S., Falb, T., & Fell, J. C. (2008). *Update of Vehicle Sanction Laws and Their Application: Volume I – Summary.* (Report No. DOT HS 811 028A). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811028a.pdf

Voas, R. B., Romano, E., & Peck, R. (2006). Validity of the passive alcohol sensor for estimating BACs in DWI-enforcement operations. *Journal of Studies on Alcohol, 67*, 714-721.

Voas, R. B., Tippetts, A. S., Fisher, D., & Grosz, M. (2010). Requiring suspended drunk drivers to install alcohol interlocks to reinstate their licenses: Effective? *Addiction*, *105*, 1422-1428.

Voas, R. B., Tippetts, A. S., & McKnight, A. S. (2010). DUI offenders delay license reinstatement: a problem? *Alcoholims: Clinical and Experimental Research*, *34*, 1282-1290.

Voas, R. B., Tippetts, S., & Taylor, E. (1998). Temporary Vehicle Impoundment in Ohio: A Replication and Confirmation. *Accident Analysis and Prevention*, *30*, 651-655.

Wagenaar, A. C., & Maldonado-Molina, M. M. (2007). Effects of drivers' license suspension policies on alcohol-related crash involvement: Long-term follow-up in forty-six states. *Alcoholism: Clinical and Experimental Research*, *31*, 1399-1406.

Wagenaar, A. C., Maldonado-Molina, M. M., Erickson, D. J. et al. (2008). General deterrence effects of U.S. statutory DUI fine and jail penalties: Long-term follow-up in 32 states. *Accident Analysis and Prevention*, *39*, 982-994.

Wagenaar, A. C., & Tobler, A. L. (2007). Alcohol sales and service to underage youth and intoxicated patrons. Effects of responsible beverage service training and enforcement interventions. *Transportation Research Circular: Traffic Safety and Alcohol Regulation*. (Number E-C123, 141-163). Available at onlinepubs.trb.org/onlinepubs/circulars/ec123.pdf

Wagenaar, A. C., Toomey, T. L., & Erickson, D. J. (2005). Preventing yough access to alcohol: outcomes from a multi-community time-series trial. *Addiction*, *100*, 335-345.

Wagenaar, A. C., Zobek, T. S., Williams, G. D., & Hingson, R. (2000). *Effects of DWI Control Efforts: a Systematic Review of the Literature from 1960-1991.* Minneapolis, MN: University of Minnesota, School of Public Health.

Walsh, J. M. (2009). *A State-by-State Analysis of Laws Dealing With Driving Under the Influence of Drugs*. (Report No. DOT HS 811 236). Washington, DC: National Highway Traffic Safety Administration. Available at http://druggeddriving.org/pdfs/WalshStatebyStateDrugLawsAnalysis811236.pdf

Weatherburn, D., & Moffatt, S. (2011). The specific deterrent effect of higher fines on drink-driving offenders. *British Journal of Criminology*, *51*, 789-803.

Wechsler, H., & Nelson, T. F. (2010). Will increasing alcohol availability by lowering the minimum legal drinking age decrease drinking and related consequences among youths? *American Journal of Public Health*, *100*, 986-992.

Wells-Parker, E., Bangert-Drowns, R., McMillan, R., & Williams, M. (1995). Final results from a meta-analysis of remedial interventions with drink/drive offenders. *Addiction, 90*, 907-926.

Wheeler, D. R., Rogers, E. M., Tonigan, J. S., & Woodall, W. G. (2004). Effectiveness of customized Victim Impact Panels on first-time DWI offender inmates. *Accident Analysis and Prevention*, *36*, 29-35.

Wiliszowski, C. H., Jones, R. K., & Lacey, J. H. (2003). *Examining the Effectiveness of Utah's Law Allowing for Telephonic Testimony at ALR Hearings.* (Report No. DOT HS 809 602). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/Utah_telephonic/Images/UTAH.PDF%20

Wiliszowski, C., Fell, J., McKnight, S., & Tippetts, S. (2011). *An Evaluation of Intensive Supervision Programs for Serious DWI Offenders*. (Report No. DOT HS 811 446). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811446.pdf

Wilk, A. L., Jensen, N. M., & Havighurst, T. C. (1997). Meta-analysis of randomized control trials addressing brief interventions in heavy alcohol drinkers. *Journal of General Internal Medicine, 12*, 274-83.

Williams, A. F. (2003). Teenage drivers: patterns of risk. *Journal of Safety Research, 34*, 5-15.

Williams, A. F. (2007). *Public Information and Education in the Promotion of Highway Safety*. Research Results Digest 322. Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_322.pdf

Willis, C., Lybrand, S., & Bellamy, N. (2006). Alcohol ignition interlock programmes for reducing drink driving recidivism. *The Cochrane Database of Systematic Reviews*. Available at www.cochrane.org/reviews/en/ab004168.html

Zador, P. L., Ahlin, E. M., Rauch, W. J., Howard, J. M., & Duncan, G. D. (2011). The effects of closer monitoring on driver compliance with interlock restrictions. *Accident Analysis and Prevention*, *43*, 1960-1967.

Zador, P. L., Krawchuk, S. A., & Voas, R. B. (2000). Alcohol-related relative risk of driver fatalities and driver involvement in fatal crashes in relation to driver age and gender: An update using 1996 data. *Journal of Studies on Alcohol*, *61*, 387-395.

Zwicker, T. J., Chaudhary, N. K., Maloney, S., & Squeglia, R. (2007). Connecticut's 2003 Impaired-Driving High-Visibility Enforcement Campaign. (Report No. DOT HS 810 689). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/810689.pdf

Zwicker, T. J., Chaudhary, N. K., Solomon, M.G., Siegler, J. N., & Meadows, J. D. (2007). West Virginia's Impaired Driving High-Visibility Enforcement Campaign, 2003-2005. (Report No. DOT HS 810 792). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/WVAImpairedDrivingLow.pdf

Zwicker, T. J., Hedlund, J., & Northrup, V. S. (2005). Breath Test Refusals in DWI Enforcement: An Interim Report. (Report No. DOT HS 809 876). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/809876.pdf

2. Seat Belts and Child Restraints

Overview

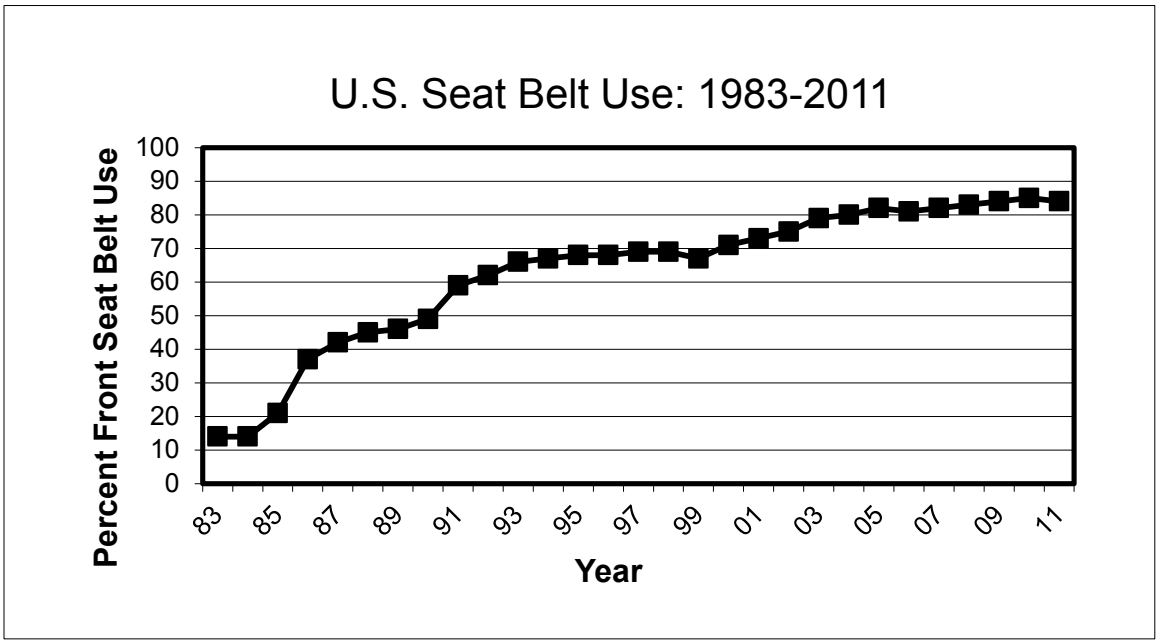
Research has shown that correctly using an appropriate child restraint or seat belt is the single most effective way to save lives and reduce injuries in crashes. Lap and shoulder combination seat belts, when used, reduce the risk of fatal injury to front-seat passenger car occupants by 45% and the risk of moderate-to-critical injury by 50% (NHTSA, 2001). For light-truck occupants, seat belts reduce the risk of fatal injury by 60% and moderate-to-critical injury by 65% (NHTSA, 2009a).

NHTSA estimates that correctly used child restraints are even more effective than seat belts in reducing fatalities. Child restraints reduce fatalities by 71% for infants younger than 1 year old and by 54% for children 1 to 4 years old in passenger cars. In light trucks, the fatality reductions are 58% for infants and 59% for children 1 to 4 years old (NHTSA, 1996). In addition, research conducted by the Partners for Child Passenger Safety Program at the Children's Hospital of Philadelphia found that belt-positioning booster seats reduce the risk of injury to children 4 to 8 in crashes by 45% when compared to the effectiveness of seat belts alone (Arbogast, Jermakian, Kallan & Durbin, 2009).

The challenge is to convince all passenger vehicle occupants to buckle up. Current data show that for adult drivers and right-front seat passengers:

- Seat belt use nationwide was 86% in 2012 (NHTSA, 2012a);
- In 2010, belt use was greater than or equal to 90% in 15 States (Alabama, California, Delaware, Hawaii, Illinois, Indiana, Iowa, Maryland, Michigan, Minnesota, Nevada, New Jersey, Oregon, Texas, and Washington) and the District of Columbia (NHTSA, 2011a); but
- In 2010, belt use was less than 75% in 4 States and a Territory (Massachusetts, New Hampshire, North Dakota, South Dakota, plus American Samoa) (NHTSA, 2011a).

See NHTSA's most recent reports (NHTSA, 2009a, 2012a) for the latest national and State data.

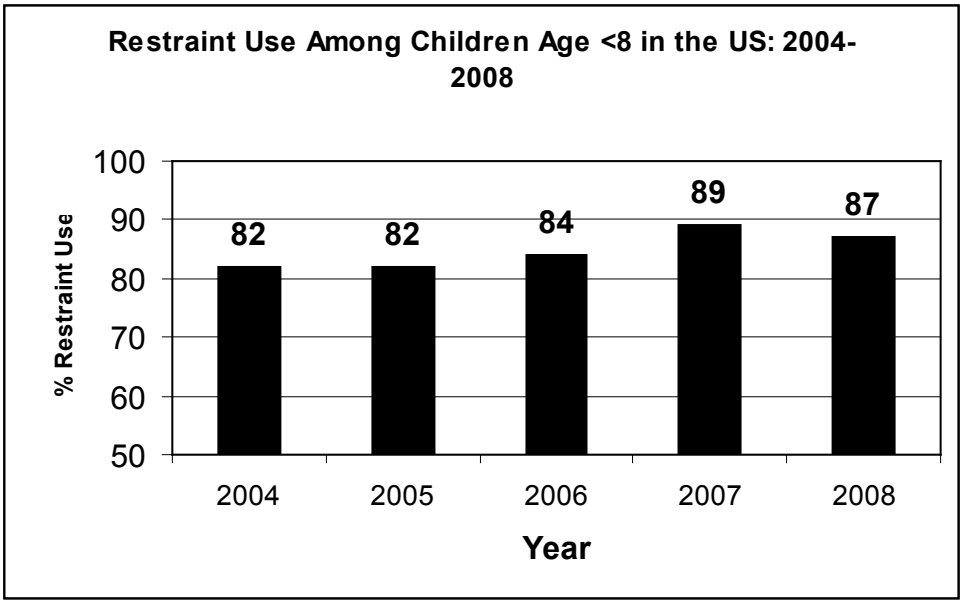


Source: NHTSA, National Occupant Protection Use Survey (NOPUS)

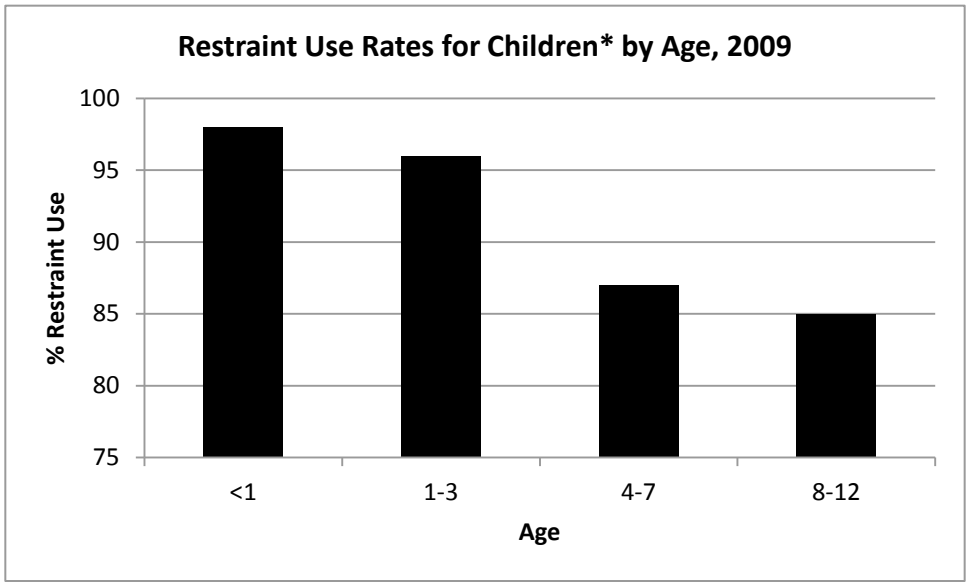
For child passengers:

- The restraint use for all children less than 8 years old was 91% in 2011 compared to 89% in 2010 (Pickrell & Ye, 2013), however differences exist by age group:
    - children younger than 1, 98%
    - children 1 to 3 years old, 96%
    - children 4 to 7 years old, 87%
    - children 8 to 12 years old, 85%.
- In 2010, 441 children under 8 were killed as passengers in motor vehicle crashes (NHTSA, 2012b). Between 1975 and 2010, the motor vehicle fatality rate for children under 5 dropped from 4.50 to 1.48 per 100,000 population (NHTSA, 2011b). Among children 5 to 9, the fatality rate decreased from 2.71 to 1.27 during that same time period.
- The National Survey of the Use of Booster Seats (NSUBS) found that in 2009:
    - About 23% of children who were under 1 or less than 20 pounds were not in rear-facing child restraints. Most of these children had been prematurely switched to front-facing restraints. Prior to the 2011 NHTSA and American Academy of Pediatrics recommendations, the minimum recommended age for turning a child forward-facing was 1 year old and 20 pounds (AAP, 2002).
    - NHTSA recommends that once children outgrow their forward-facing seats they should ride in booster seats until they are at least 8 years old or 4' 9" (57") tall. However, the 2009 NSUBS found that 48% of the children who were 37 to 53 inches tall were in a child restraint or booster, 39% were in seat belts, and 12% were unrestrained. Furthermore, only 7% of the children who were 54 to 56 inches tall were in child restraints or boosters, 78% were in seat belts, and 15% were unrestrained. (Pickrell & Ye, 2010).
- In 2003, the overall measure of "critical" child restraint misuse – misuse that could reasonably be expected to result in serious injury or death to the child – was found to be 73% with the most common critical misuses being loose harness straps securing the child

to the child restraint and loose seat belt used to install the child restraint in the vehicle (Decina & Lococo, 2004).



Source: NHTSA, Child Restraint Use in 2008 - Overall Results



Source: NHTSA, The National Survey of the Use of Booster Seats 2009

In March 2011, NHTSA and the American Academy of Pediatrics revised their child restraint usage recommendations. The new recommendations encourage parents and caregivers to keep children in rear-facing child restraints until they outgrow the rear-facing capabilities of their child restraint. AAP specifically suggests using rear-facing child restraints until at least age 2.

Additionally, the recommendations encourage use of a forward-facing 5-point harness seat until the child outgrows the harness by weight or height, and booster seats until the vehicle lap/shoulder combination belt fits properly on its own (Durbin, Committee on Injury, Violence, and Poison Prevention, 2011; NHTSA, 2012c).

It is not clear how these new recommendations will affect restraint use among children. The most recent data available does not reflect these recommendations.

Seat Belts for Adults – Trends and Laws

All new passenger cars had some form of seat belts beginning in 1964, shoulder belts in 1968, and integrated lap and shoulder belts in 1974 (ACTS, 2001). However, few occupants used the belts. The first widespread survey, done in 19 cities in 1982, observed 11% belt use for drivers and front-seat passengers (Williams & Wells, 2004). This survey became the benchmark for tracking belt use nationwide. Incentive programs which rewarded seat belt use were effective in raising belt use in low use communities where no belt use law was in effect.

New York enacted the first belt use law in 1984 with other states soon following. Evaluations of the first seat belt laws found that they tended to increase seat belt use from baseline levels of about 15% to 20% to post-law use rates of about 50% (Nichols & Ledingham, 2008).

High-visibility, short-duration belt law enforcement programs, often called STEPs (Selective Traffic Enforcement Programs), "STEP waves," or "blitzes," were demonstrated in individual communities in the late 1980s. North Carolina's *Click It or Ticket* program took this model statewide beginning in 1993 and raised the use rate above 80% (Williams & Wells, 2004). The *Click It or Ticket* model expanded nationwide in 2003 (Solomon, Compton, & Preusser, 2004) and belt use increased nationwide in almost all states from 2000-2006, in part due to the *Click It or Ticket* seatbelt enforcement programs (Tison & Williams, 2010). The national belt use rate reached 86% in 2012 (NHTSA, 2012a). As of July 2012, all States except New Hampshire require adult passenger vehicle drivers and occupants to wear seat belts.

For more information on the history of belt systems, belt use laws, enforcement programs, and belt use trends, see ACTS (2001), Solomon et al. (2004), Milano, McInturff, and Nichols (2004), NCHRP (2004), NHTSA (2001, 2003b), Williams and Wells (2004), and Hedlund, Gilbert, Ledingham, and Preusser (2008).

Child Restraints and Seat Belts for Children – Trends and Laws

The first Federal standard for child restraints, FMVSS 213, went into effect in 1971 but did not require restraint systems intended for infants and small children to be dynamically tested. FMVSS 213 was amended such that, beginning in 1981, child restraints were required to be dynamically tested in a simulated 30 mph crash into a barrier, and has been amended several times since then to address issues of potential misuse of the child restraints, to require more stringent head excursion requirements, to accommodate larger and heavier children, and to require LATCH (Lower Anchors and Tethers for Children) attachments.

During the 1970s, the medical community, governmental agencies and consumer/advocacy groups conducted widespread public awareness campaigns to educate the public about the need for children to ride in restraints designed specifically for them. These campaigns achieved only a modicum of success. In 1979, when Tennessee was the only State to have a child restraint law, restraint use for children up to 4 years old was estimated to be only 15%. Between 1978 and 1985, every State and the District of Columbia passed laws requiring safety seats for young child passengers (Kahane, 1986), and most of these laws have since been amended and strengthened to include more children and to close loopholes and exemptions.

In the early years, many State and local organizations initiated programs to make child restraints available at low or no cost to parents through child restraint loan or rental programs in order to encourage use (Orr, Hall, Woodward, & Desper, 1987). The public has supported the laws and generally understands why they are needed. By 1984, close to half of the child passenger population up to age 4 were riding in child restraints (Kahane, 1986) and by 2008, child restraint use was over 90% (99% for age less than 1), although rates drop markedly among children in successive age groups (NHTSA, 2009b).

Even though child restraints are being used, that doesn't mean they are being used correctly. The misuse of child restraints - that is, when the restraint is not being used according to the manufacturer's instructions - is an issue that has been a concern for many years. In recent years the overall measure of "critical" child restraint misuse - misuse that could reasonably be expected to result in serious injury or death to the child - was found to be 73% (Decina & Lococo, 2004).

In order to combat this misuse, programs have been implemented to provide parents and other caregivers with "hands-on" assistance with the installation and use of child restraints. The NHTSA Standardized Child Passenger Safety Training Course, complemented by a national certification process, was developed and implemented in 1998 to train safety professionals and other interested parties in the fundamentals of child passenger safety. Individuals who successfully completed the course are certified to educate the public in using child restraints properly (Womack, De La Zerda, Block, & Guzzetta, 2005). As of June 2012, there were 35,161 certified CPS technicians and instructors (Safe Kids Worldwide, 2012).

Child passenger safety inspection stations, sometimes called "fitting stations," are places or events where parents and caregivers can receive assistance from certified CPS technicians, and are popular services provided by a variety of local CPS programs. Guidebooks are available on how local programs can set up and operate a mobile CPS clinic or permanent inspection station (Hall, 1987; NHTSA 2003a).

Also in reaction to the high levels of child restraint misuse and incompatibility issues between seat belts and child restraints, a concept of standardized child restraint installation, initially called ISOFIX, was completed as an international standard in 1999 (Klinich, Manary, & Weber, 2012). The intent of ISOFIX, later renamed as LATCH (Lower Anchors and Tethers for Children) as implemented in the United States, is to provide a simpler way to install child restraints and reduce misuse using special attachments that fasten to anchors built into the vehicle.

In a LATCH use and misuse study (Decina, Lococo, & Doyle, 2006), 61% of child restraints installed in LATCH-equipped vehicles and installed with the lower attachments were correctly and securely installed. In the most recent national study before the LATCH study, less than 50% of child restraints installed with seat belts were correctly and securely installed (Decina & Lococo, 2004).

Strategies to Increase Child Restraint Use and Seat Belt Use for Adults and Older Children

This chapter addresses child restraint use by infants and young children as well as seat belt use by adults and older children. Younger children require rear-facing, forward-facing, or booster seats appropriate to their size and weight and are covered by restraint use laws different than those for adults in all States. Many issues and strategies for increasing child occupant protection are quite different from those raised by adult belt use. Therefore, countermeasures in this chapter are organized by type and occupant age:

- Adults
- Pre-teens and Teenagers in Seat Belts, and
- Infants and Children in Child Restraints/Booster Seats.

The most effective strategy for achieving and maintaining high belt use is highly publicized high-visibility enforcement of strong occupant restraint use laws. The effectiveness of high visibility enforcement has been documented repeatedly in the United States and abroad. The strategy's three components – laws, enforcement, and publicity – cannot be separated: effectiveness decreases if any one is weak or lacking (Nichols & Ledingham, 2008; Tison & Williams, 2010). Some communications and outreach programs directed to well-defined and limited audiences such as schools, businesses, and communities have been moderately successful and also are discussed in this chapter. Lucke et al. (2004) discuss several of these strategies and provides links to additional information.

Seat belt and child restraint use may also be affected by vehicle design features such as the comfort and convenience of belt systems, and by lights, buzzers or gear shift interlocks to remind occupants to buckle up (NHTSA, 2003b; Van Houten, Malenfant, Reagan, Sifrit, & Compton, 2009). These vehicular countermeasures are not included in this guide because SHSOs have little or no authority or responsibility for them.

Resources

The agencies and organizations listed below can provide more information on seat belt use and child passenger safety, and links to numerous other resources.

Seat Belts and Child Passenger Safety

- National Highway Traffic Safety Administration:
    - Occupant Protection - www.nhtsa.gov/Driving+Safety/Occupant+Protection
    - Parents Central - www.safercar.gov/parents/index.htm

  - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
  - NHTSA Car Seat "Ease of Use" Ratings: http://www.nhtsa.gov/Safety/Ease-of-Use
- Centers for Disease Control and Prevention, Injury Prevention & Control: Motor Vehicle Safety: www.cdc.gov/Motorvehiclesafety/index.html
- Governors Highway Safety Association: www.ghsa.org/html/issues/occprotection/index.html
- Insurance Institute for Highway Safety:
  - Safety Belt Use - www.iihs.org/research/topics/belt_use.html
  - Children - www.iihs.org/research/topics/children.html
- National Safety Council:
  - Seat Belts - www.nsc.org/safety_road/DriverSafety/Pages/SeatBelts.aspx
  - Child Safety Seats & Boosters - www.nsc.org/safety_road/DriverSafety/Pages/ChildPassengerSafety.aspx
- AAA
  - Safety Belts - http://exchange.aaa.com/safety/roadway-safety/safety-belts/
  - Child Passenger Safety - http://exchange.aaa.com/safety/child-safety/
- AAA Foundation for Traffic Safety: www.aaafoundation.org

Child Passenger Safety

- American Academy of Pediatrics
  - Annual *Car Seat information For Families* guide: http://www.healthychildren.org/English/safety-prevention/on-the-go/pages/Car-Safety-Seats-Information-for-Families.aspx
  - Annual *Car Seat Guide for Families*, including sizes and price ranges: http://www.healthychildren.org/English/safety-prevention/on-the-go/pages/Car-Safety-Seats-Product-Listing.aspx)
- Automotive Safety Program, Riley Hospital for Children: www.preventinjury.org
- Center for Injury Research and Prevention, The Children's Hospital of Philadelphia - www.research.chop.edu/programs/injury/
- Safe Ride News Publications: www.saferidenews.com
- SafetyBeltSafe U.S.A.: www.carseat.org
- University of Michigan Transportation Research Institute: www.cpsbestpractice.org

Key terms

- Primary enforcement: laws that permit child passenger safety law and seat belt use law violators to be stopped and cited by a law enforcement officer independently of any other traffic behavior.
- Secondary enforcement: laws that permit child passenger safety law and seat belt use law violators to be cited only after they have been stopped for some other traffic violation.

Countermeasures That Work

Countermeasures to increase seat belt use are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, cost, use, and time required for implementation. The terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information on each item.

Countermeasures Targeting Adults

1. Seat Belt Use Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 State primary enforcement belt use laws	★★★★★	$	Medium	Short
1.2 Local primary enforcement belt use laws	★★★★	$	Low	Short
1.3 Increased belt use law penalties	★★★★†	$	Low	Short

†Effectiveness has been demonstrated for increased fines but has not yet been demonstrated for driver's license points.

2. Seat Belt Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Short high-visibility belt law enforcement	★★★★★	$$$	Medium†	Medium
2.2 Combined enforcement, nighttime	★★★★	$$$	Unknown	Medium
2.3 Sustained enforcement	★★★	Varies	Unknown	Varies

† Used in many jurisdictions but often only once or twice each year

3. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Supporting enforcement	★★★★★	Varies	Medium	Medium
3.2 Strategies for low-belt-use groups	★★★★†	Unknown	Unknown	Medium

† ★★ For stand-alone programs not supporting enforcement

Countermeasures Targeting Children and Youth

4. Child/Youth Occupant Restraint Laws

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Strengthening child/youth occupant restraint laws	★★★★★	$	High	Short

5. Child Restraint/Booster Seat Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
5.1 Short high-visibility CR law enforcement	★★★★★	$$$	Medium†	Medium

† Used in many jurisdictions but often only once or twice each year

6. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
6.1 Strategies for Older Children	★★★	Varies	Unknown	Medium
6.2 Strategies for Booster Seat Use	★★†	Varies	Unknown	Medium

† For stand-alone programs not supporting enforcement

7. Other Strategies

Countermeasure	Effectiveness	Cost	Use	Time
7.1 School Programs	★★★	Varies	Unknown	Varies
7.2 CR distribution programs	★★	$$	High	Short
7.3 Inspection stations	★★	$$	High	Short

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by increases in observed occupant restraint use and decreases in motor vehicle occupant crash injuries. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, and/or facilities

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

Countermeasures Targeting Adults

1. Seat Belt Use Laws

1.1 State Primary Enforcement Belt Use Laws

Effectiveness: ★★★★★	Cost: $	Use: Medium	Time: Short

Primary enforcement belt use laws permit law enforcement officers to stop and cite a seat belt use law violator independent of any other traffic behavior. Secondary enforcement laws allow law enforcement officers to cite violators only after they first have been stopped for some other traffic violation.

Use: As of July 2012, 32 States and the District of Columbia had primary belt use laws, 17 States had secondary enforcement laws, and New Hampshire had no belt use law applicable to adults (IIHS, 2012). Some of the primary laws are secondary for drivers and passengers older than a specified age and in certain seating positions.

Effectiveness: In 2012, belt use averaged 90% in the 31 States and District of Columbia with primary belt laws and 78% in States with weaker enforcement laws (NHTSA, 2012a). Nichols, Tippetts, et al. (2010) examined the relationship between the type of seat belt law enforcement and seat belt use between 1997 and 2008. Compared with secondary laws, primary laws were associated with a higher observed seat belt use (10 to 12% higher) and higher seat belt use among front-seat occupants killed in crashes (9% higher).

The Centers for Disease Control and Prevention's systematic review of 13 high-quality studies (Shults, Nichols, Dinh-Zarr, Sleet, & Elder, 2004) found that primary laws increase belt use by about 14 percentage points and reduce occupant fatalities by about 8% compared to secondary laws. In another study, Farmer and Williams (2005) found that passenger vehicle driver death rates dropped by 7% when States changed from secondary to primary enforcement. On average, States that pass primary seat belt laws can expect to increase seat belt use by 8 percentage points. Depending on the level of high-visibility enforcement that they employ, however, far greater results are possible.

Recent research (Chaudhary, Tison, & Casanova, 2010; Masten, 2007) has provided strong support that changing from secondary to primary enforcement seat belt laws increases occupant seat belt use during the nighttime hours as well as the daytime hours. Chaudhary et al. (2010) evaluated the effects of Maine's change from secondary to primary enforcement of their seat belt law. Observational surveys conducted over an 18-month period after this change went into effect measured increases in seat belt use from 77% to 84% during the daytime and from 69% to 81% at night.

Hedlund et al. (2008) studied the effects of primary law changes on seat belt use and occupant fatalities in Michigan, New Jersey, Washington, Delaware, Illinois, and Tennessee. Strong evidence was found that primary seat belt laws increase seat belt use. Furthermore, statistically significant decreases in the number of front-seat passenger vehicle occupant fatalities were found in Michigan and Washington and the decrease in New Jersey was marginally significant. The

lack of significant effects on fatalities in Illinois and Tennessee, as well as a marginal increase in Delaware, was attributed in part to the short amount of time since the implementation of the primary provisions in these States as well as the small number of fatalities in Delaware.

Costs: Once legislation has been enacted to upgrade a secondary law to primary, the costs are to publicize the change and enforce the new law. Publicity costs to inform the public of the law change should be low because the media will cover the law change extensively. Law enforcement can adapt its secondary law enforcement strategies for use under the primary law or may be able to use new strategies permitted by the primary law. States wishing to increase enforcement and publicity to magnify the effect of the law change will incur additional costs: see Chapter 2, Section 2.1.

Time to implement: A primary belt use law can be implemented as soon as the law is enacted unless it has a delayed effective date.

Other issues:

- **Partial coverage belt laws:** Most State belt use laws cover passengers over a specified age and are designed to work in combination with child passenger safety laws covering younger passengers. However, belt use laws do not cover adult rear seat passengers in 24 States (IIHS, 2012). Most States' laws exempt some vehicles, such as those designed for more than 10 passengers, taxis, postal delivery vehicles, farm vehicles, pickup trucks, or vehicles not required to have seat belts (Glassbrenner, 2005b). Some States exempt passengers for specified medical or physical reasons (Glassbrenner, 2005b). A good belt use law should be comprehensive, covering all seating positions equipped with a seat belt in all passenger vehicles (ACTS, 2001; NCUTLO, 2004; NHTSA, 2003b). Such a law sends a clear and consistent message to the public.
- **Opposition to primary belt laws:** In most States there is substantial opposition to changing a secondary law to a primary belt use law. Opponents claim that primary laws impinge on individual rights and provide opportunities for law enforcement to harass minority groups. Studies in several States have found that minority groups were ticketed at similar or lower rates than others after a primary law was implemented (Shults et al., 2004; Tison, Williams, Chaudhary, & Nichols, 2011). When Michigan changed from a secondary to a primary law, harassment complaints were very uncommon both before and after the law change. The proportion of seat belt use citations issued to minority groups decreased under the primary law. In a telephone survey, the vast majority of people who actually received seat belt citations did not feel that they were singled out on the basis of race, age, or gender. However, some minorities and young drivers reported perceptions of harassment (Eby, Kostyniuk, Molnar, Vivoda, & Miller, 2004).
- **Effect on low-belt-use groups:** Studies in States that changed their law from secondary to primary show that belt use increased across a broad range of drivers and passengers. In some States, belt use increased more for low-belt-use groups, including Hispanics, African-Americans, and impaired drivers, than for all occupants (Shults et al., 2004).

1.2 Local Primary Enforcement Belt Use Laws and Ordinances

Effectiveness: ★★★★	Cost: $	Use: Low	Time: Short

In some States with secondary enforcement belt use laws, individual communities have enacted and enforced community-wide primary laws or ordinances. These laws differ from statewide laws only in that they are enacted, publicized, and enforced locally.

Use: No data is available on how many communities have primary laws.

Effectiveness: The available evidence suggests that local primary belt laws increase belt use (see also Lucke et al., 2004, strategy A3). Illinois Department of Transportation data show that average belt use was higher in communities with local primary belt use laws. In the annual statewide belt use surveys from 1997 to 2002, average belt use in 39 sites with local laws was 5.6 percentage points higher than the statewide belt use rate (Nassirpour, 2005). A statewide primary belt use law was enacted in 2003, in part because local ordinances already covered a large portion of the population.

St. Louis County, Missouri, implemented a primary seat belt use ordinance in March 2007. Following implementation of this ordinance, the St. Louis County Police Department conducted an intense high-visibility enforcement campaign, accompanied by publicity in the form of variable message boards and permanent road signs, along an 8-mile corridor on State Highway 21. Observational surveys were conducted along the Highway 21 corridor and a control site prior to the start of the enforcement and immediately after its conclusion. The observational surveys measured an increase in belt use from 83% to 88% along the Highway 21 corridor and a small, 59% to 57% decrease in belt use along the control corridor (Nichols, Solomon, Chaffe, & Preusser, 2010).

Costs: As with a statewide law, the costs are for publicity and enforcement. Both must be directed to the community itself.

Time to implement: As with a statewide law, a local law can be implemented as soon as it is enacted. The law's debate and passage likely will generate initial publicity.

Other issues: See the discussion under Chapter 2, Section 1.1, Primary Enforcement Belt Use Laws.

1.3 Increased Belt Use Law Penalties: Fines and Driver's License Points

Effectiveness: ★★★★†	Cost: $	Use: Low	Time: Short

†Effectiveness has been demonstrated for increased fines but has not yet been demonstrated for driver's license points.

Penalties for most belt use law violations are low. As of July 2012, a violation resulted in a typical fine of $25 or less in all but 13 States (IIHS, 2012). Low fines may not convince nonusers to buckle up and may also send a message that belt use laws are not taken seriously.

Most States penalize serious traffic law violations by assessing demerit points against a driver's license. Drivers lose their licenses if they accumulate more than a specified number of points within a specified period of time. In a national survey in 2000, drivers who were not regular belt users considered license points the most effective way to increase their belt use. License points were considered more effective than increased fines or increased enforcement, in both primary and secondary law States (ACTS, 2001).

Use: As of August 2010, 9 primary law States and 4 secondary law States had maximum fines of $30 or more. As of March 2009, 3 jurisdictions, the District of Columbia, Georgia, and New Mexico, assessed driver's license points for all seat belt law violations (Decina, Hall, & Lococo, 2010).

Effectiveness: Houston and Richardson (2006) studied the effects of belt law type (primary or secondary), fine level, and coverage (front seat only or front and rear seats) using belt use data from 1991 to 2001. They found that primary belt laws and higher fines increase belt use.

Nichols, Tippetts, et al. (2010) examined the relationship between seat belt violation fine and belt use and found that increasing fines was associated with increased belt use. Increasing a State's fine from $25 to $60 was associated with an increase of 3 to 4% in both observed belt use and belt use among front-seat occupants killed in crashes. Similarly, increasing the fine from $25 to $100 was associated with an increase of 6 to 7%.

In a national survey in 2000, 42% of drivers who did not use belts regularly said they would definitely be more likely to wear belts if the fine were increased. Another 25% of these drivers said they would probably be more likely to wear their belts (ACTS, 2001). Surveys in North Carolina also found that some nonusers would buckle up if the fine were doubled to $50 (Williams & Wells, 2004).

The effect of driver's license points on belt use has not been evaluated. The evidence from 2005 sheds little light on the effectiveness of points. All three jurisdictions with points had primary laws. Belt use averaged 86.1% in the three jurisdictions with points and 86.6% in the remaining primary law States (Glassbrenner, 2005b).

In the 2000 national survey, 49% of drivers who were not regular belt users said they would definitely be more likely to wear their seat belts if violators were assessed driver's license points. Another 27% of these drivers said they would probably be more likely to wear their belts

(ACTS, 2001). In a North Carolina survey, 62% of nonusers said they always would wear their belts if violations led to driver's license points (Williams & Wells, 2004).

Costs: The direct costs associated with increasing fine levels or assessing driver's license points are minimal.

Time to implement: Both measures can be implemented as soon as they are publicized and appropriate changes are made to the motor vehicle records systems.

Other issues:

- **Balance:** If penalties are excessively low, then they may have little effect. If they are excessively high, then law enforcement officers may be reluctant to issue citations and judges may be reluctant to impose them. States should choose penalty levels that strike an appropriate balance.
- **Penalty levels are part of a system:** Penalty levels are part of the complete system of well-publicized enforcement of strong belt use laws. Appropriate penalty levels help make strong laws. But without effective enforcement, judicial support, and good publicity, increased penalties may have little effect.

2. Seat Belt Law Enforcement

2.1 Short-Term, High-Visibility Belt Law Enforcement

Effectiveness: ★★★★★	Cost: $$$	Use: Medium†	Time: Medium

† Used in many jurisdictions but often only once or twice each year

The most common high-visibility belt law enforcement method consists of short (typically lasting for two weeks), intense, highly publicized periods of increased belt law enforcement, frequently using checkpoints (in States where checkpoints are permitted), saturation patrols, or enforcement zones. These periods sometimes are called STEP waves (Selective Traffic Enforcement Programs) or blitzes. The method was developed in Canada in the 1980s (Boase, Jonah, & Dawson , 2004) and demonstrated in several United States communities (Williams & Wells, 2004). It was implemented statewide in North Carolina in 1993 using the *Click It or Ticket* slogan (Reinfurt, 2004), and subsequently adopted in other States under different names and sponsors (Solomon et al., 2004). NHTSA's *Click It or Ticket* high-visibility enforcement model is described in detail in Solomon, Chaudhary, and Cosgrove (2003) and Solomon, Chaffe, and Cosgrove (2007).

Use: Most States currently conduct short-term, high-visibility belt law enforcement programs in May of each year as part of national seat belt mobilizations (Solomon et al., 2004; Solomon, Chaffe, et al., 2007). In previous years, two mobilizations were conducted each year, in May and November. NHTSA has supported these campaigns. Approximately 10,000 law enforcement agencies took part in the May 2007 campaign (Solomon, Preusser, Tison, & Chaudhary, 2009). See Milano et al. (2004) for a detailed account of the history and evolution of the national campaigns.

Effectiveness: CDC's systematic review of 15 high-quality studies (Dinh-Zarr et al., 2001; Shults et al., 2004) found that short-term, high-visibility enforcement programs increased belt use by about 16 percentage points, with greater gains when pre-program belt use was lower. Because many of the studies were conducted when belt use rates were considerably lower than at present, new programs likely will not have as large an effect. Following the enforcement program, belt use often dropped by about 6 percentage points demonstrating the ratchet effect typical of these programs (belt use increases during and immediately after the program and then decreases somewhat, but remains at a level higher than the pre-program belt use).

Between 2002 and 2005, NHTSA evaluated the effects of *Click It or Ticket* campaigns on belt use in the United States. In 2002, belt use increased by 8.6 percentage points across 10 States that used paid advertising extensively in their campaigns. Belt use increased by 2.7 percentage points across 4 States that used limited paid advertising and increased by 0.5 percentage points across 4 States that used no paid advertising (Solomon, Ulmer & Preusser, 2002).

The 2003 campaign used extensive paid advertising ($8 million nationally and $16 million in individual States) which supported the campaign with clear enforcement images and messages (Solomon et al., 2003, Technical Summary). Nationally, belt use following the 2003 campaign was 79% compared to 75% at the same time in 2002 (Glassbrenner, 2005a). Twenty-eight States conducted small belt use surveys immediately before the May 2003 campaign. Across these

States, belt use was 75.2% in 2002, 72.8% before the 2003 campaign and 78.5% immediately after the campaign. These results show the typical ratchet effect, with belt use dropping gradually after the 2002 campaign and then rising rapidly immediately after the 2003 campaign to a level higher than was seen during the previous campaign (Solomon et al., 2003, Chapter IV).

The 2004 campaign increased paid advertising to about $12 million nationally and $20 million in the States (Solomon, Chaffe, et al., 2007). Belt use nationally reached 80% following the campaign (Glassbrenner, 2005a). Across the 50 States and the District of Columbia, belt use increased in 42 jurisdictions compared to the same time in 2003. When averaged across all 51 jurisdictions, belt use increased by 2.4 percentage points (Solomon, Chaffe, et al., 2007).

For the 2005 campaign, paid media valued at $9.7 million nationally and $22 million in States delivered a strong enforcement related message. Following the campaign, seat belt use rates increased to 82% nationally and improved in a majority of States (35 of 47). The level of improvement was slightly higher among primary law States compared to secondary law States. Among 22 primary law States, 18 showed an increase while among 25 secondary enforcement States, 17 showed an increase (Solomon, Gilbert, et al., 2007). Campaigns were similar in 2006 and 2007, with observed seat belt use remaining at 82% through 2007. As of 2007, 12 States had achieved seat belt use rates of 90% or higher (Solomon et al., 2009).

Hedlund et al. (2008) compared 16 States with high seat belt rates and 15 States with low seat belt rates. The single most important difference between the two groups was the level of enforcement, rather than demographic characteristics or the amount spent on media. High-belt-use States issued twice as many citations per capita during their *Click It or Ticket* campaigns as low-belt-use States.

Costs: High-visibility enforcement campaigns are expensive. They require extensive time from State highway safety office and media staff and often from consultants to develop, produce, and distribute publicity and time from law enforcement officers to conduct the enforcement. Paid advertising increases a campaign's effectiveness, as discussed above, but can be quite expensive. In the average State, paid advertising costs were nearly $350,000 for the 2007 campaign (Solomon, Preusser, et al., 2009).

Time to implement: A high-visibility enforcement program requires 4 to 6 months to plan and implement.

Other issues:

- **Effects in primary and secondary belt law States:** High-visibility enforcement campaigns are effective in both primary and secondary law States. NHTSA's 2003 evaluation found that belt use increased by 4.6 percentage points across the primary law States and by 6.6 percentage points across the secondary law States with the primary law States having had higher use rates before the campaigns (Solomon et al., 2003). NHTSA's evaluation of the 2004 *Click It or Ticket* campaign found that the campaign increased belt use in 25 secondary jurisdictions by an average of 3.7 percentage points. Belt use decreased in the remaining 5 jurisdictions by an average of 2.3 percentage points (Solomon et al., 2007). Seat belt use laws were upgraded from secondary to primary in 17 states and the District of Columbia during the 1993 thorough 2007 time period. Eleven of

these 17 upgrades were evaluated and the average increase in observed seat belt use in these studies was 16 percentage points. In addition, these upgrades from secondary to primary enforcement tended to impact high-risk groups – such as young males and impaired drivers – as much as or more than lower-risk groups (Nichols & Ledingham, 2008).

- **Effects on low-belt-use groups:** CDC's systematic review observed that short-term, high-visibility enforcement campaigns increased belt use more among traditionally lower-belt-use groups, including young drivers, rural drivers, males, African-Americans, and Hispanics, than among higher-belt-use drivers such as older drivers, suburban drivers, females, and Caucasians (Shults et al., 2004). See Chapter 2, Section 3.2 for further discussion on strategies to reach low-belt-use groups.

2.2 Combined Enforcement, Nighttime

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

Short-term, high-visibility belt law enforcement programs (Chapter 2, Section 2.1) require substantial funding and law enforcement resources. In addition, a number of States have experienced smaller gains in seat belt use associated with enforcement campaigns after conducting them for several years (Nichols & Ledingham, 2008). These programs also have been conducted almost exclusively during the daylight hours, and the available data suggest that belt use is lower at night (Chaudhary, Alonge, & Preusser, 2005; Hedlund et al., 2004; Nichols & Ledingham, 2008).

According to 2005 FARS data, almost two-thirds (64%) of people killed at nighttime did not use restraints. In contrast, the percentage of fatally injured passenger vehicle occupants during daytime crashes who were unrestrained was just under one-half (47%) (Varghese & Shankar, 2007). Furthermore, according to FARS data for the 10-year period from 1998 to 2007, nighttime seat belt use was on average 18 percentage points lower than daytime belt use (Tison, Williams, & Chaudhary, 2010).

Available data and program evaluations suggest that more emphasis on seat belt enforcement during the late-night hours and in conjunction with alcohol laws can provide additional gains in seat belt use and injury reduction (Nichols & Ledingham, 2008). Retaining the short-term, high-intensity enforcement model but including other traffic safety issues such as impaired driving (DWI) and excessive speed, can be effective since the same drivers tend to drink, speed, and not buckle up. In particular, combined DWI and belt law checkpoints, saturation patrols, or enforcement zone operations can be conducted at night, when belt use is lower, DWI higher, and crash risk greater than during the day. Using night-vision technology, where permitted, or other light enhancing technologies can assist with nighttime enforcement. The first demonstration of this strategy took place in 2004 in Reading, Pennsylvania (Chaudhary et al., 2005).

Use: There is little information available on how frequently the multifocused high-visibility enforcement strategy is used. One demonstration of a nighttime program in Pennsylvania was conducted in 2004 (Chaudhary et al., 2005), another demonstration program involving three North Carolina communities was conducted in 2007 (Solomon, Chaffe, & Preusser, 2009), and Washington State conducted a two-year statewide high-visibility nighttime seat belt enforcement program from May 2007 through May 2009 (Thomas, Blomberg, & Van Dyk, 2010).

Effectiveness:
A 2004 nighttime high-visibility belt enforcement program in Reading, Pennsylvania, increased nighttime front-seat-occupant belt use by 6 percentage points, from 50% to 56%. Daytime belt use increased by 3 percentage points, from 56% to 59% (Chaudhary et al., 2005).

A 2007 evaluation of three high-visibility enforcement demonstration programs designed to improve nighttime seat belt use in three communities – two in North Carolina with a primary seat belt law and one in West Virginia with a secondary law -- concluded that nighttime high-visibility seat belt law enforcement programs can be effective for increasing nighttime belt use. Furthermore, roadside breath tests used to collect BAC measures in one North Carolina

community indicated that the program also decreased drinking and driving (Solomon, Chaffe, et al., 2009).

An evaluation of the first year of the Washington nighttime seat belt enforcement program found that the program, which used a combination of high visibility enforcement and both paid and earned media, has contributed to an increase in observed nighttime belt use (from 94.6% to 95.7%) without a decrease in daytime belt use. The program continued through May 2009 (Thomas, Blomberg, & Van Dyk, 2010).

Costs: The costs of combined high-visibility enforcement programs are similar to and probably somewhat greater than the costs of programs directed exclusively at belt law violators (Chapter 2, Section 2.1). Publicity must be directed at different offenses in turn, and law enforcement officers must have the training and equipment to address different offenses. Nighttime programs may entail somewhat higher costs if new night-vision technology is used.

Time to implement: Combined or nighttime high-visibility enforcement programs require 4 to 6 months to plan and implement.

2.3 Sustained Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Some jurisdictions, including California, Oregon, and Washington, enforce their belt use laws vigorously as part of customary traffic enforcement activities.

Use: The extent of vigorous sustained belt law enforcement, with or without extensive publicity, is unknown.

Effectiveness: There are few studies of the effectiveness of sustained enforcement (Hedlund, Preusser, & Shults, 2004). California, Oregon, and Washington, States that are reported to use sustained enforcement, have recorded statewide belt use well above national belt use rates since 2002 (California: 91 to 96%; Oregon: 88 to 97%; Washington: 93 to 98%) (NHTSA, 2011a).

Nichols and Ledingham (2008) conducted a review of the impact of enforcement, as well as legislation and sanctions, on seat belt use over the past two decades and concluded that sustained enforcement is as effective as "blitz" enforcement (short-term, high-visibility enforcement) and unlike blitz campaigns, is not usually associated with abrupt drops in belt use after program completion.

Costs: Sustained enforcement may require funds for publicity. As with short-term, high-visibility enforcement programs, publicity costs will depend on the mix of earned and paid media.

Time to implement: Sustained enforcement by law enforcement officers can be implemented immediately. Extensive publicity will take three or four months to plan and implement.

3. Communications and Outreach

3.1 Communications and Outreach Supporting Enforcement

Effectiveness: ★★★★★	Cost: Varies	Use: Medium	Time: Medium

Effective, high-visibility communications and outreach are an essential part of successful seat belt law high-visibility enforcement programs (Solomon et al., 2003). Paid advertising can be a critical part of the media strategy. Paid advertising brings with it the ability to control message content, timing, placement, and repetition (Milano et al., 2004).

Use: All high-visibility enforcement programs include communications and outreach strategies that use some combination of earned media (news stories) and paid advertising. Communications and outreach can be conducted at local, State, regional, or national levels.

Effectiveness: The May 2002 *Click It or Ticket* campaign evaluation demonstrated the effect of different media strategies. Belt use increased by 8.6 percentage points across 10 States that used paid advertising extensively in their campaigns. Belt use increased by 2.7 percentage points across 4 States that used limited paid advertising and increased by only 0.5 percentage points across 4 States that used no paid advertising (Solomon et al., 2002). Milano et al. (2004) summarize an extensive amount of information from national telephone surveys conducted in conjunction with each national campaign from 1997 through 2003.

Costs: Paid advertising can be expensive. In the average State, paid advertising costs were nearly $350,000 for the 2007 campaign (Solomon, Preusser, et al., 2009).

Time to implement: An effective media campaign requires 4 to 6 months to plan and implement.

3.2 Communications and Outreach Strategies for Low-Belt-Use Groups

Effectiveness: ★★★★†	Cost: Varies	Use: Unknown	Time: Medium

† ★★ For stand-alone programs not supporting enforcement

With belt use at 86% nationally and 75% or higher in 46 States and the District of Columbia, it is clear that the large majority of drivers and passengers are wearing their seat belts. However, there remains a group of people who still do not buckle up regularly.

Information on this group of non-users can be gathered from observations and telephone surveys. Belt use rates for male occupants are generally lower than rates for female occupants. In 2010, belt use rates for males was 83% compared to 88% for females. This trend has been evident since at least 2002 (NHTSA, 2011b). Similarly, belt use rates for occupants 16 to 24 years old tends to be lower than the use rates of other age groups. In 2010, belt use was 79% for occupants 16 to 24, 84% for occupants 8 to 15, 86% for occupants age 25 to 69, and 88% for those occupants 70 and older (Pickrell & Ye, 2011). Since 2005, belt use rates for black occupants has been lower than use rates for members of other races. In 2010, belt use for black occupants was 78% compared to 85% among white occupants, and 92% among members of other races (Pickrell & Ye, 2011). Additionally, NHTSA's 2012 national observational survey found belt use was lower for front seat passengers (84%) compared to drivers (87%), pick-up truck occupants (77%) compared to occupants of passenger cars (87%) and vans/SUVs (89%), and was lower in rural areas (84%) compared to urban (86%) and suburban (87%) areas (NHTSA, 2012a). NHTSA's 2007 national telephone survey found the same patterns, with males, young drivers, rural drivers, and pickup truck drivers reporting lower belt use (Boyle & Lampkin, 2008, p. iv).

Most nonusers report wearing seat belts at least some of the time. In NHTSA's 2007 national telephone survey, only 1% of drivers said they never used their belts and another 1% said they rarely used them (Boyle & Lampkin, 2008). Backseat passengers are more frequently unbelted: 11% said they never use belts and another 6% said they rarely use them, while only 58% reported wearing belts all the time (Boyle & Lampkin, 2008). The most frequent reasons given by drivers for not wearing a belt were that they: were only driving a short distance (59%), forgot (52%), were in a rush (39%), or they found the belt uncomfortable (35%) (Boyle & Lampkin, 2008).

Use: Communications and outreach campaigns directed at low-belt-use groups are likely common, but no summary is available.

Effectiveness: Communications and outreach campaigns directed at low-belt-use groups have been demonstrated to be effective for targeted programs that support, and are supported by, enforcement. The effectiveness of stand-alone programs not supported by enforcement is unclear, though North Dakota has demonstrated success with its 2003 "Pick Up the Habit for Someone You Love" campaign.

High-visibility enforcement programs generally have been effective in increasing belt use (see Chapter 2, Section 2.1; Shults et al., 2004). Their publicity messages and placement can be directed at specific lower-belt-use groups.

The 5 States of NHTSA's Region 6 conducted a two-week "Buckle Up in Your Truck" paid advertising campaign immediately before their May 2004 *Click It or Ticket* campaign. The truck campaign's message complemented the *Click It or Ticket* message by focusing on the dangers of riding unrestrained in a truck and stressing the usefulness of belts in rollover crashes. The campaign spent nearly $600,000 for paid advertising in the 5 participating States. Surveys at the end of the campaign, before any enforcement-based *Click It or Ticke*t publicity, showed that belt use among pickup truck occupants increased by about 2 percentage points. Following the *Click It or Ticket* publicity, belt use among pickup truck occupants increased by another 6 percentage points (Solomon, Chaffe, et al., 2007).

In a November 2004 follow-up study, an intensive campaign using the same "Buckle Up in Your Truck" message was conducted in Amarillo, Texas. The campaign used paid advertising emphasizing belt law enforcement as well as earned media featuring local law enforcement officers. Belt use in pickup trucks increased by 12 percentage points in Amarillo and belt use in cars increased by 8 percentage points. At the same time, belt use in a comparison community increased by 5 percentage points for pickup truck occupants and by 4 percentage points for car occupants (Solomon, Chaffe, et al., 2007).

Iowa, Kansas, Missouri, and Nebraska (in NHTSA's Region 7) implemented a similar "Buckle Up in Your Truck" program in May 2006 and 2007. The campaign sought to increase seat belt use among pickup truck occupants by focusing on the dangers of riding unbuckled and increasing awareness of ongoing enforcement efforts. Following this campaign, these States also conducted statewide *Click It or Ticket* campaigns that included additional paid media and enforcement directed at occupants of all vehicle types. The "Buckle Up in Your Truck" campaign did increase the awareness of "buckle up in trucks" messages, but in terms of observed seat belt use, the *Click It or Ticket* campaign had the greater effect (Nichols, Tison, Solomon, Ledingham, Preusser, & Siegler, 2009).

NHTSA's Region 5 implemented a Rural Demonstration Program prior to the May 2005 *Click It or Ticket* mobilization. The goal of the Rural Demonstration Project was to evaluate strategies for increasing seat belt usage in rural areas. Paid media was used to notify rural residents that seat belt laws were being enforced. Active enforcement was included during the initial phase in 3 of the 6 Region 5 States (Illinois, Indiana, Ohio), but only the paid media component was implemented in the remaining three States (Minnesota, Michigan, Wisconsin). During the Demonstration Project phase, States that had intensified enforcement had significant increases in usage in their targeted rural areas. All 6 Region 5 States intensified enforcement during the *Click It or Ticket* mobilization, but States that had intensified enforcement during the Demonstration Project showed substantially greater overall statewide gains during the *Click It or Ticket* phase than did the States that had not intensified enforcement during the Rural Demonstration Program (Nichols, Ledingham, & Preusser, 2007).

Demonstration programs conducted in Kentucky, Mississippi, North Dakota, and Wyoming during 2004–2007 sought to increase seat belt use through a variety of innovative approaches. The primary method employed by Mississippi, North Dakota, and Wyoming was to target low-belt-use counties for additional enforcement and enforcement focused publicity. The seat belt laws in Kentucky and Mississippi were also upgraded from secondary to primary enforcement

during the demonstration programs. All 4 States achieved significant statewide increases in belt use above baseline belt use rates (Blomberg, Thomas, & Cleven, 2009).

The North Dakota and Amarillo campaigns are well-documented examples of successful programs that target low-belt-use groups. They used all the characteristics of effective communications and outreach campaigns: good target audience research, effective and creative message development, and good message placement using both paid and earned media. The overall South Central Region campaign produced only modest gains, but Kentucky (67% to 76% statewide), Mississippi (58% to 65% in targeted counties), North Dakota (66% to 80% in targeted counties), and Wyoming (55% to 70% in targeted counties) were able to achieve significant increases in seat belt use through their programs (Blomberg, Thomas, & Cleven, 2009).

North Dakota's "Pick Up the Habit for Someone You Love" campaign in 2003 provides one of the few examples of a successful communications and outreach program not directly connected to enforcement. It was directed at male pickup drivers, whose pre-program belt use was 20 percentage-points lower than the statewide 63% rate. A survey of these drivers identified effective message goals (*choose* and *remember* to buckle up), message strategies (motivation through loved ones, sometimes using humor), and message placement (combining paid and earned radio and television, posters, and public relations events). The program increased observed belt use of male pickup drivers by 7 percentage points at a total cost of $295,000 (North Dakota DOT, 2004).

Costs: As with enforcement-related communications and outreach, costs vary depending on program quality and delivery. Paid advertising can be expensive.

Time to implement: A good media campaign will require 4 to 6 months to plan and implement.

Countermeasures Targeting Children and Youth

4. Child/Youth Occupant Restraint Laws

4.1 Strengthening Child/Youth Occupant Restraint Laws

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Short

Beginning with Tennessee, every State between 1978 and 1985 passed laws requiring children traveling in motor vehicles to be restrained in child restraints appropriate for the child's age and size. Today, State child restraint laws vary in terms of who is covered by the law, the types of restraints required, and where in the vehicle the restraints can be positioned. In some States, children as young as 5 may be restrained using the adult seat belt, while other State laws require children up to age 9 or 80 pounds or 57 inches tall to be restrained in a child safety seat or booster seat.

Ninety percent of the States have booster seat provisions for children who have outgrown their child safety seats, but there are exemptions and limited coverage to many of these laws (Decina et al., 2010). In general, young children are usually covered by child restraint laws, while older children and adults are covered by seat belt laws. However, in 5 States some children under 16 are covered by neither law (IIHS, 2012).

Strong occupant restraint use laws for a State – that is, the combination of child restraint and seat belt laws – should be comprehensive, covering all seating positions equipped with a seat belt in all passenger vehicles (ACTS, 2001; NCUTLO, 2006; NHTSA, 2003b; NHTSA, 2006). Such a law sends a clear and consistent message to the public. NHTSA and various partners have encouraged States to expand their child restraint laws to include "booster" provisions; that is, to not allow children to be restrained by a seat belt alone until they are big enough for the lap and shoulder belts to fit properly.

Use: As of March 2009, 45 States and the District of Columbia had enacted "booster" seat provisions that require child restraint/booster seat use for children 5 and older or heavier than 40 pounds (Decina et al., 2010). However, a wide variation in age, height, and weight requirements exists between the laws of the various States.

Effectiveness: Research conducted by Arbogast et al. (2009) found that transitioning children from child restraints with harnesses to belt-positioning booster seats instead of vehicle seat belts provides significant safety benefits for children at least through age 8, and that belt-positioning booster seats lower the risk of injury to children in crashes by 45% compared to the use of vehicle seat belts alone. A number of studies evaluated the effect of booster provisions in States' laws on booster seat use (Gunn, Phillippi, & Cooper, 2007). Observational surveys conducted in Washington State before their booster seat law was expanded found that only 21% of children between 4 and 8 were using booster seats (Ebel, Koepsell, Bennett, & Rivara, 2003). Following a new law requiring booster seats for children weighing between 40 and 60 pounds or younger than 6 years old, observational surveys in Washington State found close to half of children 4 to 8 years old in a booster seat (Stehr & Lovrich, 2003).

One study evaluated the effects of Tennessee's "booster" provisions that added new requirements for 4- to 8-year-olds in 2005 (Gunn et al., 2007). Pre- and post-law observational survey data revealed a significant increase in booster seat use among 4- to 8-year-olds from 29% to 39%. Decina et al. (2008) reported that an observational study conducted to evaluate a demonstration program found a 9-percentage-point increase in the use of child restraints, including booster seats, for children age 4 to 8 following enactment of an enhanced child restraint law (booster seat law) in Wisconsin. Similarly, a second evaluation of Wisconsin's booster seat law found that while total booster seat use did increase, the law did not impact all children equally. Specifically, use of booster seats and proper use of booster seats varied among different racial and socioeconomic groups suggesting that further study is needed of the effects of booster seat legislation on all children (Brixey, Corden, Guse, & Layde, 2011).

A number of research studies (Fell et. al., 2005; Guerin & MacKinnon, 1985; Margolis, Bracken, & Stewart, 1996) have found restraint use levels among children and teens covered by restraint use laws are higher than those not covered, and that injury levels among children covered by child passenger safety laws are lower than children not covered.

Costs: The costs of expanding a restraint use law to include all seating positions in all passenger vehicles are minimal.

Time to implement: Expanded restraint use law coverage can be implemented as soon as the law is enacted and publicized.

5. Child Restraint/Booster Seat Law Enforcement

5.1 Short-Term High-Visibility Child Restraint/Booster Law Enforcement

Effectiveness: ★★★★★	Cost: $$$	Use: Medium†	Time: Medium

† Used in many jurisdictions but often only once or twice each year

As noted in Section 2.1, high-visibility short-duration belt law enforcement programs, such as *Click It or Ticket,* have proven to be the most effective countermeasure to date for increasing seat belt use. NHTSA typically includes child restraint and booster seat use and enforcement as a part of their *Click It or Ticket* campaigns. There is concern, however, that law enforcement officers are reluctant to enforce child restraint laws due to a lack of commitment by their departments and a lack of knowledge on the part of officers on the subject of child restraints (Decina, Lococo, Ashburn, Hall, & Rose, 2008; Decina, Temple, & Dorer, 1994; NHTSA, 1990). More recent research demonstrates that effective approaches for enforcing child restraint laws – in particular booster seat laws – are possible, but they depend on top management support and enforcement methods that are dedicated to booster seat and other child restraint laws (Decina, Hall, & Lococo, 2010).

As with high visibility enforcement aimed at adult occupants (section 3.1), enforcement of child restraint/booster laws should be coupled with high visibility communications and outreach (Solomon et al., 2003). Paid advertising can be a critical part of the media strategy. Paid advertising brings with it the ability to control message content, timing, placement, and repetition (Milano et al., 2004).

Use: Most States currently conduct short-term, high-visibility seat belt law enforcement programs in May of each year as part of national seat belt mobilizations (Solomon et al., 2004; Solomon, Chaffe, et al., 2007).

Effectiveness: Pilot programs conducted in 1989 in 8 communities demonstrated the potential effectiveness of child passenger safety law enforcement (NHTSA, 1990). The enforcement efforts increased the correct use of child restraints in the demonstration sites and the use of seat belts by older children also increased. In their systematic review of evidence of effectiveness for child restraint interventions, Zaza et al. (2001) determined that community-wide information plus enhanced enforcement campaigns were effective in increasing child restraint use.

Costs: High-visibility enforcement campaigns are expensive. They require extensive time from State highway safety offices, time from law enforcement officers to conduct the enforcement, and time from media staff and often from consultants to develop, produce, and distribute publicity. Paid advertising increases a campaign's effectiveness but can be quite expensive.

Time to implement: A high-visibility enforcement program requires 4 to 6 months to plan and implement.

Other issues:

- **Barriers to enhanced enforcement programs:** Decina et al. (2008) concluded that barriers to enhanced enforcement programs, especially as related to booster seats, include: low awareness of child restraint laws among parents/caregivers; low perception of risk to child passengers; lack of knowledge about the safety benefits of booster seats among the public; lack of knowledge about the safety benefits of booster seats among law enforcement officers and members of the courts; low threat of being ticketed for violations; and lack of commitment to child passenger safety by law enforcement top management.
- **Strategies to enhance enforcement programs**: NHTSA (1990) suggests that in order to maximize child restraint enforcement efforts, certain activities should be part of the overall program. These are: media coverage of enforcement and public information activities by the local press and radio and television stations; training of law enforcement officers in the benefits of child passenger protection and methods of effective law enforcement; information activities aimed at target audiences; information activities coinciding with community events; child restraint distribution programs; and public service announcements and other media coverage. Decina et al. (2010) found that the most effective approaches for enforcing booster seat laws depend on top management support to enforce these laws, having resources to support dedicated booster seat law enforcement programs, and enforcement methods that are dedicated to booster seat and other child restraint laws.

6. Communications and Outreach

6.1 Communications and Outreach Strategies for Older Children

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Medium

As noted by Kuhn and Lam (2008a; 2008b), there is not a great deal of information on the factors influencing restraint use for children 8 to 15 years old. The few available studies have tended to focus on changing nonuse behaviors without investigating attitudinal or motivational factors that might be useful in developing additional strategies.

Use: There is beginning to be more of an emphasis on developing and implementing programs targeting children ages 8 to 15. NHTSA is developing material and resources for States and programs interested in targeting this age group and some pilot programs have been implemented and evaluated that can be used as resources for program development. One extensive resource available is the report titled "Increasing Seat Belt Use Among 8- to 15-Year-Olds: Volumes I and II" (Kuhn & Lam, 2008a, 2008b).

Effectiveness: The few studies that have been conducted have produced encouraging but inconclusive results. The Automotive Coalition for Traffic Safety launched two pilot programs in 2005 targeting 8- to 15-year-olds, sometimes called "tweens." These brief school and community-based interventions targeted both children and their parents. Both programs were successful in changing knowledge and attitudes of the parents and children, but limited observations did not show significant changes in belt use among the targeted children (Jennings, Merzer, & Mitchell, 2006).

Colorado and Nevada implemented a Teen Seat Belt Demonstration Project in 2007-2008 consisting of publicity and enforcement. Each State held four enforcement waves focused in areas and times when teenagers were most likely to be driving. In addition to increases in teen awareness of seat belt messages and enforcement, teen belt use increased significantly in both States (5% in Colorado and 8% in Nevada) (Nichols, Haire, Solomon, Ellison-Potter, & Cosgrove, 2011).

Costs: Program costs will depend on the size of the target audience and the components of the program.

Time to implement: Complete programs will require at least four months to plan and implement. School programs may require a full year.

6.2 Communications and Outreach Strategies for Booster Seat Use

Effectiveness: ★★†	Cost: Varies	Use: Unknown	Time: Medium

† For stand-alone programs not supporting enforcement

Both the American Academy of Pediatrics and NHTSA recommend that children use booster seats until the lap/shoulder combination belt fits properly on its own, typically when a child is between 8 and 12 years old. However, observational data from the National Survey of the Use of Booster Seats (NSUBS) show that children are moving into the seat belt much earlier than is recommended. In 2009, 32% of children 4 to 7 were restrained using the seat belt alone and 41% were using the vehicle belt plus a booster seat. Only 5% of children 8 to 12 were using booster seats (Pickrell & Ye, 2010).

In 2011, both NHTSA and AAP revised their child restraint/booster seat recommendations with significant earned media coverage surrounding the announcements. Currently, the most recent NSUBS observational data is from 2009, 2 years prior to the most recent revisions. It is not known what effect this messaging had on restraint use.

Use: Communications and outreach campaigns directed at booster-seat-age children are likely common, but no summary is available.

Effectiveness: The effectiveness of communication and outreach strategies aimed at booster seat use is unclear. Will, Sabo, and Porter (2009) note that parents and care givers of booster-seat-aged children are difficult reach with effective messages. They also note that many booster-seat programs are unsuccessful because they are too informational in nature, but that applying messages of high-threat consequences (without gore) to booster seat interventions is promising. Another study found that the strongest predictors of booster seat use among Canadian parents of 4- to 9-year-olds was the parents' knowledge of the purpose and benefit of booster seat use as well as perceived community norms (Bruce et al., 2011).

Costs: As with enforcement-related communications and outreach, costs vary depending on program quality and delivery.

Time to implement: A good educational campaign will require 4 to 6 months to plan and implement.

7. Other Strategies

7.1 School Programs

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Schools provide well-defined and somewhat controlled audiences for seat belt use programs. Education and other communications strategies can be tailored to a specific audience. While these programs are often well received in the community, there is limited information on their effectiveness.

Use: There are no data on the number of school programs operating currently.

Effectiveness: School programs have been shown to increase belt use in the few evaluations of school programs that have been conducted. Williams, Wells, and Ferguson (1997) conducted a pilot program to increase restraint use and rear seating position among elementary schools and day care centers. The programs, held in conjunction with an ongoing statewide *Click It or Ticket* program, included letters and pamphlets sent to parents, proper restraint use demonstrations, assemblies emphasizing proper restraint use (at the schools), and enforcement checkpoints. Proper use increased substantially at elementary schools (36% to 64%; 49% to 71%) with smaller increases at the daycare centers (71% to 76%; 60% to 75%). The researchers concluded also that enforcement is a key ingredient of programs even among school age children.

Costs: Program costs will depend on the size of the target audience and the components of the program.

Time to implement: School policies can be implemented immediately. Complete programs will require at least 4 months to plan and implement and may require a full year.

7.2 Child Restraint Distribution Programs

Effectiveness: ★★	Cost: $$	Use: High	Time: Short

One of the issues identified when child passenger safety laws were being considered was the costs associated with obtaining child restraints. Because of this, many State and local organizations initiated programs to make child restraints available at low or no cost to parents though child restraint loan or rental programs (Orr et al., 1987; Zaza et al., 2001). Continuing educational and distribution programs, and especially the implementation and enforcement of child passenger safety laws, increased the levels of child restraint use to 80% for children up to 4 in 1987 (Partyka, 1988), to over 90% (99% for age less than 1, 92% for ages 1 to 3) in 2008 (NHTSA, 2009b).

Use: There is no estimate of the number of child restraint distribution programs operating throughout the United States, but they are common components of State and local child passenger safety programs.

Effectiveness: Louis and Lewis (1997) conducted a project to increase child restraint use in low-income minority families. Families in the program were divided into two study groups with both groups receiving free child restraints. One group also received education regarding child restraint use. The results of the study indicated that distributing child restraints resulted in increased long-term use among a low-use population. Zaza et al., (2001) conducted a systematic review of evidence of effectiveness for five interventions, including child restraint laws, to increase child safety seat use. One of the four interventions found to be effective was child restraint distribution plus education programs.

Costs: Program costs will depend on the size of the target audience and the components of the program.

Time to implement: Complete programs typically require several months to plan and implement.

Other issues: When implementing a program, one of the primary issues to decide is whether the child restraints are to be given away, or whether the parents/caregivers receiving the restraints will be required to purchase them (at a low cost or modest fee, depending on ability to pay). Also, program planners must decide whether parents should be required to attend a child passenger safety educational session, as is considered essential by many in the public health community to ensure proper and continuous use.

7.3 Inspection Stations

Effectiveness: ★★	Cost: $$	Use: High	Time: Short

The misuse of child restraints has been a concern for many years. A number of programs have been implemented to provide parents and other caregivers with "hands-on" assistance with the installation and use of child restraints in an effort to combat widespread misuse. Child passenger safety (CPS) inspection stations, sometimes called "fitting stations" are places or events where parents and caregivers can receive this assistance from certified CPS technicians and are popular services provided by a variety of local CPS programs. Guidebooks on how local programs can set up and operate a mobile CPS clinic or permanent inspection station are available from NHTSA (NHTSA, 2003a).

Use: Child restraint inspection stations have become common components of State and local child passenger safety programs. There are over 4,000 inspection stations listed on NHTSA's Web site.

Effectiveness: One study evaluated Safe Kids child restraint inspection events held at car dealerships, hospitals, retail outlets and other community locations (to provide as much local exposure as possible). The objective of the study was to measure parent confidence levels, skill development and safe behavior over a 6-week interval using checklists and a matching behavioral survey. Results showed that within the 6-week time period, the child passenger safety checkup events successfully and positively changed parents' behavior and increased their knowledge: children arriving at the second event were restrained more safely and more appropriately than they were at the first (Dukehart, Walker, Lococo, Decina, & Staplin, 2007).

Another study evaluated whether a "hands-on" educational intervention makes a difference in whether or not parents correctly use their child restraints. All study participants received a free child restraint and education, but the experimental group also received a hands-on demonstration of correct installation and use of the child restraint in their own vehicles. Parents who received this demonstration were also required to demonstrate in return that they could correctly install the restraint. Follow-up observations found that the intervention group was four times more likely to correctly use their child restraints than was the control group (Tessier, 2010).

A recent evaluation of the child restraint fitting station network in New South Wales, Australia found that children whose parents attended a fitting station were significantly more likely to be properly restrained than children whose parents had not visited a fitting station. While specific to Australia, these results suggest similar benefits are possible in the United States (Brown, Finch, Hatfield, & Bilston, 2011).

Costs: Program costs will depend on the size of the target audience, the components of the program, and the level of services offered.

Time to implement: Complete programs typically require several months to plan and implement.

Seat Belts and Child Restraints References

American Academy of Pediatrics. (2002). *Selecting and Using the Most Appropriate Car Safety Seats for Growing Children: Guidelines for Counseling Parents.* Elk Grove Village, IL: Author. Available at http://pediatrics.aappublications.org/content/109/3/550.full

Automotive Coalition for Traffic Safety. (2001). *2001 Seat Belt Summit: Policy Options for Increasing Seat Belt Use in the United States.* Arlington, VA: Author.

Arbogast, K. B., Jermakian, J. S., Kallan, M. J., & Durbin, D. R. (2009). Effectiveness of belt positioning booster seats: An updated assessment. *Pediatrics*, *124*, 1281-1286.

Blomberg, R.D., Thomas, F.D., & Cleven, A.M. (2009). *Innovative Seat Belt Demonstration Programs in Kentucky, Mississippi, North Dakota, and Wyoming.* (Report No. DOT HS 811 080). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811080.pdf

Boase, P., Jonah, B. A., & Dawson, N. (2004). Occupant Restraint Use in Canada. *Journal of Safety Research*, *35*, 223-229.

Boyle, J. M. & Lampkin, C. (2008). 2007 Motor Vehicle Occupant Safety Survey. Volume 2 Seat Belt Report. (Report No. DOT HS 810 975). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810975.pdf

Brixey, S. N., Corden, T. E., Guse, C. E., & Layde, P.M. (2011). Booster seat legislation: does it work for all children? *Injury Prevention, 17,* 233-237.

Brown, J., Finch, C. F., Hatfield, J., Bilston, L. E. (2011). Child restraint fitting stations reduce incorrect restraint use among child occupants. *Accident Analysis and Prevention, 43,* 1128-1133.

Bruce, B. S., Snowden, A. W., Cunningham, C., Cramm, C. L., Whittle, K., et al. (2011). Predicting parents' use of booster seats. *Injury Prevention, 17,* 313-318.

Chaudhary, N.K., Alonge, M., & Preusser, D.F. (2005). Evaluation of the Reading, PA nighttime safety belt enforcement campaign: September 2004. *Journal of Safety Research, 36*, 321-326.

Chaudhary, N.K., Tison, J., & Casanova, T. (2010). *Evaluation of Maine's Seat Belt Law Change From Secondary to Primary Enforcement.* (Report No. DOT HS 811 259). Washington, DC: National Highway Traffic Safety Administration.
Available at www.nhtsa.gov/staticfiles/nti/pdf/811259.pdf

Cynecki, M. J., & Goryl, M. E. (1984). *The Incidence and Factors Associated With Child Safety Seat Misuse*. (Report No. DOT HS 806 676). Washington, DC: National Highway Traffic Safety Administration.

Decina, L.E., Hall, W.L., & Lococo, K.H. (2010). *Booster Seat Law Enforcement: Examples From Delaware, New Jersey, Pennsylvania, and Washington.* (Report No. DOT HS 811 247). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811247.pdf

Decina, L. E., & Lococo, K. H. (2004). *Misuse of Child Restraints*. (Report No. DOT HS 809 671). Washington, DC: National Highway Traffic Safety Administration.

Decina, L. E., Lococo, K. H., Ashburn, W., Hall, W. L., & Rose, J. (2008). *Identifying Strategies to Improve the Effectiveness of Booster Seat Laws.* (Report No. DOT HS 810 969). Washington, DC: National Highway Traffic Safety Administration.

Decina, L.E., Lococo, K.H. & Doyle, C. T. (2006). *Child Restraint Use Survey: LATCH Use and Misuse.* (Report No. DOT HS 810 679). Washington, DC: National Highway Traffic Safety Administration.

Decina, L. E., Temple, M. G., & Dorer, H. S. (1994). *Local Police Enforcement, Public Information And Education Strategies To Foster More And Proper Use Of Child Safety Seats By Toddlers: Evaluation Of A Demonstration Project. Final Report*. (Report No. HS 808 120). Washington, DC: National Highway Traffic Safety Administration.

Dinh-Zarr, T. B., Sleet, D. A., Shults, R. A., Zaza, S., Elder, R. W., Nichols, J. L., Thompson, R. S., Sosin, D. M., & the Task Force on Community Preventive Services. (2001). Reviews of Evidence Regarding Strategies to Increase the Use of Safety Belts. *American Journal of Preventive Medicine*, *21*, 48-65.
Available at www.thecommunityguide.org/mvoi/mvoi-AJPM-evrev-seat-belts.pdf

Dukehart, J. G., Walker, L., Lococo, K., Decina, L. E., & Staplin, L. (2007). *Safe Kids Checkup Events: A National Study*. Washington, DC: Safe Kids Worldwide. Available at www.safekids.org/assets/docs/ourwork/research/research-report-cps-2006.pdf

Durbin, D. R., & Committee on Injury, Violence, and Poison Prevention. (2011). Policy Statement – Child Passenger Safety. *Pediatrics, 127*, 788-793.

Ebel, B. E., Koepsell, T. D., Bennett, E. E., & Rivara, F. P. (2003). Too small for a seat belt: Predictors of booster seat use by child passengers. *Pediatrics*, *111*, e323-e327.

Eby, D. W., Kostyniuk, L. P., Molnar, L. J., Vivoda, J. M., & Miller, L. L. (2004). The effect of changing from secondary to primary safety belt enforcement on police harassment. *Accident Analysis and Prevention, 36*, 819-828.

Farmer, C. M., & Williams, A. F. (2005). Effect on fatality risk of changing from secondary to primary seat belt enforcement. *Journal of Safety Research, 36,* 189-194.

Fell, J. C., Baker, T. K., McKnight, A. S., Brainard, K., Langston, E., Rider, R., Levy, D., & Grube, J. (2005). *Increasing Teen Safety Belt Use: A Program and Literature Review*. (Report No. DOT HS 809 899). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/NewDriver/TeenBeltUse/images/DOTHS809899TeenBeltUse.pdf

Glassbrenner, D. (2005a). *Traffic Safety Facts, Research Note: Safety Belt Use in 2005 - Overall Results.* (Report No. DOT HS 809 932). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/809932.PDF

Glassbrenner, D. (2005b). *Safety Belt Use in 2005: Use Rates in the States and Territories*. (Report No. DOT HS 809 970). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/809970.pdf

Guerin, D., & MacKinnon, D. P. (1985). An assessment of the California Child Passenger Restraint Requirement. *American Journal of Public Health*, *75*, 142-144.

Gunn, V. L., Phillippi, R. M., & Cooper, W. O. (2007). Improvement in Booster Seat Use in Tennessee. *Pediatrics*, *119*, 131-136.

Hagenzieker, M. P., Bijleveld, F. D., & Davidse, R. J. (1997). Effects of Incentive Programs to Stimulate Safety Belt Use: A Meta-Analysis. *Accident Analysis and Prevention, 29*, 759-777.

Hall, W. L. (1985). *The North Carolina Child Passenger Protection Law: Implementation and Evaluation, July 1982 - June 1985*. Chapel Hill, NC: University of North Carolina, Highway Safety Research Center.

Hall, W. L. (1987). *Guide To Conducting A Safety Seat Installation Clinic*. Chapel Hill, NC: University of North Carolina, Highway Safety Research Center.

Hedlund, J. H., Preusser, D. F., & Shults, R. A. (2004). A Research Agenda for Increasing Safety Belt Use in the United States. *Journal of Safety Research*, *35*, 231-235.

Hedlund, J., Gilbert, S. H., Ledingham, K., & Preusser, D. (2008). *How States Achieve High Seat Belt Use Rates.* (Report No. DOT HS 810 962). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/810962.pdf

Houston, D. J., & Richardson, L. E. (2006). Getting Americans to buckle up: The efficacy of state seat belt laws. *Accident Analysis and Prevention, 37*, 1114-1120.

Houston, D. J., Richardson, L E., & Neeley, G. W. (2001). The Effectiveness of Child Safety Seat Laws In The Fifty States. *Policy Studies Review*, *18*, 163-184.

Insurance Institute for Highway Safety (2012). *Safety belt and child restraint laws.* Arlington, VA: Author. Available at www.iihs.org/laws/SafetyBeltUse.aspx

Jennings, C., Merzer, A., & Mitchell, P. (2006). *Tween Traffic Safety: Influencing 8- to 12-year-olds to Sit Safely Buckled in a Back Seat*. Arlington, VA. Automotive Coalition for Traffic Safety Inc.

Jones, R. K., Joksch, H. C., Lacey, J. H., Wiliszowski, C., & Marchetti, L. (1995). *Summary Report: Field Test of Combined Speed, Alcohol, and Safety Belt Enforcement Strategies*. (Report No. DOT HS 808 242). Washington, DC: National Highway Traffic Safety Administration.

Jones, R. K., & Lacey, J. H. (2001). *Alcohol and Highway Safety 2001: A Review of the State of Knowledge*. (Report No. DOT HS 809 383). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/26000/26000/26018/DOT-HS-809-383.pdf

Kahane, C. J. (1986). *An Evaluation of Child Passenger Safety: The Effectiveness and Benefits of Safety Seats.* (Report No. DOT HS 806 89). Washington, DC: National Highway Traffic Safety Administration.

Klinich, K. D., Manary, M. A., & Weber, K. B. (2012). Crash protection for child passengers: rationale for best practice. *UMTRI Research Review, 43*, 1-35.

Kuhn, M., & Lam, J. (2008a). *Increasing Seat Belt Use Among 8- to 15-Year-Olds: Volume I: Findings*. (Report No. DOT HS 810 965). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810965.pdf

Kuhn, M., & Lam, J. (2008b). *Increasing Seat Belt Use Among 8- to 15-Year-Olds: Volume II: Appendices*. (Report No. DOT HS 810 966). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810966.pdf

Louis, B., & Lewis, M. (1997). Increasing Car Seat Use For Toddlers From Inner-City Families. *American Journal of Public Health*, *87*, 1044-1045.

Lucke, R., Raub, R. A., Pfefer, R., Neuman, T. R., Slack, K. L., & Hardy, K. K. (2004). *A Guide for Increasing Seatbelt Use.* (Report No. 500, Vol. 11) Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v11.pdf

Margolis, L. H., Bracken, J., & Stewart, J.R. (1996). Effects of North Carolina's Mandatory Safety Belt Law on Children. *Injury Prevention*. *2*, 32-35.

Masten, S. (2007). *The Effects of Changing to Primary Enforcement on Daytime and Nighttime Seat Belt Use. Research Note.* (Report No. DOT HS 810 743). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810743.pdf

Milano, M., McInturff, B., & Nichols, J. L. (2004). The Effect of Earned and Paid Media Strategies in High-Visibility Enforcement Campaigns. *Journal of Safety Research, 35*, 203-214.

Nassirpour, M. (2005). Personal communication.

National Committee on Uniform Traffic Laws and Ordinances. (2004). *Model Occupant Protection Law.* Alexandria, VA: Author.

NCUTLO. (2006). *Model Child Restraint Act.* Alexandria, VA: National Committee on Uniform Traffic Laws and Ordinances. Available at www.ncutlo.org/restraint.htm

NHTSA. (1990). *Enforcing Child Passenger Safety Laws: Eight Community Strategies*. (Report No. DOT HS 807 631). Washington, DC: Author.
Available at http://ntl.bts.gov/lib/25000/25800/25880/DOT-HS-807-631.pdf

NHTSA. (1996). *Research Note: Revised Estimates of Child Restraint Effectiveness.* (Report No. 96855). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/96855.PDF

NHTSA. (2001). *Fifth/Sixth Report to Congress: Effectiveness of Occupant Protection Systems and Their Use.* (Report No. DOT HS 809 442). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/809-442.pdf

NHTSA. (2003a). *A Guide To Implementing Child Passenger Safety Inspection Stations.* (Report No. DOT HS 809 627). Washington, DC: Author. Available at http://www.nhtsa.gov/people/injury/childps/CPSInspectionStation/

NHTSA. (2003b). *Initiatives to Address Safety Belt Use*. Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/SafetyBelt/OPIPT_FinalRpt_07-17-03.html

NHTSA. (2006). *Uniform Guidelines for State Highway Safety Programs - Occupant Protection.* Washington, DC: Author.
Available at
www.nhtsa.dot.gov/nhtsa/whatsup/tea21/tea21programs/pages/OccupantProtection.htm

NHTSA. (2009a). *Traffic Safety Facts, 2008 Data: Occupant Protection*. (Report No. DOT HS 811 160). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811160.PDF

NHTSA. (2009b). *Traffic Safety Facts, Research Note: Child Restraint Use in 2008 - Overall Results.* (Report No. DOT HS 811 135). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811135.PDF

NHTSA. (2009c). *Traffic Safety Facts 2008: Early Edition.* (Report No. DOT HS 811 170). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811170.PDF

NHTSA. (2009d). *Traffic Safety Facts, Research Note: Child Restraint Use in 2008 - Use of Correct Restraint Types.* (Report No. DOT HS 811 132). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811132.PDF

NHTSA. (2009e). *Traffic Safety Facts, Research Note: Seat Belt Use in 2009 – Overall Results.* (Report No. DOT HS 811 100). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811100.pdf

NHTSA. (2011a). *Traffic Safety Facts: Seat Belt Use in 2010 – Use Rates in the States and Territories.* (Report No. DOT HS 811 493). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811493.pdf

NHTSA. (2011b). *Traffic Safety Facts: 2009*. (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.pdf

NHTSA. (2012a). *Traffic Safety Facts: 2010*. (Report No. DOT HS 811 659). Washington, DC: Author. Available at http://www-nrd.nhtsa.dot.gov/Pubs/811659.pdf

NHTSA. (2012b). *Traffic Safety Facts: Seat Belt Use in 2012 - Overall Results*. (Report No. DOT HS 811 691). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811691.pdf

NHTSA. (2012c). *Parents Central*. Available at www.safercar.gov/parents/CarSeats.htm

Nichols, J. L., & Ledingham, K. A. (2008). *The Impact of Legislation, Enforcement, and Sanctions on Safety Belt Use.* (NCHRP Report 601). Washington, DC. Transportation Research Board.

Nichols, J., Haire, E., Solomon, M., Ellison-Potter, P., & Cosgrove, L. (2011). *Evaluation of Teen Seat Belt Demonstration Projects in Colorado and Nevada*. (Report No. DOT HS 811 518). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811518.pdf

Nichols, J. L., Ledingham, K. A., & Preusser, D. F. (2007). *Effectiveness of the May 2005 Rural Demonstration Program and the Click It or Ticket Mobilization in the Great Lakes Region: First Year Results.* (Report No. DOT HS 810 753). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/buckleup/CIOT2005_effectiveness/images/810753l.pdf

Nichols, J.L., Solomon, M.G., Chaffe, R.H.B., & Preusser, D.F. *Evaluation of a County Enforcement Program With a Primary Seat Belt Ordinance: St. Louis County, Missouri.* (2010). (Report No. DOT HS 811 292). Washington, DC: National Highway Traffic Safety Administration. http://ntl.bts.gov/lib/32000/32900/32972/6804-811292-050710-v1a.pdf

Nichols, J. L., Tippetts, A. S., Fell, J. C., Auld-Owend, A., Wiliszowski, C. H., Haseltine, P. W., & Eichelberger, A. (2010). *Strategies to Increase Seat Belt Use: An Analysis of Levels of Fines and the Type of Law.* (Report No. DOT HS 811 413). Washington, DC: National Highway

Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/occupant_protection/pdf/811413.pdf

Nichols, J. L., Tison, J., Solomon, M. G., Ledingham, K. A., & Preusser, D. F. (2009). *Evaluation of a Rural Demonstration Program to Increase Seat Belt Use in the Great Lakes Region.* (Report No. DOT HS 811 084). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811084.pdf

Nichols, J. L., Tison, J., Solomon, M. G., Ledingham, K. A., Preusser, D. F., & Siegler, J. N. (2009). *Evaluation of the "Buckle Up in Your Truck" Programs*. (Report No. DOT HS 811 131). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811131.pdf

North Dakota Department of Transportation. (2004). *"Pick Up the Habit for Someone You Love" Campaign.* (Final report, Contract PHSP4030301). Bismarck, ND: Author.

Orr, B. T., Hall, W. L., Woodward, A. R., & Desper, L. P. (1987) *A Guide For Establishing A Car Safety Seat Rental Program*. Chapel Hill, NC: University of North Carolina Highway Safety.

Partyka, S. C. (1988). *Lives Saved By Child Restraints From 1982 Through 1987*. (Report No. DOT HS 807 371). Washington, DC: National Highway Traffic Safety Administration.

Pickrell, T. M. & Ye, T. J. (2010). *The 2009 National Survey of the Use of Booster Seats.* (Report No. DOT HS 811 377). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/811377.pdf

Pickrell, T. M., & Ye, T. J.. (2011). *Occupant Restraint Use in 2010: Results from the National Occupant Protection Use Survey Controlled Intersection Study*. (Report No. DOT HS 811 527). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811527.pdf

Pickrell, T. M., & Ye, T. J. (2013, January). *Occupant Restraint Use in 2011: Results from the National Occupant Protection Use Survey Controlled Intersection Study*. (Report No. DOT HS 811 697). Washington, DC: National Highway Traffic Safety Administration.

Reinfurt, D. W. (2004). *Click It or Ticket* in North Carolina: A Decade of Progress. *Journal of Safety Research, 35*, 181-188.

Safe Kids Worldwide. (2012). *Tech Stats.* Washington, DC: Safe Kids Worldwide CPS Certification. http://cert.safekids.org/WhoWeAre/TechStats.aspx

Shults, R. A., Nichols, J. L., Dinh-Zarr, T. B., Sleet, D. A., & Elder, R. W. (2004). Effectiveness of Primary Enforcement Safety Belt Laws and Enhanced Enforcement of Safety Belt Laws: A

Summary of the Guide to Community Preventive Services Systematic Reviews. *Journal of Safety Research, 35*, 189-196.

Solomon, M. G., Chaffe, R. H. B., & Cosgrove, L. A. (2007). *May 2004 Click It or Ticket Seat Belt Mobilization Evaluation*. (Report No. DOT HS 810 716). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/CIOT2004FinalReport.pdf

Solomon M. G., Chaffe, R. H. B., & Preusser, D. F. (2009). *Nighttime Enforcement of Seat Belt Laws: An Evaluation of Three Community Programs.* (Report No. DOT HS 811 189). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811189.pdf

Solomon, M. G., Chaudhary, N. K., & Cosgrove, L. A. (2003). *May 2003 Click It or Ticket Safety Belt Mobilization Evaluation Final Report.* (Report No. DOT HS 809 694). Washington, DC: National Highway Traffic Safety Administration. Available at
www.nhtsa.dot.gov/people/injury/airbags/clickit_ticke03/ciot-report04/CIOT%20May%202003/

Solomon, M. G., Compton, R. P., & Preusser, D. F. (2004). Taking the *"Click It or Ticket"* model nationwide. *Journal of Safety Research, 35*, 197-201.

Solomon, M. G., Gilbert, S. H. Nichols, J., Chaffe, R. H. B., Tison, J., & Chaudhary, N. K. (2007). *Evaluation of the May 2005 Click It or Ticket Mobilization to Increase Seat Belt Use.* (Report No. DOT HS 810 778). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/2005CIOTReport.pdf

Solomon, M. G., Preusser, D. F., Tison, J., & Chaudhary, N. K. (2009) *Evaluation of the May 2007 Click It or Ticket Mobilization.* (Report No. DOT HS 811 239). Washington, DC: National Highway Traffic Safety Administration. Available at
www.nhtsa.gov/staticfiles/nti/pdf/811239.pdf

Solomon, M. G., Ulmer, R. G., & Preusser, D. F. (2002). *Evaluation of Click It or Ticket Model Programs.* (Report No. DOT HS 809 498). Washington, DC: National Highway Traffic Safety Administration. Available at
www.nhtsa.dot.gov/people/injury/airbags/clickitcomposite/clickit_composite.pdf

Stehr, S. D., & Lovrich, N. (2003). *An Assessment of Child Car Booster Seat Usage in the State of Washington*. Pullman, WA: Washington State University.

Tessier, K. (2010). *Effectiveness Of Hands-On Education For Correct Child Restraint Use By Parents.* Accident Analysis & Prevention, 42/4, Pages 1041-1047. Available at www.seatsforkidscanada.com/f/Effectiveness_of_hands-on_education_for_correct_child_restraint_use_by_parents.pdf

Thomas III, F. D., Blomberg, R. D., Van Dyk, J. (2010). *Evaluation of the First Year of the Washington Nighttime Seat Belt Enforcement Program.* (Report No. DOT HS 811 295). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811295.pdf

Tison, J., Solomon, M. G., Nichols, J. L., Gilbert, S. H., Siegler, J. N., & Cosgrove, L. A. (2008). *May 2006 Click It or Ticket Seat Belt Mobilization Evaluation: Final Report.* (Report No. DOT HS 810 979). Washington, DC: National Highway Traffic Safety Administration. http://ntl.bts.gov/lib/30000/30200/30258/810979.pdf

Tison, J., & Williams, A.F. (2010). *Analyzing the First Years of the* Click It or Ticket *Mobilizations.* (Report No. DOT HS 811 232). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811232.pdf

Tison, J., Williams, A. F., & Chaudhary, N. K. (2010). *Daytime and Nighttime Seat Belt Use by Fatally Injured Passenger Vehicle Occupants.* (Report No. DOT HS 811 281 Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811281.pdf

Tison, J., Williams, A. F., Chaudhary, N. K., & Nichols, J. L. (2011). *Determining the Relationship of Primary Seat Belt Laws to Minority Ticketing.* (Report No. DOT HS 811 535). Washington, DC: National Highway Traffic Safety Administration. Available at www.*nhtsa.gov/staticfiles/nti/pdf/811535.pdf*

Van Houten, R., Malenfant, J. E. L., Reagan, I., Sifrit, K., & Compton, R. (2009*). Pilot Tests of a Seat Belt Gearshift Delay on the Belt Use of Commercial Fleet Drivers.* (Report No. DOT HS 811 230). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811230.pdf

Varghese, C., & Shankar, U. (2007). *Passenger Vehicle Occupant Fatalities by Day and Night – A Contrast. Research Note.* (Report No. DOT HS 810 637). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/810637.PDF

Weber, K. (2000). Crash Protection for Child Passengers: A Review of Best Practice. *UMTRI Research Review July-September 2000, Vol. 31, No. 3*

Will, K. E., Sabo, C. S., & Porter, B. E. (2009). Evaluation of the Boost 'em in the Back Seat Program: Using fear and efficacy to increase booster seat use. *Accident Analysis and Prevention*, *41*, 57-65.

Williams, A. F., & Wells, J. K. (2004). The role of enforcement programs in increasing seat belt use. *Journal of Safety Research*, *35,* 175-180.

Williams, A. F., Wells, J. K., & Ferguson, S. A. (1997). Development and evaluation of programs to increase proper child restraint use. *Journal of Safety Research*, *28*, 69-73.

Womack, K. N., De La Zerda, S., Block, A. W., & Guzzetta, C. S. (2005). *Assessment of the NHTSA Standardized Child Passenger Safety (CPS) Training Course.* (Report No. DOT HS 809 885). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/CPS_Assessment/images/809_885.pdf

Ye, J., & Pickrell, T. (2008). *Traffic Safety Facts, Research Note: Child Restraint Use in 2007, Overall Results*. (Report No. DOT HS 810 931). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/810931.PDF

Zaza, S., Sleet, D. A., Thompson, R. S., Sosin, D. M., & Bolen, J. C. (2001). Reviews of evidence regarding interventions to increase use of child safety seats. *American Journal of Preventive Medicine*, *21*, 31-47.

3. Aggressive Driving and Speeding

Overview

Characteristics and problem size: aggressive driving. Aggressive driving is generally understood to mean driving actions that markedly exceed the norms of safe driving behavior and that directly affect other road users by placing them in unnecessary danger. Aggressive driving may also involve driver anger, attempts to gain an advantage over other drivers, and deliberate violations and deviations from normal traffic speeds (NCHRP, 2003a). It has proven challenging to arrive at a consensus for a theoretical definition of aggressive driving, and hence to come up with a working definition. Not every moving violation is considered aggressive driving. However, multiple violations that encroach on others' safe space, such as driving much faster than prevailing speeds, following too closely, making unsafe lane changes, and running red lights, either on one occasion or over a period of time, may indicate a pattern of aggressive driving. Although some States have passed laws criminalizing aggressive driving, it should not be confused with road rage, an intentional assault by a driver or passenger with a motor vehicle or a weapon that occurs on the roadway or is precipitated by an incident on the roadway.

Causes of aggressive driving can include both personal and environmental triggers. A predisposal to immature and "selfish" driving that frequently puts others at risk might be the norm for a small proportion of drivers, while others may be provoked to drive aggressively at least occasionally by exceptional congestion, work zone delays, poorly timed traffic signals, being late, and other frustrating conditions. Other drivers' actions are also sources of irritation for "reactive" style drivers. More than half of drivers in one study reported that they would react aggressively, particularly to being impeded, but also to others' reckless driving or actions perceived as directly hostile (Björklund, 2008). Other life stressors may also contribute to aggressive driving. A recent paper suggests that soldiers who have been recently deployed to a combat zone may be more prone to taking risks, losing their temper, and retaliating while driving than other soldiers (Sarkar, 2009). The perceived rise in aggressive driving is therefore likely to be related, at least in part, to increasingly crowded roadways, longer commute times, increases in trips, complexity of personal schedules, and other sources of stress; however, driving actions are ultimately under individual drivers' control. Behavioral countermeasures for aggressive driving and speeding must reinforce and help teach such control.

Aggressive driving actions are perceived to be common, although they are difficult to measure accurately. In NHTSA's 2002 survey of speeding and unsafe driving behaviors, 40% of drivers reported that they sometimes enter an intersection "just as the light turned from yellow to red," and 11% said they often did this. In the same survey, 10% reported sometimes cutting in front of another driver, and 2% said they often did this (NHTSA, 2004). About one-third (34%) of drivers reported that they feel threatened by other drivers at least several times monthly (NHTSA, 2004). NHTSA estimated that two-thirds of traffic fatalities involve behaviors commonly associated with aggressive driving such as speeding, red-light running, and improper lane changes (NHTSA, 2001a). The AAA Foundation for Traffic Safety has estimated that 56% of fatal crashes involved one or more driver actions typically associated with aggressive driving, the most common being excessive speed (AAA Foundation for Traffic Safety, 2009).

Characteristics and problem size: speeding. Speeding-related fatalities decreased by 3% from 10,664 in 2009 to 10,395 in 2010, but speeding was still a contributing factor in about 31% of fatal U.S. crashes (NHTSA, 2012), a percentage that has remained relatively unchanged for decades. Younger drivers and particularly young, male drivers involved in fatal crashes were most likely to be designated as speeding in 2010 as in earlier years. Thirty-nine percent of male drivers in both 15- to 20-year-old and 21- to 24-year-old age groups involved in fatal crashes were speeding. In addition, other risk factors including alcohol use, lack of seat belt wearing, and late night hours and not being properly licensed at the time of the crash are associated with higher percentages of speeding in fatal crashes. Thirty-five percent of motorcycle riders nationally were speeding compared with 23% for passenger car drivers, 19% for light-truck drivers, and 8% for large-truck drivers (NHTSA, 2012).

The legal definitions of speeding include exceeding the posted speed limit or driving too fast for existing conditions. Speeding becomes aggressive driving when a vehicle's speed substantially exceeds the prevailing travel speeds of other vehicles. Speeding is a more clearly defined problem than aggressive driving, and strategies to reduce speeding (and other serious traffic law violations) may provide a means to address the problem of aggressive driving.

Speeding is legally defined by municipalities and States in terms of a "basic speed rule" and statutory maximum speed limits. Although the wording of the basic speed rule varies, it usually requires drivers to drive at a reasonable and prudent rate for roadway conditions. This is open to the officer's judgment, but is frequently related to weather, surface conditions, congestion, or other roadway conditions. Statutory speed limits set maximum limits for different types of roads, and generally apply to all roads of that type even when the limits are not posted. These limits can be superseded by limits posted for specific roadway segments, usually determined on the basis of an engineering study. Special Report 254 of the Transportation Research Board summarizes much of the past research regarding the effects of speed on crashes and best practices for setting speed limits and managing speeds (TRB, 1998). Aarts and van Schagen (2006) provide a more recent review of studies of the effects of speed and speeding on crash and injury risk.

Speeding is the most frequently cited aggressive-driving infraction, and has been incorporated into most aggressive driving laws as one of the violations required to invoke an aggressive driving offense. Speeding is common. About three-quarters of all drivers in NHTSA's 2002 national survey reported that they exceeded the posted speed limit on various types of roads. Specifically, 78% of drivers reported speeding on interstates, 83% on non-interstate multilane roads, 78% on two-lane roads, and 73% on city streets during the past month. One-fourth to one-third of drivers reported speeding on the various types of roads on the day of the interview (NHTSA, 2004). In addition, one-third (34%) of all drivers reported that they drive, at least some of the time, 10 or more miles per hour faster than most other vehicles (NHTSA, 2004). Approximately two-thirds (68%) of drivers felt that other speeding drivers pose a major threat to their personal safety (NHTSA, 2004). NHTSA reports that speeding, as determined by the investigating officer, was a contributing factor in 31% of fatal crashes in 2009 resulting in 10,591 lives lost (NHTSA, 2010a). The percentage of speeding-related fatal crashes has changed little over the years. In-depth investigations found speeding to be a causal factor in 19% of a sample of serious crashes in 1996-1997, second only to driver distraction/inattention (Hendricks, Fell, & Freedman, 2001; Hendricks, Freedman, Zador, & Fell, 2001).

Speeding can be dangerous on all types of roads. In 2009, 50% of U.S. speed-related traffic fatalities occurred on roads posted at 50 mph or less and 24% occurred on roads posted at 35 mph or less (NHTSA, 2010, Table 121). In 2010, only 14% of fatal speeding-related crashes occurred on Interstate highways, with 24% occurring on local roads, 22% on non-interstate collectors, 36% on non-interstate principal and minor arterials combined, and 4% on other types of freeways and expressways (NHTSA, 2012).

Strategies to Reduce Aggressive Driving and Speeding

Aggressive driving, speeding, and red-light running all involve traffic law violations. Therefore, deterrence through traffic law enforcement is the basic behavioral strategy that has been used to control them. This strategy involves the same components used to deter alcohol-impaired driving or seat belt nonuse: highly publicized and highly visible enforcement of practical, sound, and broadly accepted laws. In particular, speed limits should be set carefully, taking into account the road segment's design, vulnerable users, traffic operations, and environmental conditions. (Information on different speed limit setting approaches is described in *Methods and Practices for Setting Speed Limits*, a report sponsored by FHWA and ITE available at http://safety.fhwa.dot.gov/speedmgt/ref_mats/fhwasa12004/.) Additionally, the NCHRP Guide for Addressing Aggressive-Driving Collisions (NCHRP, 2003a) suggests that successful anti-aggressive driving programs place an emphasis on enforcing all traffic laws. Such a strategy increases respect for all laws and the public's expectation that laws should be obeyed.

Aggressive driving enforcement can be conducted through regular traffic patrols; sustainable levels of widespread, randomized but well-targeted enforcement (Newstead, Cameron, & Leggett, 2001); intense, highly publicized enforcement periods; and automated speed or red-light enforcement. The sections in this chapter discuss relevant laws and sanctions, special enforcement techniques, and publicity.

Environmental and vehicular measures also can be effective. As examples, traffic calming measures can reduce speeds, especially on local roads (TRB, 1998), but these must be carefully implemented so as not to shift speeding or safety problems to other locations. A variety of measures to reduce congestion, such as mass-transit or ride-sharing, can diminish driver frustration that leads to aggressive driving (Shinar & Compton, 2004). Well-timed and coordinated traffic signals can improve traffic flow and reduce red-light running and are potentially useful for managing speeds. Advance warnings of congestion or delays and well-designed and managed work zones may also decrease unexpected frustration. Intelligent Transportation System technologies such as real-time transit information, variable speed limits, variable message signs, traffic control warning devices and other systems that provide motorists with information and respond to changing traffic and environmental conditions, also hold promise for improving mobility and safety by mitigating causes of delay and hazardous conditions. Adequately designed turn bays and entrance and exit ramps can reduce improper merging and driving on the shoulder (NCHRP, 2003a, Strategy B1). Company policies, backed up with speed monitors and logs or even speed regulators, can reduce commercial vehicle speeding. These environmental and vehicular strategies are not included in this guide because State Highway Safety Offices (SHSOs) have little or no direct authority or responsibility for them. However, managing traffic operations in general and speeds in particular requires cooperative efforts between State Departments of Transportation (DOTs) and SHSOs. SHSOs

are encouraged to act cooperatively with State DOTs to identify their aggressive driving and speeding problems and to adopt comprehensive plans and programs to address them. For example, targeted enforcement requires agencies that maintain crash data, such as DOTs, join with researchers who analyze the data, and with law enforcement agencies to identify and target enforcement to areas and times where aggressive driving crashes are highly represented (Strategy 4.1, A.1). See NCHRP (2003a) for more examples of cooperative strategies on aggressive driving and NCHRP (2009) for more information on speed limit setting, roadway design and traffic control strategies to reduce speeding-related crashes, and developing a comprehensive speed management program that includes enforcement, education and engineering strategies. State highway safety offices can also promote dissemination of effective practices through the types of safety projects recommended and funded.

The same cooperative methods can be useful in addressing local aggressive driving or speeding concerns, for example, in a neighborhood or on a road segment or corridor. Working together, State and community traffic engineers, law enforcement, safety officials, community leaders, and concerned citizens can develop comprehensive plans and programs.

The Department of Transportation, together with GHSA and several national organizations sponsored a National Forum on Speeding in June 2005. The forum's invited presentations documented speed-related issues and summarized speed management practices in Australia, Canada, and the Netherlands. The presentations are available at www.nhtsa.dot.gov/people/injury/enforce/Speed_Forum_Presentations/. The forum report (NHTSA, 2005) presents an action agenda.

The Department of Transportation's 2005 Speed Management Strategic Initiative (FWHA, FMCSA, & NHTSA, 2005) contains a comprehensive set of engineering, enforcement, and education strategies to reduce speeding-related fatalities and injuries. A key component of the Speed Management Strategic Initiative has been to emphasize the interdisciplinary nature of effective speed management, whereby engineering, enforcement, and the judiciary are all critical components. Law enforcement officers can only rigorously enforce speed limits when engineering and the judiciary provide infrastructure support. Engineering is required to design roadways and set speed limits that consider the safety and mobility of all users, and to re-engineer problematic roadway segments. If the judiciary does not follow-through by supporting tickets levied by officers, regard for the limits as meaningful and credible acquired through rigorous enforcement is undermined. Victoria, Australia implemented a comprehensive effort to reduce speed that combined review and adjustment of speed limits, covert and overt forms of enforcement, a media campaign, penalty restructuring, and other efforts. An evaluation found these combined elements reduced injury crashes by 10% and fatal crashes by 27% (D'Elia, Newstead & Cameron, 2007).

Efforts to address dangerous speeding and aggressive driving could also benefit from better understanding of the motivations and choices of drivers who are willing to accept increased risks not only for themselves, but for other drivers as well. More comprehensive, or at least different, measures may be needed to address certain types of offenders, including flagrant and repeat offenders, than are generally employed. For example, as part of a comprehensive road safety strategy, the United Kingdom has embarked upon an ambitious research program known as High UnSafe Speed Accident Reduction (HUSSAR) to understand the human factors and

psychological reasons for speeding and other dangerous driver behaviors so that educational and enforcement programs may better target barriers to speed compliance (Fuller et al., 2008a; Fuller et al., 2008b; Stradling et al., 2008). Other significant research is emerging, as well, that can shed light on theoretical frameworks, motivations, and effective strategies to consider in developing anti-speeding and anti-aggressive driving campaigns. There may be lessons available for the United States as a whole, and for States and communities resulting from these and similar efforts to better-understand the psychology of driving including those involving an anti-social component such as aggressive driving and flagrant speeding, and to treat driver behavioral problems accordingly.

Resources

As mentioned in the introduction, this document is restricted to behavioral countermeasures that are typically under the direct authority of SHSOs. But a comprehensive, multifaceted approach that incorporates assessing and addressing engineering and environmental issues as well as enforcement, legislative, and program evaluation needs is essential to most effectively reduce speeding-related crashes and injuries.

Other resources and links include:

- National Highway Traffic Safety Administration
    - Aggressive Driving - www.nhtsa.gov/Aggressive
    - Enforcement and Justice Services - www.nhtsa.gov/Driving+Safety/Enforcement+&+Justice+Services
    - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
    - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- FHWA Safety Office, Speed Management Safety page and links: safety.fhwa.dot.gov/speedmgt/
- AASHTO Strategic Highway Safety Plan, including the NCHRP Report 500 series guides on reducing crashes. Volume 1 describes strategies to reduce aggressive-driving crashes and Volume 23 addresses speeding-related crashes: safety.transportation.org/guides.aspx
- NCHRP Report 504, Design Speed, Operating Speed, and Posted Speed Practices: onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_504.pdf
- Transportation Research Information Services (TRIS) database – bibliographic database of transportation-related research: tris.trb.org

Countermeasures That Work

Countermeasures to reduce aggressive driving and speeding are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Laws

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Speed limits	★★★★★†	$	High	Short
1.2 Aggressive driving laws	★	$	Low	Short

† When enforced and obeyed

2. Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Automated enforcement	★★★★★	$$$†	Medium	Medium
2.2 High-visibility enforcement	★★	$$$	Low††	Medium
2.3 Other enforcement methods	★★	Varies	Unknown	Varies

† Can be covered by income from citations

†† For aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

3. Penalties and Adjudication

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Penalty types and levels	★★	Varies	High	Low
3.2 Diversion and plea agreements	★	Varies	Unknown	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Public Information supporting enforcement	★★★	Varies	Medium	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, or equipment, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, and/or facilities

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities

Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:

Long: more than one year

Medium: more than three months but less than one year

Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws

1.1 Speed Limits

Effectiveness: ★★★★★†	Cost: $	Use: High	Time: Short

† When enforced and obeyed

Speed limits are only one part of the system that attempts to control driving speeds. Without broad public acceptance and active enforcement they have little effect. With public acceptance and enforcement, lower speed limits can reduce travel speeds and casualties.

Speed limits are set both by legislation and by administrative action. General speed limits apply to all roads in a class, such as rural interstates or local streets. They are set by State, municipal, or even at times by Federal law based on tradeoffs between safety, travel efficiency, and community concerns, taking into account the design characteristics of each road class. Speed zones apply to road segments where the general speed limit is thought to be inappropriate. Speed limits in these zones usually are set by administrative action based on the road segment's free-flowing travel speeds, crash experience, road and land use conditions, and other factors (TRB, 1998).

The effects of maximum speed limits on speeds, crashes, and casualties have been studied extensively over the past 30 years. In 1974 the 55 mph National Maximum Speed Limit (NMSL) was enacted to conserve fuel. Travel decreased, speeds decreased on roads where the speed limit was lowered to 55 mph, and total traffic fatalities decreased by 9,100 from 1973. The slower and more uniform speeds due to the 55 mph limit are judged to have saved between 3,000 and 5,000 lives in 1974 (TRB, 1984). As fuel became plentiful again, travel increased and compliance with the 55 mph limit decreased markedly (TRB, 1984). In 1987 Congress allowed States to raise speed limits to 65 mph on rural interstate highways. States that raised their limits generally saw increases of about 4 mph in average speeds and 85th percentile speeds and statistically significant increases in traffic fatalities on these roads (TRB, 1998). In 1995, Congress repealed the NMSL and returned full authority to set speed limits back to the States. Again, increased speed limits produced modest increases in both average and 85th percentile speeds as well as increases in traffic fatalities (TRB, 1998; for the most recent analysis, see TRB, 2006). Speed limit increases from 75 to 80 mph on rural Texas interstates in 2006 also resulted in increased speeds relative to a comparison highway with no increase in limit (Retting & Cheung, 2008). For summaries of each State's maximum speed limits see the Governors Highway Safety Association (GHSA, 2010c) and the Insurance Institute for Highway Safety (IIHS, 2010) Web sites. NHTSA (2011) provides a publication with each State's complete speed limit laws.

Few studies have examined the effects of speed limit changes on lower-speed roads. Earlier studies found little effect on driving speeds or crash rates when speed limits were raised to near the 85th percentile travel speed or lowered to near the 35th percentile speed, either on rural roads or on urban and suburban arterials (TRB, 1998, p. 6). A more recent study found that crashes increased by 20 to 30% when speed limits were increased from 50 to 70 kph (31 to 43 mph) or from 70 to 80 kph (43 to 50 mph) on 19 urban road segments in Hong Kong (Wong, Sze, Lo, Hung, & Loo, 2005).

Use: A speed limit is in effect on all road segments in all States.

Effectiveness: Lower maximum speed limits definitely reduce crashes and casualties when the limits are obeyed. The same holds true on any road: if a lower speed limit is obeyed, then crashes and casualties will drop. But lower speed limits by themselves may not reduce travel speeds.

Costs: The immediate costs of changing speed limits are for new signage and for publicizing the new limit. Enforcing the new limit may involve substantial costs.

Time to implement: Speed limit changes can be implemented quickly, as soon as signage is in place and the new limits are publicized.

Other issues:

- **Public acceptance, roadway characteristics, enforcement, and publicity:** Speed limit changes may not by themselves affect speeding, whether defined either as average travel speed or as the proportion of drivers traveling substantially faster than the average speed. Speed limits can reduce speeding if most drivers believe that the limits are reasonable and if the threat of enforcement is great enough to affect the few drivers who would not comply voluntarily. It is generally very difficult to enforce and obtain general compliance with a lower speed limit on a roadway designed for higher speeds (TRB, 1998). Thus, speed limits must be considered as part of a system including broad public acceptance, roadway characteristics, active enforcement, and publicity (TRB, 1998).
- **Rational speed limits:** Speed limits on many road segments are frequently not obeyed, and average travel speeds on these segments substantially exceed the speed limit. One strategy that has been proposed to increase overall safety is to carefully set and enforce credible speed limits for homogeneous road segments. Once rational speed limits are established, aggressive enforcement is used to enforce close to the actual limit. The goal of this strategy is to increase the public's overall acceptance of speed limits while reducing the number of people driving at speeds considerably higher than the limit. Emerging evidence suggests that drivers' perceptions of safe speed are in fact influenced by their expectation of what speed above the limit would trigger a ticket. Therefore lower tolerances would help to increase the perception of the risk of exceeding limits by even small amounts (Mannering, 2009).
- **Variable speed limits**: Speed limits that may adjust to adverse or changing environmental conditions are also considered by FHWA to have promise in restoring credibility of speed limits on some highways. Whether this promise will hold up, however, is uncertain. As of 2007, six metropolitan areas were employing enforceable, variable speed limits on freeways (posted on changeable message signs) (RITA, 2007). Effects on safety have not, as yet, been established. Preliminary investigation of a Wyoming freeway VSL system show speed reductions from 0.47 to 0.75 mph for every mph reduction in speed limit (Buddemeyer, Young, & Dorsey-Spitz, 2010). Automated speed enforcement could be linked to variable limits.

1.2 Aggressive Driving and Other Laws

Effectiveness: ★	Cost: $	Use: Low	Time: Short

Aggressive driving actions are covered by specific traffic laws, such as the laws regarding speeding, improper lane changes, and following too closely, or by general laws, such as those that target reckless driving. Most existing reckless driving statues carry relatively minor penalties and may be difficult to prosecute according to NHTSA (NHTSA, 2001a). Aggressive drivers, as distinct from aggressive driving, often can be identified as those who violate traffic laws repeatedly or whose violations lead to crashes producing serious injury or death. Therefore, the primary traffic law strategy to address aggressive driving is to assure that more severe penalties are available for repeat offenders and for violations causing death or serious injuries. Existing statutes, including reckless driving laws, may be strengthened or aggressive driving laws may be enacted.

NHTSA's 1999 Symposium on Aggressive Driving and the Law (NHTSA, 2001a) recommended that States implement laws targeting aggressive drivers by providing for:

- enhanced penalties for repeat offenders, including increased driver's license points, license suspension or revocation, higher fines, and jail or probation; and
- felony charges for violations resulting in serious injury or death.

NHTSA also developed a model statute that defines aggressive driving as three moving violations in a single driving incident and a number of States have adopted similar laws; however, aggressive driving violations may be difficult to enforce and prosecute (Flango & Keith, 2004). The NCHRP Aggressive Driving Guide also suggests a strategy of applying increased sanctions and treatment for repeat offenders and serious offenses (NCHRP, 2003a, Strategy A3).

Use: In general, States provide for increased penalties for repeat offenders and for violations with serious consequences. Ten States have aggressive driving laws (NHTSA, 2011).

Effectiveness: There are no studies of the effects of aggressive driving laws in general or of increased penalties in particular on aggressive driving and related crashes. See Chapter 3, Section 3.1 for a discussion of the effects of driver improvement actions in general.

Costs: The only immediate costs of the recommended law changes are to publicize the new or altered laws. Additional costs may result as drivers are sentenced to more costly sanctions.

Time to implement: Law changes can be implemented quickly, as soon as they are publicized.

Other issues:

- **Public acceptance, enforcement, and publicity:** Law changes by themselves cannot reduce aggressive driving. Traffic laws in general and aggressive driving laws in particular are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, effective adjudication, and publicity (NHTSA, 2001a).
- **Record-keeping:** Information on prior convictions of offenders must be up-to-date and available to prosecutors and court officials so that repeat and flagrant violators may be

prosecuted in keeping with the strategy to increase sanctions for these offenders. Providing the technology and ability for patrol officers to obtain up-to-date driver history information at the time of traffic stops is another strategy recommended to deal with drivers with suspended or revoked licenses who continue to violate traffic laws (NCHRP, 2003b).

2. Enforcement

2.1 Automated Enforcement

Effectiveness: ★★★★★	Cost: $$$†	Use: Medium	Time: Medium

† Can be covered by income from citations

Automated enforcement is used in some jurisdictions to reduce red-light running and speeding. At intersections with traffic lights, automated cameras take photographs of vehicles entering the intersection on a red light. Citations are sent to the vehicle's registered owner. FHWA's Red-Light Camera Systems Operational Guidelines (FHWA, 2005) provides information on red-light camera program costs, effectiveness, implementation, and other issues. Maccubbin, Staples, and Salwin (2001) provide more detailed information on programs operating in 2001. Speed cameras, also called photo radar or automated speed enforcement, operate similarly, recording a vehicle's speed using radar or other instrumentation and taking a photograph of the vehicle when it exceeds a threshold limit. NHTSA and FHWA have released speed camera enforcement program and operational guides with information on problem identification and program planning, communications strategies, obtaining community and other stakeholder support, processing of violations, and program evaluation (NHTSA, 2008; NHTSA & Federal Highway Administration, 2008).

Use: Red-light cameras are used extensively in other industrialized countries and were first employed in the United Sates in 1993 (NCSRLR, 2002). As of August, 2012, red-light cameras were being used in 555 U.S. communities in 24 States and the District of Columbia. Speed cameras were being used in 116 jurisdictions in 12 States and the District of Columbia (IIHS, 2012).

Speed cameras also are used extensively in other countries (WHO, 2004).

Effectiveness: Red-light camera effectiveness has been studied fairly extensively. Summary reviews conclude that they increase rear-end crashes, reduce side-impact crashes (the target group), and reduce overall crash severity (Aeron-Thomas & Hess, 2006; Decina, Thomas, Srinivasan, & Staplin, 2007; Maccubbin et al., 2001; McGee & Eccles, 2003; Retting, Ferguson, & Hakkert, 2003; Shin & Washington, 2005; WHO, 2004). Because there tend to be increases in lower-severity rear end crashes that somewhat offset reductions in the target group of higher-severity angle crashes, cameras were found to be more beneficial at intersections with a higher ratio of angle crashes to rear-end crashes. The best-controlled studies have found that intersections with high total volumes, higher entering volumes on the main road, longer green (through) cycle lengths, protected left turn phases, and higher publicity may also increase the safety and cost benefits of red light camera enforcement (Council, Persaud, Eccles, Lyon, & Griffith, 2005; Shin & Washington, 2005). Other factors that may improve safety benefits included the posting of warning signs in advance of the intersection. Shin and Washington (2005) also caution that less expensive engineering solutions should be sought before implementing camera programs.

Speed cameras can reduce crashes substantially. Decina et al. (2007) reviewed 13 safety impact studies of automated speed enforcement internationally, including one study from a U.S.

jurisdiction. The best-controlled studies suggest injury crash reductions are likely to be in the range of 20 to 25% at conspicuous, fixed camera sites. Covert, mobile enforcement programs also result in significant crash reductions area-wide (Thomas, Srinivasan, Decina, & Staplin, 2008). Prior reviewers also concluded that, although the quality of evidence was not high, speed cameras and speed detection technologies are effective at reducing traffic crashes and injuries (Pilkington & Kinra, 2005; Wilson, Willis, Hendrikz, & Bellamy, 2006). Recent crash-based studies from the United States have reported positive safety benefits of crash and speed reductions from mobile camera enforcement on 14 urban arterials in Charlotte, NC (Cunningham Hummer, & Moon, 2008), and from fixed camera enforcement on an urban Arizona freeway (Shin, Washington, & van Schalkwyk, 2009).

The Shin et al. (2009) study examined effects of a fixed camera enforcement program applied to a 6.5-mile urban freeway section through Scottsdale, Arizona. The speed limit on the enforced freeway is 65 mph; the enforcement trigger was set to 76 mph. Total *target* crashes were reduced by an estimated 44 to 54%, injury crashes by 28 to 48%, and property damage only crashes by 46 to 56% during the 9-month program period. (The program was temporarily suspended, then reactivated; future evaluations may elaborate on the results.) Since analyses found low speeding detection rates during peak travel times, the target crashes (speeding-related crashes) were considered to be those that occurred during non-peak flow periods (weekends, holidays, and non-peak weekdays hours). In addition to the crash reductions, average speed was decreased by about 9 mph and speed variance was also decreased around the enforced zones. Another positive finding from this study was that all types of crashes appeared to be reduced, with the possible exception of rear-end crashes, for which effects were non-significant. Thus, there were no obvious trade-offs of decreases in some crash types at the expense of increases in others. The program effects should be considered short-term. There was also very limited examination of spillover effects, including the possibility of traffic or crash diversion to other routes.

Pilot project evaluations of speed camera use in the United States have also obtained promising speed reductions from fixed speed cameras on a high-speed, urban freeway in Scottsdale, Arizona (Retting, Kyrychenko, & McCartt, 2008), low-speed, school zones in Portland, Oregon (Freedman et al., 2006), and low-speed limit residential streets and school zones in Montgomery County, Maryland (Retting, Farmer, & McCartt, 2008). In the latter case, speed reductions attributed to spillover from the automated enforcement program were also observed on unenforced comparison streets (Retting et al., 2008). The percentage of speeders was also substantially reduced when police-operated photo radar enforcement vans were present in a work zone on a non-interstate highway in Portland, Oregon, but there was no carry-over when the enforcement was not present (Joerger, 2010). Given that there was no evidence of any accompanying publicity, there was, however, no reason to expect carry-over outside of the enforced periods. Crash and injury outcomes were not evaluated in these studies.

Costs: Costs will be based on equipment choices, operational and administrative characteristics of the program, and arrangements with contractors. Cameras may be purchased, leased, or installed and maintained by contractors for a negotiated fee (NHTSA & Federal Highway Administration, 2008). In 2001, red-light film-based camera systems cost about $50,000 to $60,000 and digital systems around $100,000 to purchase and $25,000 to install. Monthly operating costs were about $5,000 (Maccubbin et al., 2001). Most jurisdictions contract with private vendors to install and maintain the cameras and, to process images and violations. A

substantial portion of the fines from red-light citations is used to cover program costs (Shin & Washington, 2005).

A case study from Portland Oregon's RLC program indicates that the vendor payment structure is a blended contract. The vendor receives a fixed amount per intersection to install and operate the cameras (the city picks the sites) and a monthly amount based on the number of citations that are issued. The marginal amount decreases with more citations issued. The current payment structure is $27 per citation for the first 500 paid citations in a month, $20 for citations 501-700, and $18 for each paid citation over 700 in a month (NCHRP, 2012).

Fixed speed camera costs probably are similar to those for red-light camera programs. An economic analysis estimated the total cost savings of the Scottsdale freeway fixed speed enforcement were from $16.5 to $17.1 million per year, considering only camera installation and operational cost estimates and crash cost impacts (other potential economic impacts were not considered) (Shin, Washington, & van Schalkwyk, 2009). Chen (2005) provides an extensive analysis of the costs and benefits of the British Columbia, Canada, mobile speed camera program and estimated a societal savings of C$114 million and a savings of over C$38 million for the Insurance Corporation of British Columbia (ICBC) that funded the program. Gains, Heydecker, Shrewsbury, and Robertson (2004) reported a 4:1 overall societal cost to benefit ratio of operating the national (fixed) speed camera program in the U.K. based on 33% reductions in personal injury crashes at camera sites and a 40% reduction in the number of people killed and seriously injured.

Time to implement: Once any necessary legislation is enacted, automated enforcement programs generally require 4 to 6 months to plan, publicize, and implement.

Other issues:

- **Laws:** Many jurisdictions using automated enforcement are in States with laws authorizing its use. Some States permit automated enforcement without a specific State law. A few States prohibit or restrict some forms of automated enforcement (GHSA, 2010b; IIHS, 2010a). In yet others, there is no specific statute, and it cannot be inferred from case law whether the State allows automated enforcement. As of February 2010, 9 states had statutes specifically authorizing the use of automated speed enforcement, three implicitly allowed automated speed enforcement (but had no specific authorizing statute), and 6 had statutes allowing specific or limited automated speed enforcement (NHTSA, 2011). See NCUTLO (2004) for a model automated enforcement law.
- **Public acceptance:** Public surveys typically show strong support for red-light cameras and somewhat weaker support for speed cameras (IIHS, 2009; NHTSA, 2004). Support appears highest in jurisdictions that have implemented red-light or speed cameras. However, efforts to institute automated enforcement often are opposed by people who believe that speed or red-light cameras intrude on individual privacy or are an inappropriate extension of law enforcement authority. They also may be opposed if they are viewed as revenue generators rather than methods for improving safety. Per citation payment arrangements to private contractors should be avoided to reduce the appearance of conflicts of interest (FHWA, 2005). Australian researchers discussed how Australia and the United Kingdom have dealt with the opponents of and controversies associated

with speed cameras and expanded programs at the same time (Delaney, Diamantopoulou, & Cameron, 2003; Delaney, Ward, Cameron, & Williams, 2005).

- **Legality:** State courts have consistently supported the constitutionality of automated enforcement.
- **Covert vs. overt enforcement:** Covert, mobile speed camera enforcement programs may provide a more generalized deterrent effect and may have the added benefit that drivers are less likely to know precisely when and where cameras are operating. Drivers may therefore be less likely to adapt to cameras by taking alternate routes or speeding up after passing cameras, but data are lacking to confirm this idea (Thomas et al., 2008). Public acceptance may be somewhat harder to gain with more covert forms of enforcement (NHTSA & Federal Highway Administration, 2008). Fixed, or signed, conspicuous mobile enforcement may also be more noticeable and achieve more rapid site-specific speed and crash reductions. However, the use of general signs in jurisdictions with automated enforcement (not at specifically enforced zones), media, and other program publicity about the need for speed enforcement may help to overcome the idea that covert enforcement is unfair, and promote the perception that enforcement is widespread, enhancing deterrence effects. Based on lessons learned abroad, a mix of conspicuous and covert forms of enforcement may be most effective. See Belin, Tillgren, Vedung, Cameron, & Tingvall (2010) for a comparison of Australian covert and Swedish fixed, overt systems. The recent operational guidelines outline other considerations of overt and covert speed enforcement and signing strategies (NHTSA & Federal Highway Administration, 2008).
- **Halo effects:** More research is needed to shed light on spillover effects (positive or negative) of automated speed enforcement programs of varying characteristics. While fixed cameras may yield more dramatic decreases in crashes at the treated sites (which, however, are often sites with high crash frequencies) than mobile enforcement, there is little reason to expect that there would be a significant positive spillover effect. In fact some studies have detected crash migration related to conspicuous, fixed camera enforcement (Decina et al., 2007). There is also a possibility of negative spillover resulting from mobile camera enforcement, but signing and random deployment practices may reduce that possibility (Thomas, Srinivasan, et al., 2008).
- **Enforcement threshold:** Victoria, Australia has had success with a program that tightened enforcement tolerances as part of an overall speed management package that included automated and other enforcement, publicity, and penalty restructuring (D'Elia, Newstead, & Cameron, 2007). A recent experiment in Finland also found that lowering the enforcement threshold of fixed, speed camera enforcement on a rural, two-lane road from 20 kph to 4 kph (advertised as zero tolerance) and publicity of the measure reduced mean speeds by 2.5 kph and speed variance by 1.1 kph in comparison with a similar, camera-enforced corridor where the threshold was not reduced (Luoma, Rajamäki, & Malvivuo, 2012). The percentage of vehicles exceeding the speed limit was reduced from 23% to 10%, so deterrence of speeding was increased without increasing the processed citations (police or administrative burden). The speed effect of the reduced threshold was within the range of effect of the initial implementation of the automated camera enforcement.

2.2 High Visibility Enforcement

Effectiveness: ★★	Cost: $$$	Use: Low†	Time: Medium

† For aggressive driving, but use of short-term, high-visibility enforcement campaigns for speeding is more widespread

High-visibility enforcement campaigns have been used to deter aggressive driving and speeding through both specific and general deterrence. In the high-visibility enforcement model, law enforcement targets selected high-crash or high-violation geographical areas using either expanded regular patrols or designated aggressive driving patrols. This model is based on the same principles as high-visibility seat belt and alcohol-impaired-driving enforcement: to convince the public that speeding and aggressive driving actions are likely to be detected and that offenders will be arrested and punished (see Chapter 1, Alcohol-Impaired Driving, Sections 2.1 and 2.2, and Chapter 2, Seat Belt Use, Section 2.1).

In the high-visibility enforcement model, officers focus on drivers who commit common aggressive driving actions such as speeding, following too closely, and running red lights. Enforcement is publicized widely. The strategy is very similar to saturation patrols directed at alcohol-impaired drivers (Chapter 1, Section 2.2). Because speeding and aggressive driving are moving violations, officers cannot use checkpoints. Rather, they must observe driving behavior on the road.

Use: No data are available on the number of jurisdictions operating high-visibility aggressive driving enforcement campaigns, but it is likely that they are not common. NCHRP (2003a, Strategy A1) provides a few examples of aggressive driving enforcement programs.

Effectiveness: Moon and Hummer (2010) estimated that 8 to 10% of the total and injury crash reduction effects of around 25% associated with an automated mobile, speed enforcement program in Charlotte, NC were attributable to media coverage of the program. In addition to results from automated camera enforcement programs, which typically incorporate a significant amount of publicity and media coverage (see section 2.1), some crash-based effectiveness evidence comes from NHTSA demonstrations in three communities. All three demonstrations lasted 6 months and included extensive publicity but differed in other respects. Milwaukee was the most successful. Red-light running decreased at targeted intersections. Crashes in the city dropped by 12% in targeted corridors and by 2% in comparison corridors (McCartt, Leaf, Witkowski, & Solomon, 2001). The Indianapolis demonstration was not a success. Average speeds dropped slightly. Total crashes *increased* 32% over the previous year. Crashes increased *more* in the demonstration area than in other areas, and the proportion of crashes involving aggressive driving behaviors also increased in the demonstration areas (Stuster, 2004). Tucson had mixed results. Average speeds dropped moderately. Total crashes *increased* 10% in the demonstration areas and *decreased* in comparison areas. However, the proportion of crashes involving aggressive driving behaviors decreased by 8% in the demonstration areas (Stuster, 2004).

Several studies have reported reductions in crashes or reductions in speeding or other violations attributed to both general and targeted high-visibility enforcement campaigns. Although the evidence is not conclusive, the trends are promising. These efforts have included a substantial

increase in general traffic enforcement in Fresno, California (Davis et al., 2006), and a neighborhood high-visibility speed enforcement campaign in Phoenix and Peoria, Arizona (Blomberg & Cleven, 2006). Publicity measures for the latter included both street and yard signs, educational material and active participation of neighborhood groups. Speed reductions were greatest in neighborhoods where new vertical traffic calming measures were also installed. No particular publicity measures were noted for the Fresno campaign, but it is likely that the increase from 20 to 84 traffic patrol officers, the addition of 20 new police motorcycles and radar guns, and more than 3-fold increase in citations in two years generated substantial publicity.

Although consistency in speed-limit setting practices should provide better information about expectations to drivers, the safety effects of combining rational speed limit setting (with raised limits) followed by enhanced or high visibility enforcement are uncertain. Over the longer term, there is evidence that higher speed limits will lead to higher average speeds and, consequently, greater risk of fatal and injury crashes. When testing the effects of raising speed limits followed by enhanced enforcement in Mississippi and Virginia, speeds increased over the short term, although not by as much as the speed limits had been increased (Freedman, De Leonardis, Polson, Levi, & Burkhardt, 2007; Fontaine, Park, & Son, 2007). There were no significant crash effects over these fairly short term evaluations (1 to 1.5 years). A test in Minnesota yielded more promising, though inconclusive speed and crash trends (Harder & Bloomfield, 2007). The Minnesota campaign, which used speeding and crash histories to help target enforcement, effectively reduced mean speeds and especially excessive speeding (speeds of 70 mph and more). Extensive radio publicity supplemented by earned media was used in the Minnesota campaign, but it was unclear if these efforts were successful at reaching a wider audience.

A 2008 test of a 4-week, high-visibility enforcement campaign along a 6-mile corridor in London, U.K. with a significant crash history found significant reductions in driver speeding in the enforced area. There was also a halo effect up to two weeks following the end of the campaign (Walter, Broughton, & Knowles, 2011). A crash-based analysis was not conducted. The campaign was covered by print media as well as by billboards and active messaging along the enforced corridor.

High-visibility model programs to target specific aggressive driving actions around large trucks have also been undertaken in several States. The program, known as TACT (Ticketing Aggressive Cars and Trucks) is modeled on the *Click It or Ticket* belt use campaigns. An evaluation found promising results in reducing the number of targeted violations as the program was implemented in Washington State; effects on crashes or injuries were not determined (Nerup et al., 2006; Thomas, Blomberg, Peck, Cosgrove, & Salzberg, 2008).

Taken together, the evaluation evidence suggests that high-visibility, aggressive driving enforcement campaigns have promise, but safety benefits are far from guaranteed. Given the current challenge in administering police enforcement resources, one approach to develop a sustainable and effective campaign may be to randomly target low levels of enforcement on an unpredictable basis (Newstead, Cameron & Leggett, 2001). In a study from Queensland, Australia, the Random Road Watch enforcement program aimed explicitly to cover a large portion of the road network, not just crash black spots, by randomly targeting police enforcement for two hour periods from 6 a.m. to midnight using marked, parked police vehicles. Significant reductions in fatal and all crashes were estimated for the enforced zones that translated into

statewide reductions of 12% in all severity of crashes and 15% of the state's fatal road crashes (including non-metro areas). No additional publicity was undertaken; it is unknown how much free publicity the program generated.

Other methods of making use of enforcement time halos such as enforcing a corridor or other area for up to 4 weeks as described earlier, and then moving the enforcement to another zone could be utilized to maximize enforcement's deterrent effects.

Costs: As with alcohol-impaired driving and seat belt use enforcement campaigns, the main costs are for law enforcement time and for publicity. The Minnesota Speed Management Program cost approximately $3 million, with $2.5 million for increased enforcement, $350 thousand for paid media (primarily radio), and $150 thousand for data collection and evaluation. The Minnesota DOT and State Patrol also made significant in-kind contributions toward project management, sign installation, speed detection equipment, engineering reviews, and fuel & vehicle costs (Harder & Bloomfield, 2007). The Milwaukee demonstration received a $650,000 grant and the other two demonstrations each received a $200,000 grant.

Time to implement: High-visibility enforcement campaigns may require 4 to 6 months to plan, publicize, and implement.

2.3 Other Enforcement Methods

Effectiveness: ★★	Cost: Varies	Use: Unknown	Time: Varies

Many traffic enforcement operations help to deter speeding and aggressive driving as well as other traffic offenses. In addition to high-visibility enforcement campaigns (Chapter 3, Section 2.2) and automated enforcement (Section 2.1), a number of new technologies have been recommended to address speeding and aggressive driving (NHTSA, 2001a). Law enforcement agencies around the country have also conducted innovative and effective aggressive driving enforcement programs (NHTSA, 2000).

Technology: Both external and in-vehicle technologies may help in several ways.

- In-car video equipment in patrol cars allows law enforcement to record aggressive driving actions and can enhance the ability to prosecute and convict offenders (NHTSA, 2001a).
- Laser speed measuring equipment can provide more accurate and reliable evidence of speeding (NHTSA, 2001a).
- Unstaffed speed display devices, also known as speed trailers, can show drivers that they are speeding and may encourage some drivers to slow down, but effects may last only as long as the devices are in place (Donnell & Cruzado, 2008). They may also suggest to drivers that speeds are being monitored or enforcement is nearby. Signs that provided either an implication that speeds were being monitored or a social norms message (average speed at the site; your speed) were effective at reducing speeds in a 50 km/h zone although not as much as in earlier studies (Wrapson, Harre, & Murrell, 2006). Other studies have shown that speed trailers can be effective in reducing speeds in work zones (Brewer, Pesti, & Schneider, 2006; Mattox, Sarasua, Ogle, Eckenrode, & Dunning, 2007) and school zones (Lee, Lee, Choi, & Oh, 2006). Automated speed display monitors also provide a method to collect location-specific travel speed data. However, speeds seem to rebound quickly downstream and as soon as the devices are removed (Walter & Broughton, 2011; Hajbabaie, Medina, Wang, Rahim, & Chitturi, 2011).
- In work zones, a combination of a parked police vehicle and speed feedback trailer reduced average and 85th percentile traffic stream speeds and free flow speeds to a similar degree as automated camera enforcement, whereas the effect of speed trailers alone was the same as no treatment. Parked police alone was also effective, but to a lesser extent than the combination of police + trailer or the camera system. The number of speeders above 10 mph over the limit was essentially reduced to zero by both the automated enforcement and police + trailer combination. However, the treatment effects on speeds in work zones disappeared within 40 – 50 minutes of removal (Hajbabaie et al., 2011).
- Drone radar - A study of the use of this technology in work zones suggests that it may be effective at reducing overall speed of the traffic stream, with particularly large speed reductions among vehicles equipped with radar detectors (Eckenrode, Sarasua, Mattox, Ogle, & Chowdhury, 2007).
- Both in-vehicle driver warning systems, as well as traditional cruise control, are widely available technologies that may be well-accepted by drivers to help govern their own speeds and have begun to be evaluated in Europe (Sivak et al., 2007; Young & Regan,

2007). However, a study of the effects of in-vehicle warning and monitoring systems was disappointing with respect to speed control by young teens (Farmer, Kirley, & McCartt, 2010). Even with parental notification (immediate or delayed) and with or without in-vehicle alerts, there was either no reduction in instances of teens exceeding the limit by more than 10 mph or initial declining trends reversed after a few weeks.

- Rewards may work better than warnings and alerts. Lease cars in the Netherlands were equipped with technology that continuously monitored and displayed whether drivers were allowing a safe following distance and complying with the speed limit. Rewards were given by the lease company for good driving behavior over a 16-week period. Drivers were about 20% more likely to drive within posted speed limits and 25% more likely to maintain adequate following distances when receiving feedback and rewards (Mazureck & van Hattem, 2006). A pay-as-you drive plan to save young drivers' insurance costs also reduced the percentage of miles that young drivers exceeded the limit by 14% (Bolderdijk, Knockaert, Steg, & Verhoef, 2011).
- Intelligent Speed Adaptation involves systems that "know" the speed limit through accurate mapping and digital data, that either warn when the limit is being exceeded or apply active controls to slow the vehicle. Drivers' intentions to speed and actual behaviors were assessed following driving with an Intelligent Speed Adaptation in-vehicle system that provided direct resistance to speeding (Chorlton & Connor, 2012). While measured intentions to speed and impressions of time-savings that could be gained by speeding were decreased among the participants, actual speeding behavior after the system was inactivated returned to pre-exposure levels within 4 weeks.

Many jurisdictions use some of these new technologies. Each has costs for new equipment, maintenance, and training. Each can be implemented quickly as soon as equipment is purchased and training completed.

Other enforcement programs: NHTSA's *Aggressive Driving Enforcement: Strategies for Implementing Best Practices* (NHTSA, 2000) provides brief descriptions of 12 aggressive driving enforcement programs from around the country. See NHTSA's *Aggressive Driving Programs* (NHTSA, 2001b) for additional examples.

- The Albuquerque, New Mexico, Safe Streets program used saturation patrols in four high-crash and high-crime areas. On freeways they observed speeding and aggressive driving from a "cherry picker" platform and radioed to patrol officers.
- The Arizona Department of Public Safety's Operation Chill used both marked and unmarked patrol vehicles backed up with an extensive publicity campaign.
- The Colorado State Patrol ADAPT (Aggressive Drivers Are Public Threats) campaign used unmarked patrol vehicles, motorcycles, airplanes, and motorist calls to *277 to detect aggressive drivers. The campaign was publicized extensively.
- The Maryland State Police used a special ADVANCE (Aggressive Driving Video and Non-Contact Enforcement) vehicle equipped with lasers to determine a vehicle's range and speed and a computer system to record video images of the vehicle.
- The Massachusetts State Police 3D Program, (Dangerous Drunk and Drugged Driving) used unmarked patrol vehicles as well as unmarked or nontraditional vehicles, equipped with in-car video cameras and radar units, and emergency lights, working in cooperation with two or more marked patrol vehicles.

- The Milwaukee, Wisconsin, Police Department used an "angel patrol" (for those drivers who “drive faster than their guardian angel can fly”), a "flasher patrol" for those drivers who do not use their turn signals when turning or switching lanes, and a "basket patrol" for the drivers who like to weave in and out of traffic. See Chapter 3, Section 2.2 for evaluation data.
- The Ohio State Highway Patrol’s Operation TRIAD (Targeting Reckless, Intimidating, and Aggressive Drivers) used a large, fixed-wing aviation division and local highway patrol officers to target aggressive driving.
- The Oklahoma City Police Department’s RAAID (Reduction of Accidents and Aggressive and Inconsiderate Drivers) used dedicated law enforcement teams to target 10 high-crash areas.
- The Pennsylvania State Police used two programs. Operation Centipede stationed 8 to 10 officers one to two miles apart along a roadway, in both marked and unmarked vehicles. TAG-D (Ticket the AGgressive Driver) used saturation patrols with marked and unmarked law enforcement vehicles, a vehicle that appears disabled, radar, fixed-wing aircraft, and pursuit vehicles.
- The Richardson, Texas, Police Department used a downstream light system to reduce red-light running. A white light on the back of a traffic light was activated when the light turned red. Officers across the intersection or downstream from the traffic light could then tell when the light turned red and wait for the red-light runners to reach them.
- The St. Petersburg, Florida, Police Department’s “Where’s Jockers?” program featured Patrol Officer Mike Jockers, equipped with a radar gun and hand-held radio, sitting in unexpected places to observe aggressive driving and call ahead to marked patrol vehicles. Locations included on lawn mowers and bus benches, and in road construction vehicles.
- The greater Washington, DC, area multi-agency Smooth Operator program used shared publicity and coordinated enforcement waves with marked and unmarked patrol vehicles as well as nontraditional vehicles.

3. Penalties and Adjudication

3.1 Penalty Types and Levels

Effectiveness: ★★†	Cost: Varies	Use: High	Time: Low

† For general traffic offenses

Penalty types and levels for speeding and the various traffic offenses included under aggressive driving are part of each State's overall driver control system. Penalties typically are low for first offenses that do not produce serious crashes and casualties and include small fines and perhaps a few demerit points assessed against the driver's license. When violations cause a crash producing serious injury or death, the offense may carry criminal charges and sanctions may be more severe. As discussed in Chapter 3, Section 1.2, NHTSA's Aggressive Driving Symposium and NCHRP's Aggressive Driving Guide recommend enhanced penalties for repeat aggressive driving offenders and felony charges for offenses resulting in serious injury or death (NCHRP, 2003a, Strategy A3; NHTSA, 2001a).

States use the demerit point system in an attempt to prevent drivers from committing repeated traffic offenses. As drivers accumulate demerit points, States use various actions and penalties such as warning letters, educational brochures, group counseling meetings, individual counseling, administrative hearings, and driver's license suspension or revocation (Masten & Peck, 2004). Penalty levels and types for speeding and aggressive driving offenses should be considered within the context of a State's overall driver control and problem driver remediation system.

Use: Each State has a system of penalties for traffic offenses. Each system includes more severe penalties for significant individual offenses, such as those producing serious injury or death, and for repeated offenses, often determined through accumulated driver's license demerit points.

Effectiveness: Generally, for penalties to be effective, perceived risk of getting caught must be high. Evidence is mixed about effectiveness of varying severity of penalties. Masten and Peck (2004) reviewed the effectiveness evidence for different driver improvement and driver control actions, including penalty levels and types, from 35 high-quality studies of 106 individual actions and penalties. They found that, taken together, all actions and penalties reduced subsequent crashes by 6% and violations by 8%. Even simple warning letters had some effect on both violations and crashes. The effect increased as the "obtrusiveness" of the action increased, with license suspension or revocation the most effective by far. The authors noted that the threat of license suspension probably is responsible for the effectiveness of the weaker actions such as warning letters. Educational brochures by themselves had no effect. Finally, administrative penalties imposed by the driver licensing agency were more effective than penalties imposed by the courts.

In Norway, Elvik and Christensen (2007) reported that there was a weak tendency for speeding violations to decrease near camera-enforced sites in response to increasing fixed penalties over time. There was no general effect of increasing fixed penalties over the road system at large, likely due to the overall low risk of detection.

Research in Maryland found that various legal consequences for speeding had little impact on future citations for individual drivers (Lawpoolsri, Li, & Braver, 2007). Drivers who received legal consequences had the same likelihood of receiving another speeding citation as drivers who escaped legal consequences. Only fines coupled with probation before judgment (PBJ) was associated with a reduced risk of receiving a subsequent speeding ticket (Lawpoolsri et al., 2007). A follow-on longitudinal study found that the 54% of cited drivers who opted for court appearance to contest their speeding citations were more likely to be involved in future crashes and receive future speeding citations than drivers who accepted a guilty verdict and paid fines by mail (Li et al., 2011). In addition, whether drivers who opted for court appearance received guilty or not-guilty verdicts, or had charges dismissed had little effect on deterrence of future speeding *or* prevention of crashes, even controlling for prior driver histories and other potential confounders. Only suspended types of prosecutions (e.g. probation before judgment or other suspension) were associated with somewhat decreased risk of speeding recidivism and future crashes, but a still higher risk compared to those who paid fines by mail. The two types of suspended prosecutions associated with somewhat reduced future speeding and crash risk both provide some incentive to avoid additional citations that would result in a reinstatement of charges and potential loss of license. Also, many of the drivers receiving suspended judgments may have had reduced exposure owing to having prior alcohol traffic violations and license restriction/suspension.

Similar to the results from Maryland, a U.K. study that examined survey and conviction data found that the immediate threat of being disqualified from driving deterred those with points on their license from further speeding. However, for a subset of drivers, the threat of this sanction did not appear to affect their choice to speed (Corbett, Delmonte, Quimby, & Grayson, 2008).

Most evidence suggests there is a population of drivers for whom increasing penalties do not seem to have the desired deterrent effect. Many studies and NHTSA statistics verify the prevalence of young, male driver involvement in speeding crashes. A review of the literature by Fuller et al. (2008a) suggests that young males may simply be immature, with incomplete development of self-knowledge, self-control, social responsibility and independence of judgment. Drivers with attention deficit hyperactivity disorder (ADHD) may be particularly at risk because of self-control challenges. In addition, there is evidence of socially deviant speeders for whom speeding is an expression of general social deviance which is associated with other forms of risk taking. These groups are distinguished from those who speed unintentionally due to failure to perceive risks and adjust accordingly (Fuller et al., 2008a).

Repeat offenders: Repeat speeding and aggressive driving offenders may be especially difficult to deter. Recommended methods to reach them include:

- enhanced penalties, including increased driver's license points, immediate license suspension or revocation, higher fines, and jail or probation, but research described in this section makes clear that the availability of such penalties alone is unlikely to lead to individual deterrence of speeding. See Chapter 3, Sections 1.2 and 3.1, for more information. The certainty of punishment may be more important than the level of penalty (Li et al., 2011; Shinar, 2007). Furthermore, courts may be reluctant to impose the most serious penalties, such as license suspension, for speeding violations, or simply unable to effectively prosecute speeders as charged.

- improved traffic record systems, to better identify repeat offenders and to allow patrol officers to immediately access a driver's complete driving record (NCHRP, 2003b; NHTSA, 2001a). There are no studies of the effects of improved record systems on repeat offenders. Costs and implementation time will vary.
- providing alternate modes of transportation, electronic monitoring, enforced restrictions or limits on mobility through license plate "striping" or vehicle impoundment are other recommendations to address unlicensed drivers, including those who have already received the maximum penalties but continue to drive (NCHRP, 2003b).

Costs: Costs vary by penalty type. For example, warning letters are very cheap once a record system has been established to identify drivers who should receive letters. Individual counseling and administrative hearings may require substantial staff time. Some costs may be recovered through offender fees.

Time to implement: Most changes in penalty levels can be implemented quickly within a State's overall driver improvement system.

Other issues:

- **Public acceptance, enforcement, and publicity:** Changes in speeding and aggressive driving sanctions by themselves cannot reduce speeding and aggressive driving. To be effective, sanctions must be well-known to violators and they must have a high probability of being imposed (Preusser, Williams, Nichols, Tison, & Chaudhary, 2008). Traffic laws, penalty types, and penalty levels are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, effect administration of penalties, and publicity (NHTSA, 2001a).

3.2 Diversion and Plea Agreement Restrictions; Traffic Violator School

Effectiveness: ★	Cost: Varies	Use: Unknown	Time: Varies

In many jurisdictions, drivers who have accumulated a specific number of demerit points on their driver's licenses are given the option of attending Traffic Violator School in order to reduce their punishment. In most instances, if they complete Traffic Violator School, their traffic offenses are dismissed or removed from their driving record (Masten & Peck, 2004).

Negotiated plea agreements are a necessary part of an effective and efficient court system. However, plea agreements may allow offenders to have their penalties reduced or eliminated, for example if a driver is allowed to avoid a driver's license suspension by attending Traffic Violator School.

Use: No data are available on the number of jurisdictions in which Traffic Violator School is available or the number of offenders who use Traffic Violator School to reduce their penalties. Similarly, no data are available on the use of other plea agreements for speeding or aggressive driving violations.

Effectiveness: Masten and Peck's review (2004) included high-quality studies of over 30 group meeting programs, including Traffic Violator School. Taken together, these group meeting programs reduced subsequent crashes by 5% and violations by 8%. Masten and Peck point out that Traffic Violator School programs in California increased, rather than decreased, crashes because they allowed offenders to escape more severe penalties and start again with a clean driving record. Their review was not able to determine whether other Traffic Violator School programs that dismissed an offender's violation had similar negative effects. These reductions or eliminations of penalties also make it difficult to use driver histories to track and provide serious sanctions to repeat violators.

Costs: Costs for establishing diversion or Traffic Violator School programs will depend on the nature of the program. Costs include developing and maintaining a tracking system, notifying offenders, and administering the Traffic Violator School. Costs for limiting or eliminating diversion programs, plea agreements, and Traffic Violator School can be determined by comparing the per-offender costs of these programs with the costs of the penalties that would otherwise be applied.

Time to implement: Diversion or Traffic Violator School programs will require at least 6 months to establish and implement. They can be modified within a few months.

Other issues:

- **Diversion and plea agreement issues in alcohol-impaired driving:** Diversion and plea agreements have been discussed and evaluated more extensively for alcohol-impaired driving offenses than for speeding and aggressive driving offenses. See Chapter 1, Section 3.2 for additional discussion.
- **Public acceptance, enforcement, and publicity:** Changes in the adjudication of speeding and aggressive driving infractions, such as limiting or eliminating diversion and plea agreements, by themselves cannot reduce speeding and aggressive driving. Traffic

laws and adjudication are essential to, but only a part of, a system that includes broad public acceptance, active enforcement, and publicity (NHTSA, 2001a).

4. Communications and Outreach

4.1 Communications and Outreach Supporting Enforcement

Effectiveness: ★★★	Cost: Varies	Use: Medium	Time: Medium

Effective, high-visibility communications and outreach are an essential part of successful speed and aggressive-driving enforcement programs (NCHRP, 2003a; NHTSA, 2000). All of the examples discussed in Chapter 3, Sections 2.2, High-Visibility Enforcement, and 2.3, Other Enforcement Methods, used extensive communications campaigns to support their enforcement efforts. Most campaigns to date have not used paid advertising. The success of paid advertising in seat belt use campaigns (Chapter 2, Section 3.1) suggests that it is worth considering for speed and aggressive driving enforcement campaigns.

The objective should be to provide information about the program, including expected safety benefits, and to persuade motorists that detection and punishment for violations is likely. See also NCHRP (2003a, Strategy A2). Communications and outreach programs urging drivers to behave courteously or not to speed are unlikely to have any effect unless they are tied to vigorous enforcement (NCHRP, 2003a, Strategy A2). Campaign messages that are pre-tested to ensure they are relevant to the target audience and that reach the audience with sufficient intensity and duration to be perceived and noticed are most likely to be effective (Preusser et al., 2008).

Use: Most aggressive driving and speed enforcement programs have a communications and outreach component.

Effectiveness: Reductions in crashes in Victoria, Australia, have been attributed to a television advertising campaign that supported, but did not relate directly, to automated speed enforcement initiatives (Bobevski, Hosking, Oxley, & Cameron, 2007). Earlier evidence from Australia also suggested that paid media advertising could enhance the effectiveness of automated speed enforcement (Cameron, Cavallo, & Gilbert, 1992). The evidence from seat belt (Chapter 2, Sections 2.1, 2.2, and 3.1) and alcohol-impaired driving (Chapter 1, Sections 2.1 and 2.2) enforcement programs strongly suggests that good communications and outreach are essential to a successful enforcement program.

Costs: Good media campaigns can be expensive. See Chapter 2, Section 3.1.

Time to implement: An effective media campaign requires 4 to 6 months to plan and implement.

Speed and Aggressive-Driving References

AAA Foundation for Traffic Safety (2009). *Aggressive Driving: Research Update*. Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/AggressiveDrivingResearchUpdate2009.pdf

Aarts, L., & van Schagen, I. (2006). Driving speed and the risk of road crashes: A review. *Accident Analysis and Prevention, 38*, 215-224.

Aeron-Thomas, A. S., & Hess, S. (2006) Red-light cameras for the prevention of road traffic crashes. *The Cochrane Database of Systematic Reviews* 2006, Issue 2, CD003862. Available at onlinelibrary.wiley.com/o/cochrane/clsysrev/articles/CD003862/pdf_fs.html

Belin, M-Å, Tillgren, P., Vedung, E., Cameron, M., & Tingvall, C. (2010). Speed cameras in Sweden and Victoria, Australia—A case study. *Accident Analysis and Prevention, 42*, 2165–2170.

Björklund, G. M. (2008). Driver irritation and aggressive behaviour. *Accident Analysis and Prevention, 40*, 1069-1077.

Blomberg, R. D., & Cleven, A. M. (2006). *Pilot Test of* Heed the Speed*, A Program to Reduce Speeds in Residential Neighborhoods*. (Report No. DOT HS 810 648). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/people/injury/research/HeedSpeedWeb/images/HeedTheSpeedLo.pdf

Bobevski, I., Hosking, S., Oxley, P., & Cameron, M. (2007). *Generalized Linear Modeling of Crashes and Injury Severity in the Context of the Speed-related Initiatives in Victoria During 2000-2002*. (Report No. 268). Victoria, AU: Monash University Accident Research Centre.

Bolderdijk, J., Knockaert, J., Steg E. M., Verhoef, E. T. (2011). Effects of pay-as-you-drive vehicle insurance on young drivers' speed choice: Results of a Dutch field experiment. *Accident Analysis and Prevention, 43*, 1181-1186.

Brewer, M. A., Pesti, G., & Schneider IV, W. (2006). Improving compliance with work zone speed limits. *Transportation Research Record, 1948*, 67-76.

Buddemeyer, J., Young, R. K., & Dorsey-Spitz, B. (2010). Rural, variable speed limit system for southeast Wyoming. *Transportation Research Record, 2189,* 37-44.

Cameron, M. A., Cavallo, A., & Gilbert, A. (1992). *Crash-Based Evaluation of the Speed Camera Program in Victoria 1990-91. Phase 1: general effects, Phase 2: effects of program mechanisms*. (Report No. 42). Victoria, AU: Monash University Accident Research Centre .

Chen, G. (2005). Safety and economic impacts of photo radar program. *Traffic Injury Prevention, 6*, 299-307.

Chorlton, K., & Conner, M. (2012). Can enforced behavior change attitudes: Exploring the influence of Intelligent Speed Adaptation. *Accident Analysis and Prevention*, *48*, 49-56.

Corbett, C., Delmonte, E., Quimby, A., & Grayson, G. (2008). *Does the Threat of Disqualification Deter Drivers from Speeding?* (Road Safety Research Report No.96). London: Department for Transport. Available at www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/summary.pdf

Council, F. M., Persaud, B., Eccles, K., Lyon, C., and Griffith, M. S. (2005). *Safety evaluation of red-light cameras*. (FHWA-HRT-05-048) Washington, DC: Federal Highway Administration. Available at www.tfhrc.gov/safety/pubs/05049/index.htm

Cunningham, C. M., Hummer, J. E., and Moon, J. P. (2008). Analysis of automated speed enforcement cameras in Charlotte, NC. *Transportation Research Record*, 2078, 127-134.
Davis, J. W., Bennink, L. D., Pepper, D. R., Parks, S. N., Lemaster, D. M., & Townsend, R. N. (2006). Aggressive traffic enforcement: a simple and effective injury prevention program. *Journal of Trauma, 60*, 972-977.

Decina, L. E., Thomas, L., Srinivasan, R., & Staplin L. (2007). *Automated Enforcement: A Compendium of Worldwide Evaluations of Results*. (Report No. DOT HS 810 763). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810763.pdf

Delaney, A., Diamantopoulou, K., & Cameron, M. (2003). *MUARC's Speed Enforcement Research: Principles Learnt and Implications for Practice.* Monash University Accident Research Centre Report No. 200.

Delaney, A., Ward, H., Cameron, M., & Williams, A. F. (2005). Controversies and speed cameras: Lessons learnt internationally. *Journal of Public Health Policy, 26*, 404-415.

D'Elia, A., Newstead, S., & Cameron, M. (2007). *Overall Impact During 2001-2004 of Victorian Speed-Related Package.* (Report No. 267). Victoria, AU: Monash University Accident Research Centre. Available at www.monash.edu.au/muarc/reports/muarc267.pdf

Donnell, E. T., & Cruzado, I. (2008). *Effectiveness of Speed Minders in Reducing Driving Speeds on Rural Highways in Pennsylvania.* Harrisburg, PA: Pennsylvania Department of Transportation. Available at ftp://ftp.dot.state.pa.us/public/pdf/BPR_PDF_FILES/Documents/Research/Complete%20Projects/Reducing%20Fatalities/Effectiveness%20of%20Speed%20Minders%20in%20Reducing%20Driving%20Speeds%20on%20Rural%20Highways.pdf

Eckenrode, R. T., Sarasua, W. A., Mattox, J. H., III, Ogle, J. H., & Chowdhury, M. A. (2007). *Revisiting the use of drone radar to reduce speed in work zones: South Carolina's experience.* Transportation Research Board 86th Annual Meeting, Transportation Research Board.

Elvik, R., & Christensen, P. (2007). The deterrent effect of increasing fixed penalties: The Norwegian Experience. *Journal of Safety Research, 38*, 689-695.

Farmer, C. M., Kirley, B. B., & McCartt, A. T. (2010). Effects of in-vehicle monitoring on the driving behavior of teenagers. *Journal of Safety Research, 41,* 39-45.

FHWA. (2005). *Red-Light Camera Systems Operational Guidelines.* Washington, DC: Federal Highway Administration. Available at safety.fhwa.dot.gov/intersection/redlight/cameras/fhwasa05002/fhwasa05002.pdf

Federal Highway Administration, Federal Motor Carrier Safety Administration, & National Highway Traffic Safety Administration. (2005, September). *Speed Management Strategic Initiative*. (Report No. DOT HS 809 924). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/enforce/SpeedManagement-content/

Flango, V. E., & Keith, A. L. (2004). How useful is the new aggressive driving legislation? *Court Review*, Winter 2004, 34-41.

Fontaine, M. D., Park, B., & Son, H. (2007). *Demonstration and Evaluation of Rational Speed Limits: Virginia Department of Transportation Evaluations*. Charlottesville, VA: Center for Transportation Studies. Available at cts.virginia.edu/docs/UVACTS-13-0-122.pdf

Freedman, M., De Leonardis, D., Polson, A., Levi, S., & Burkhardt, E. (2007). *Field Test of the Impact of Setting and Enforcing Rational Speed Limits; Final Report for Gulfport, Mississippi--Demonstration Community*. (Report No. DOT HS 810 849). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/hs810849.pdf

Freedman, M., De Leonardis, D., Raisman, G., Inyo Swan, D., Davis, A., Levi, S., Rogers, I., & Bergeron, E. (2006). *Demonstration of Automated Speed Enforcement in School Zones in Portland, Oregon*. (Report No. DOT HS 810 764). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810764.pdf

Fuller, R., Bates, H., Gormley, M., Hannigan, B., Stradling, S., Broughton, P., Kinnear, N., & O'Dolan, C. (2008a). *The Conditions for Inappropriate High Speed: A Review of the Research Literature from 1995 to 2006.* Road Safety Research Report 92. London: Department for Transport. Available at
http://webarchive.nationalarchives.gov.uk/+/http:/www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/conditions1.pdf

Fuller, R., Hannigan, B., Bates, H., Gormley, M., Stradling, S., Broughton, P., Kinnear, N., and O'Dolan, C. (2008b). *Understanding Inappropriate High Speed: A Qualitative Analysis.* (Road Safety Research Report 94). London: Department for Transport.

Gains, A., Heydecker, B., Shrewsbury, J., & Robertson S. (2004). *The National Safety Camera Program: Three-year Evaluation Report*. PA Consulting Group.

Governors Highway Safety Association. (2010a). *Aggressive Driving Laws, August 2010*. Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/aggressivedriving_laws.html

GHSA. (2010b). *Speed and Red Light Camera Laws, August 2010*. Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/auto_enforce.html

GHSA. (2010c). *Speed Limit Laws, August 2010*. Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/speedlimit_laws.html

Hajbabaie, A., Medina, J. C., Wang, M.-H., Rahim, F. B., & Chitturi, M. (2011). Sustained and halo effects of various speed reduction treatments in Highway Work Zones. *Transportation Research Record*, *2265*, 118-128.

Harder, K. A., & Bloomfield, J. R. (2007). *Evaluating the Effectiveness of the Minnesota Speed Management Program. St*. Paul, MN: Minnesota Department of Transportation. Available at www.lrrb.org/PDF/200721.pdf

Hendricks, D. L., Fell, J. C., & Freedman, M. (2001). *The Relative Frequency of Unsafe Driving Acts in Serious Traffic Crashes: Summary Technical Report.* Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/UDAshortrpt/UDAsummtechrept.pdf

Hendricks, D. L., Freedman, M., Zador, P. L., & Fell, J. C. (2001). *The Relative Frequency of Unsafe Driving Acts in Serious Traffic Crashes.* Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/UDAshortrpt/UDAlongreport.pdf

Insurance Institute for Highway Safety. (2009). *Q&As: Red Light Cameras*. Arlington, VA: Author. Available at www.iihs.org/research/qanda/rlr.html

IIHS. (2010). *Maximum posted speed limits, August 2010.* Arlington, VA: Author. Available at www.iihs.org/laws/speedlimits.aspx

IIHS. (2012). *Communities Using Red Light and/or Speed Cameras as of August 2012*. Arlington, VA: Author. Available at www.iihs.org/laws/auto_enforce_cities.aspx

Joerger, M. (2010). *Photo Radar Speed Enforcement in a State Highway Work Zone: Yeon Avenue Demonstration Project*. (Report No. OR-RD-10-17). Salem, OR: Oregon Department of Transportation.

Lawpoolsri, S., Li, J., & Braver, E. R. (2007). Do speeding tickets reduce the likelihood of receiving subsequent speeding tickets? A longitudinal study of speeding violators in Maryland. *Traffic Injury Prevention, 8,* 26-34.

Lee, C., Lee, S., Choi, B., & Oh, Y. (2006). Effectiveness of speed-monitoring displays in speed reduction in school zones. *Transportation Research Record,* 1973, 27-35.

Li, J., Amr, S., Braver, E. R., Langenberg, P., Zhan, M., Smith, G. S., & Dischinger, P. C. (2011). Are current law enforcement strategies associated with a lower risk of repeat speeding citations and crash involvement? A longitudinal study of speeding Maryland drivers. *Annals of Epidemiology*, *21*, 641-647.

Luoma, J., Rajamäki, R., & Malvivuo, M. (2012). Effects of reduced threshold of automated speed enforcement on speed and safety. *Transportation Research Part F*, *15*, 243-248.

Maccubbin, R., Staples, B., & Salwin, A. (2001). *Automated Enforcement of Traffic Signals: A Literature Review*. Washington, DC: Federal Highway Administration. Available at http://ntl.bts.gov/lib/11000/11700/11790/RLCLitReview.pdf

Mannering, F. (2009). An empirical analysis of driver perceptions of the relationship between speed limits and safety. *Transportation Research Part F*, *12*, 99-106.

Masten, S. V., & Peck, R. C. (2004). Problem driver remediation: A meta-analysis of the driver improvement literature. *Journal of Safety Research, 35*, 403-425.

Mattox, J. H. III, Sarasua, W. A., Ogle, J. H., Eckenrode, R. T., & Dunning, A. E. (2007). *Development and Evaluation of a Speed-Activated Sign to Reduce Speeds in Work Zones*. Transportation Research Board 86th Annual Meeting, Transportation Research Board.

Mazureck, U., & van Hattem, J. (2006). Rewards for safe driving behavior: Influence on following distance and speed. *Transportation Research Record, 1980*, 31-38.

McCartt, A. T., Leaf, W. A., Witkowski, T. L., & Solomon, M. G. (2001). *Evaluation of the Aggression Suppression Program, Milwaukee, Wisconsin*. (Report No. DOT HS 809 395). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/Aggressionwisc/contents.htm

McGee, H. W., & Eccles, K. A. (2003). *Impact of Red Light Camera Enforcement on Crash Experience*. NCHRP Synthesis No. 310). Washington, DC: Transportation Research Board. onlinepubs.trb.org/onlinepubs/nchrp/nchrp_syn_310.pdf

NCHRP. (2003a). *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 1: A Guide for Addressing Aggressive-Driving Collisions.* Washington, DC: Transportation Research Board. onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v1.pdf

NCHRP. (2003b). *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 2: A Guide for Addressing Collisions Involving Unlicensed Drivers and Drivers with*

Suspended or Revoked Licenses. Washington, DC: Transportation Research Board. onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v2.pdf

NCHRP (2009). *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan,Volume 23: A Guide for Reducing Speeding-Related Crashes.* Washington, DC: Transportation Research Board. onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v23.pdf

NCHRP (2012). Automated Enforcement for Speeding and Red Light Running. Prepared for: National Cooperative Highway Research Program. Washington, DC: Transportation Research Board. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_729.pdf

NCSRLR. (2002). *Stop on Red = Safe on Green: A Guide to Red Light Camera Programs*. Washington, DC: National Campaign to Stop Red Light Running. Available at www.stopredlightrunning.com/pdfs/StopOnRedSafeOnGreen.pdf

NCUTLO. (2004). *Automated Traffic Law Enforcement Model Law*. Alexandria VA: National Committee on Uniform Traffic Laws and Ordinances. Available at www.ncutlo.org/autoenforce622.htm

Nerup, P., Salzberg, P., VanDyk, J., Porter, L., Blomberg, R., Thomas, F. D., & Cosgrove, L. (2006). *Ticketing Aggressive Cars and Trucks in Washington State: High Visibility Enforcement Applied to Share the Road Safety*. (Report No. DOT HS 810 603). Washington, DC: National Highway Traffic Safety Administration.
Available at www.nhtsa.dot.gov/people/injury/Aggressive/TACT/TACTReportLo.pdf

Newstead, S. V., Cameron, M. H., & Leggett, L. M. W. (2001). The crash reduction effectiveness of a network-wide traffic police deployment system. *Accident Analysis and Prevention, 33*, 393-406.

National Highway Traffic Safety Administration. (2000). *Aggressive Driving Enforcement: Strategies for Implementing Best Practices*). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/enforce/aggressdrivers/aggenforce/index.html

NHTSA. (2001a). *National Aggressive Driving Action Guide: A Criminal Justice Approach.* (Report No. DOT HS 809 351). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/enforce/DOT%20Aggress%20Action/index.htm

NHTSA. (2001b). *Aggressive Driving Programs.* (Report No. DOT HS 808 730). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/enforce/AggressiveDrivingHTML/Aggressive_index.htm

NHTSA (2004). *National Survey of Speeding and Unsafe Driving Attitudes and Behavior: 2002; Vol. II: Findings.* (Report No. DOT HS 809 730). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/research/speed_volII_finding/SpeedVolumeIIFindingsFinal.pdf

NHTSA. (2005). *National Forum on Speeding: Strategies for Reducing Speed-Related Fatalities and Injuries*. (Report No. DOT HS 809 963). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/enforce/NatForumSpeeding/

NHTSA. (2008). *Speed Enforcement Program Guidelines*. (Report No. DOT HS 810 915). Washington, DC: Author. Available at ntl.bts.gov/lib/30000/30100/30165/810915.pdf

NHTSA (2010). *Traffic Safety Facts 2009: Early Edition.* (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.PDF

NHTSA (2011). Summary of State Speed Laws, 11th ed. (Report No. DOT HS 811 457). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/pdf/811457.pdf

NHTSA. (2012). *Traffic Safety Facts, 2010. Data: Speeding.* (Report No. DOT HS 811 636). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/811397.PDF

NHTSA & Federal Highway Administration. (2008). *Speed Enforcement Camera Systems: Operational Guidelines*. (Report No. DOT HS 810 916). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/30000/30100/30166/810916.pdf

Pilkington, P., & Kinra, S. (2005). Effectiveness of speed cameras in preventing road traffic collisions and related casualties: systematic review. *British Medical Journal, 330*, 331-334. bmj.bmjjournals.com/cgi/reprint/330/7487/331

Preusser, D. F., Williams, A. F., Nichols, J. L., Tison, J., & Chaudhary, N. K. (2008). *Effectiveness of Behavioral Highway Safety Countermeasures*, *NCHRP Report 622*). Washington, DC: Transportation Research Board.

Retting, R. & Cheung, I. (2008). Traffic speeds associated with implementation of 80 mph speed limits on West Texas rural interstates. *Journal of Safety Research* 39, 529-534.

Retting, R. A., Ferguson, S. A., & Hakkert, A. S. (2003). Effects of red light cameras on violations and crashes: a review of the international literature. *Traffic Injury Prevention, 4*, 17-23.

Retting, R. A., Farmer, C. M., & McCartt, A. T. (2008) Evaluation of automated speed enforcement in Montgomery County, Maryland. *Traffic Injury Prevention* 9, 440-445.

Retting, R. A., Kyrychenko, S. Y., & McCartt, A. T. (2008). Evaluation of automated speed enforcement on Loop 101 freeway in Scottsdale, Arizona. *Accident Analysis and Prevention*, *40*, 1506-1512.

RITA. (2007). *Deployment Statistics*. Washington, DC: Research and Innovative Technology Administration. Available at www.itsdeployment.its.dot.gov/

Sarkar, S. (2009). *Driving behaviors, risk perceptions, and stress: examination of military personnel during wartime deployment.* Transportation Research Board 88th Annual Meeting: Washington, DC [Compendium of Papers.]

Shin, K., Washington, S. P., & van Schalkwyk, I. (2009). Evaluation of the Scottsdale Loop 101 automated speed enforcement demonstration program. *Accident Analysis and Prevention*, *41*, 393-403.

Shinar, D. (2007). *Traffic Safety and Human Behavior*. Bingley,UK: Emerald Publishing Group, Ltd., 813 pp.

Shinar, D., & Compton, R. (2004). Aggressive driving: an observational study of driver, vehicle, and situational variables. *Accident Analysis and Prevention, 36*, 429-437.

Sivak, M., Luoma, J., Flannagan, M. J., Bingham, C.R., Eby, D. W., & Shope, J. T. (2007). Traffic safety in the U.S.: Re-examining major opportunities. *Journal of Safety Research*, *38*, 337-355.

Stradling, S., Broughton, P., Kinnear, N., O'Dolan, C., Fuller, R., Gormley, M., & Hannigan, B. (2008). *Understanding Inappropriate High Speed: A Quantitative Analysis.* Road Safety Research Report 93. London: Department for Transport.

Stuster, J. (2004). *Aggressive Driving Enforcement: Evaluation of Two Demonstration Programs.* (Report No. DOT HS 809 707). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/research/AggDrivingEnf/images/AggresDrvngEnforce-5.0.pdf

Thomas, F. D., Blomberg, R. D., Peck, R. C., Cosgrove, L. A., & Salzberg, P. M. (2008). Evaluation of a high-visibility enforcement project focused on passenger vehicles interacting with commercial vehicles. *Journal of Safety Research* 39, 459-468.

Thomas, L. J., Srinivasan, R., Decina, L. E., & Staplin L. (2008). Safety effects of automated speed enforcement programs: Critical review of international literature. *Transportation Research Record* 2078:117-126.

Transportation Research Board. (1984). *55: A Decade of Experience.* (Transportation Research Board Special Report 254). Washington, DC: Author.

TRB. (1998). *Managing Speed: Review of Current Practice for Setting and Enforcing Speed Limits.* Transportation Research Board Special Report 254). Washington, DC: Author. Available at gulliver.trb.org/publications/sr/sr254.pdf

TRB. (2006). *Safety Impacts and Other Implications of Raised Speed Limits on High-speed Roads.* Research Results Digest 303). Washington, DC: Author. Available at onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_303.pdf

Walter, L., & Broughton, J. (2011). Effectiveness of speed indicator devices: An observational study in South London. *Accident Analysis and Prevention, 43*, 1355-1358.

Walter, L., Broughton, J., & Knowles, J. (2011). The effects of increased police enforcement along a route in London. *Accident Analysis and Prevention, 43*, 1219–1227.

WHO. (2004). *World Report on Road Traffic Injury Prevention*. Geneva, Switzerland: World Health Organization.

Wilson, C., Willis, C., Hendrikz, J. K., & Bellamy, N. (2006). Speed enforcement detection devices for preventing road traffic injuries (Review). *Cochrane Database of Systematic Reviews Issue 2*. Art. No.: CD004607. DOI: 10.1002/14651858.CD004607. pub2.

Wong, S. C., Sze, N. N., Lo, H. K., Hung, W. T., & Loo, B. P. Y. (2005). Would relaxing speed limits aggravate safety? A case study of Hong Kong. *Accident Analysis and Prevention, 37*, 377-388.

Wrapson, W., Harre, N., & Murrell, P. (2006). Reductions in driver speed using posted feedback of speeding information: Social comparison or implied surveillance? *Accident Analysis and Prevention*, *38*, 1119-1126.

Young, K. L., & Regan, M. A. (2007). Use of manual speed alerting and cruise control devices by car drivers, *Safety Science, 45*, 473-485.

4. Distracted and Drowsy Driving

Overview

Distracted driving and drowsy driving are common, though both are difficult to define, measure, and sometimes observe. Both distracted and drowsy driving result in large part from lifestyle patterns and choices: they are societal issues rather than just driving and transportation system issues. For these reasons, few behavioral highway safety countermeasures have been shown to reduce distracted or drowsy driving, although a number of new countermeasures are currently being developed and evaluated.

Distracted driving has received a great deal of attention in recent years. The U.S. Department of Transportation has held two distracted driving summits in Washington DC, developed a Blueprint for Ending Distracted Driving (NHTSA, 2012), and created a Web site to address this issue (www.distraction.gov). Although much of the attention and research has concentrated on cell phones (and texting), this is just one of many potential distractions behind the wheel. Attention and research on drowsiness has concentrated on commercial truck drivers, but the problem is far more widespread.

Problem size and characteristics: distracted driving. Distraction occurs when a driver's attention is diverted away from driving to some other activity. A distraction can be produced by something a driver sees or hears, some physical task not directly involved in driving such as eating or operating the car radio, or mental activities such as conversations on a cell phone (NHCRP, 2005, Section III).

NHTSA conducted a telephone survey of a nationally representative sample of more than 6,000 drivers in 2010, asking about a variety of attitudes and behaviors related to distracting driving (Tison, Chaudhary, & Cosgrove, 2011). Among the behaviors that drivers reported doing on at least some trips:

- 80% talked to other passengers;
- 66% adjusted the car radio;
- 51% used a navigation system;
- 46% ate or drank;
- 41% made or accepted phone calls;
- 30% used a portable music player with speakers;
- 27% interacted with children in the back seat;
- 26% used a smartphone for driving directions;
- 22% changed CDs, DVDs, or tapes;
- 10% read e-mail or text messages;
- 6% did personal grooming;
- 6% sent text messages or email.

A survey in 2011 of 1,208 Canadian drivers found that 74% reported distracted drivers are a "very" or "extremely" serious problem, up from about 40% in 2005 (Marcoux, Valnaar, & Robertson, 2012). Similarly, a AAA Foundation survey of 2,501 U.S. residents found that one-

third (34%) of drivers reported feeling less safe while driving today than they did 5 years ago. The most commonly cited reason for feeling less safe was the frequency of distracted driving (AAAFTS, 2009).

According to NHTSA, there were 3,092 fatalities in "distraction-affected crashes" in 2010 (NHTSA, 2011a). Distracted-affected crashes is a new measure that "focuses on distractions that are most likely to affect crash involvement, such as distraction by dialing a cellular phone or texting and distraction by an outside person/event" (NHTSA, 2011a). Because of the new measure, direct comparisons cannot be made to the 5,474 "distraction-related fatalities" reported in 2009 (NHTSA, 2010a).

NHTSA has previously estimated that driver distraction is involved in 16% of all fatalities (NHTSA, 2010a). The true role of distraction in crashes may be even higher because pre-crash distractions often leave no evidence for law enforcement officers or crash investigators to observe, and drivers are understandably reluctant to admit to being distracted following a crash. A study that monitored 100 drivers for a year using specialized instrumentation found that secondary-task distractions such as dialing a hand-held device or eating contributed to 22% of the crashes and near-crashes that occurred during the study (Klauer, Dingus, Neale, Sudweeks, & Ramsey, 2006).

The 100-Car study also examined the risk associated with engaging in various secondary tasks compared to regular driving. In the table below, a change in risk greater than 1 represents an increase in risk due to the secondary task, while a change in risk less than 1 represents a decrease in risk. Secondary tasks were classified as "simple" if they required, at most, one button press and/or eye glance from the roadway, "moderate" if they required one to two button presses and/or eye glances, and "complex" if they required more than two button presses and/or eye glances (Klauer, Guo, Sudweeks, & Dingus, 2010).

Type of secondary task	**Change in risk**
Complex • Dialing a hand-held device • Locating/reaching/answering hand-held device • Operating a PDA • Viewing a PDA • Reading • Animal/object in vehicle • Reaching for moving object • Insect in vehicle • Applying makeup	2.1
Moderate • Talking/listening to hand-held device • Hand-held device—other • Inserting/retrieving CD • Inserting/retrieving cassette • Reaching for object (not hand-held device) • Combing or fixing hair	1.3

• Other personal hygiene • Eating • Looking at external object	
Simple • Adjusting radio • Adjusting other devices integral to vehicle • Talking to passenger in adjacent seat • Talking/singing: no passenger present • Drinking • Smoking • Lost in thought	n.s.

Note: n.s. indicates no significant change in crash risk. Source: Klauer et al. (2010), Tables 10 and 14.

The risk of having a crash or near-crash risk was twice as high when drivers were engaged in a complex secondary task than when they drove normally under similar conditions. Crash risks were also increased when drivers engaged in moderate secondary tasks. On the other hand, simple tasks, such as adjusting the radio, did not change the risk of a crash. None of the distractions listed in the table above is easily addressed. Moreover, it is important to note that many of the studies on distracted driving and its consequences were conducted prior to the proliferation of text messaging, GPS navigation systems, and other newly developed technologies. Consequently, it is possible that distraction-related crashes will escalate as the use of new technologies continues to increase.

Problem size and characteristics: drowsy driving. Several U.S. and international telephone surveys provide consistent estimates of the prevalence and key characteristics of drowsy driving. A 2010 survey of 2,000 U.S. residents found 41% of drivers reported having ever fallen asleep or nodding off while driving (AAA Foundation, 2010). Four percent of drivers reported falling asleep while driving in the past month, while 11% had done so within the past year. Canadian responses from 1,209 drivers were similar: 57% had driven while tired and 20% had dozed off while driving in the past year (Beirness, Simpson, & Desmond, 2005). NHTSA surveyed 4,010 drivers in spring 2002 and found 11% reported that they had nodded off while driving during the past year (Royal, 2003). Of those who nodded off, 66% said they had 6 or fewer hours of sleep the previous night.

These surveys provide additional useful information about drowsy driving. All three found that young drivers and male drivers were more likely than older drivers and female drivers to have dozed off at the wheel (AAA Foundation, 2010; Beirness et al., 2005; Royal, 2003). Moreover, driving while drowsy does not just occur late at night. About one-third of those drivers who admit to nodding off say the most recent incident occurred in the afternoon (noon to 6 p.m.), which might be attributable to circadian rhythms. Drowsy driving is also not limited to long trips. In each survey, roughly half of the drivers who nodded off had been driving for an hour or less.

It's often difficult to determine whether drowsy driving contributed to a crash. Similar to distracted driving, drivers may be reluctant to admit they dozed off following a crash. NHTSA

estimated in 1998 that drowsy driving results in 40,000 injuries and 1,550 deaths each year, which represented slightly less than 4% of the total traffic injuries and fatalities in the United States at that time (NHTSA, 1998). A more recent study using data from 1999 through 2008 suggests driver drowsiness may contribute to 7% of all crashes and 16.5% of fatal crashes (Tefft, 2012).

Strategies to Reduce Distracted and Drowsy Driving

The obvious way to reduce distracted or drowsy driving crashes is to convince or require drivers to get enough sleep and to pay attention to their driving. These are very difficult goals. Drowsy driving may result from lifestyles that include insufficient or irregular sleep (shift workers, for instance) or from medical problems – issues beyond a driver's immediate control. Many drivers consider some distractions, such as eating or drinking, listening to the radio, or talking on a cell phone, to be important and common activities and are unlikely to give them up. Moreover, studies indicate that drivers themselves are poor judges of the performance decrements that result from distracting activities (Horrey, Lesch, & Garabet, 2008).

Behavioral strategies to reduce distracted or drowsy driving attempt to remove some of the underlying causes or to promote awareness of the risks. Currently, few studies have examined whether the standard behavioral countermeasures of laws, enforcement, and sanctions, which are used successfully for alcohol impairment, seat belt use, aggressive driving, and speeding, are effective for distracted or drowsy drivers. One exception is for young drivers: some graduated driver licensing provisions help reduce distracted and drowsy driving by limiting the number of passengers, prohibiting nighttime driving, and restricting cell phone use (see Chapter 6, Sections 1.3 to 1.5).

Distracted or drowsy driving that is related to a driver's job may be reduced through employer policies and programs. The Network of Employers for Traffic Safety, the Occupational Safety and Health Administration, and other employer-based resources are available through distraction.gov. Drowsy driving caused by medical conditions such as sleep apnea or by drugs or medications may be addressed through policies, communications, and outreach. Similarly, communications and outreach may be useful in raising awareness of specific distraction or drowsiness issues among certain high-risk populations. However, none of these strategies has been evaluated.

This chapter discusses these behavioral strategies. It does not include the environmental, vehicular, and regulatory countermeasures mentioned below because State Highway Safety Offices do not have authority or responsibility in these areas.

Environmental strategies can address both distracted and drowsy driving. Rumble strips, both on the shoulder and the centerline, have demonstrated their effectiveness in preventing crashes caused by inattention or drowsiness. Other roadway improvements, such as wide and visible edge lines, more easily visible road signs, and better lighting at night can help drivers who are not fully alert. See National Cooperative Highway Research Program (NCHRP, 2005) for a thorough discussion and for references to other NCHRP guides.

Vehicular strategies also affect driver distraction and drowsiness. In-car televisions, vehicle location and route-finding systems, and other new technologies in vehicles may create more potential distractions (Hedlund, Simpson, & Mayhew, 2006). On the other hand, in-vehicle technology in the future may be able to detect driver distraction or drowsiness, by monitoring driver performance, and then alert drivers (Donmez, Boyle, & Lee, 2007; May & Baldwin, 2009; Papadelis et al., 2007). Such driver assistance technologies include lane departure warning, crash-imminent braking, and forward collision warning. Automobile manufacturers and NHTSA are vigorously investigating many possibilities.

Driver drowsiness is a critical issue for commercial drivers. The Federal Motor Carrier Safety Administration attempts to control commercial driver drowsiness through Hours of Service regulations, driver logs and inspections (see for example FMCSA, 2008). FMCSA has an extensive drowsy driver research program focused on commercial drivers (FMCSA, 2005). Additionally, NHTSA has developed a prototype Drowsy Driver Warning System that appears promising in reducing drowsiness among drivers of heavy vehicles (Blanco et al., 2009). As with the environmental and vehiclular countermeasures mentioned above, commercial driver countermeasures are not discussed in this guide because they do not fall under SHSO jurisdiction.

Resources

The agencies and organizations listed below can provide more information on distracted and drowsy driving and links to numerous other resources.

- U.S. Department of Transportation Web site on distracted driving: www.distraction.gov
- National Highway Traffic Safety Administration:
    - Research and Evaluation - http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
    - Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Governors Highway Safety Association: www.ghsa.org
- National Safety Council: www.nsc.org/safety_road/Distracted_Driving/Pages/distracted_driving.aspx
- National Conference of State Legislatures: www.ncsl.org/issues-research/transport/spotlight-distracted-driving.aspx
- National Sleep Foundation: www.sleepfoundation.org
- Insurance Institute for Highway Safety: www.iihs.org
- AAA Foundation for Traffic Safety: www.aaafoundation.org

For overviews of distracted driving prevalence, risks, legislation, research, and recommended strategies, see NHTSA's *Driver Distraction: A Review of the Current State-of-Knowledge* (Ranney, 2008) and *Overview of the National Highway Traffic Safety Administration's Driver Distraction Program* (NHTSA, 2010b). Also see GHSA's *Distracted Driving: What Research Shows and What States Can Do* (GHSA, 2011) and the World Health Organization's *Mobile Phone Use: A Growing Problem of Driver Distraction* (WHO/NHTSA, 2011). For overviews on drowsy driving, see NCHRP (2005), TIRF (2009), and Grigo & Baldock (2011).

Key terms

- GDL: Graduated driver licensing, a three-phase system for beginning drivers consisting of a learner's permit, a provisional license, and a full license. A learner's permit allows driving only while supervised by a fully licensed driver. A provisional license allows unsupervised driving under certain restrictions.
- NCSDR: National Center for Sleep Disorders Research
- NSF: National Sleep Foundation.

Countermeasures That Work

Countermeasures to reduce distracted and drowsy driving are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Laws and Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
1.1 GDL requirements for beginning drivers	★★★★★†	$	High	Medium
1.2 Cell phone and text messaging laws	★★	$	Medium	Short
1.3 High Visibility Cell phone/text messaging enforcement	★★★★	$$$	Low	Medium
1.4 General drowsiness and distraction laws	★	Varies	High††	Short

† Effectiveness proven for nighttime and passenger restrictions

†† Included under reckless driving; use of explicit drowsiness and distraction laws is low

2. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Drowsy driving	★	$$	Unknown	Medium
2.2 Distracted driving	★	$$	High	Medium

3. Other Countermeasures

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Employer programs	★★	$	Unknown	Short
3.2 Education Regarding Medical conditions and medications	★	Variable	Unknown	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Laws and Enforcement

1.1 Graduated Driver Licensing Requirements for Beginning Drivers

Effectiveness: ★★★★★†	Cost: $	Use: High	Time: Medium

† Effectiveness proven for nighttime and passenger restrictions

GDL is designed to provide novice drivers with substantial driving experience in low-risk settings. It consists of three-phases: a learner permit, provisional license, and full license. The learner permit phase typically lasts 6 months or more, and allows driving only while supervised by a fully licensed driver. The provisional license allows unsupervised driving under certain restrictions. The NCHRP guide for reducing crashes involving young drivers describes the key provisions of GDL laws (NCHRP, 2007). The Insurance Institute for Highway Safety (IIHS, 2012a) and the Governors Highway Safety Association (GHSA, 2012a) summarize State GDL laws. These summaries are updated monthly. See Chapter 6, Sections 1.1 to 1.7, for a complete discussion of GDL for beginning young drivers.

During the provisional phase of GDL, driving under certain high-risk circumstances is restricted. Some of these restrictions are directly linked to drowsiness and distractions. For example, nighttime driving is typically restricted under GDL. Driving at night is more dangerous than during the day and also may pose greater risks of drowsy driving. In addition, GDL systems usually include a passenger restriction. Passengers, especially teenage passengers, are a major source of distraction for young, beginning drivers. Cell phones can also distract drivers (see Chapter 4, Section 1.2), so they are often restricted under GDL.

Use: As of July 2012, all 50 States and the District of Columbia had some GDL components in place. The laws in 49 States and the District of Columbia do not allow driving during certain nighttime hours. Laws in 45 States and the District of Columbia limit the number of passengers allowed with a driver with a provisional license (GHSA, 2012a; IIHS, 2012a). Thirty-two States and the District of Columbia prohibit the use of cell phones, both hand-held and hands-free, by drivers with learner's permits or provisional licenses or by drivers under 18 (GHSA, 2012a; IIHS, 2012a).

Effectiveness: Several studies document that nighttime and passenger GDL restrictions reduce teenage driver crashes and injuries (Hedlund & Compton, 2005; NCHRP, 2007; Williams, 2007a). The only evaluation of a GDL cell phone restriction suggests these laws may have little effect on teenage drivers' cell phone use (Foss, Goodwin, McCartt, & Hellinga, 2009; Goodwin, O'Brien, & Foss, 2012).

Costs: Publicity for GDL restriction changes can be delivered directly by the Department of Motor Vehicles to young drivers as they apply for their learner's permits and provisional licenses, so costs will be minimal. Information about GDL restrictions can also be provided through driver education courses.

Time to implement: GDL nighttime, passenger, or cell phone restriction changes require several months to implement for drivers receiving a provisional license. They then will take one or two years before all provisionally licensed drivers are subject to the new restrictions.

1.2 Cell Phone and Text Messaging Laws

Effectiveness: ★★	Cost: $	Use: Medium	Time: Short

Cell phones have become an essential feature of modern life. In December 2011, Americans owned more than 331 million cell phones, an increase of about 100 million phones in 5 years (CTIA, 2010). In a NHTSA survey of 6,000 U.S. residents, two out of three drivers (67%) admitted to making or accepting phone calls while driving, with 25% reporting they do so on some trips, and 15% saying they do so on most or all trips (Tison, Chaudhary, & Cosgrove, 2011). NHTSA's 2010 national observation survey found 5% of drivers on the road at any given moment were using hand-held cell phones, unchanged from 2009 (NHTSA, 2011b). The percent of drivers who were manipulating a hand-held device (e.g., texting or dialing) increased from 0.6% in 2009 to 0.9% in 2010. NHTSA currently estimates that 9% of drivers are using some type of phone (hand-held or hands-free) in a typical daylight moment (NHTSA, 2011b).

Many studies have investigated the effects of cell phone use on driving (See Caird, Willness, Steel, & Scialfa, 2008, and McCartt, Hellinga, & Braitman, 2006, for reviews). Experiments on simulators or test tracks document that talking on a cell phone use has some effect on driving performance, most commonly slowed reaction times, but these experiments cannot measure the impact on crash risk. For reasons outlined in the overview, it can be difficult to determine whether cell phones contribute to individual crashes. Two studies examining cell phone billing records concluded drivers are four times more likely to be involved in a serious crash when talking on a cell phone (McEvoy et al., 2005; Redelmeier & Tibshirani, 1997). In addition, these two studies and others have found that hands-free phones offer little or no safety advantage over hand-held phones (Caird et al., 2008; Ishigami & Klein, 2009). However, recent studies have questioned the estimates of crash risk and argued the real risk may be much smaller (Farmer, Braitman, & Lund, 2010; Young, 2012). For example, the 100-car study found a 29% increased risk from talking on a phone while driving (Klauer et al., 2006), much lower than the 400% increase found in earlier studies.

There is less disagreement about the dangers posed by texting while driving. In a study using highly instrumented commercial motor vehicles, texting drivers were 23 times more likely to be involved in a crash, near-crash, or other safety-critical event compared to uneventful baseline driving (Olson et al., 2009). This is supported by experimental studies using driving simulations, which suggest that texting drivers spend up to 400% more time looking away from the road and are more likely to leave their lane than when not text messaging (Drews, Yazdani, Godfrey, Cooper, & Strayer, 2009; Hosking, Young, & Regan, 2009). In the NHTSA survey, 21% of drivers admitted to reading text messages or emails while driving, and 16% reported sending text messages/emails (Tison, Chaudhary, & Cosgrove, 2011).

States have been very active in using legislation to address this issue. Since 2000, every State has considered legislation to curtail distracted driving or driver cell phone use. In 2011, approximately 160 distracted driver bills were considered in 37 States (NCSL, 2012). Although distracted driving legislation generally falls under the jurisdiction of individual States, the Federal Government has recently directed its attention to this issue. In September 2009, and again in September 2010, the U.S. Department of Transportation convened a Distracted Driving Summit. At the 2009 meeting, Transportation Secretary Ray LaHood announced that President

Obama had issued an executive order prohibiting Federal employees from texting while driving on official government business. In addition, the Federal Motor Carrier Safety Administration enacted an interim ban prohibiting commercial vehicle drivers from texting while driving. Public support is high for bans on hand-held cell phone use and texting while driving, at 71% and 94%, respectively (Tison, Chaudhary, & Cosgrove, 2011).

Use: As of July 2012, talking on a hand-held cell phone was prohibited in 10 States (California, Connecticut, Delaware, Maryland, Nevada, New Jersey, New York, Oregon, Washington, and West Virginia) and the District of Columbia (GHSA, 2012b; IIHS, 2012b). With the exception of Maryland, the cell phone bans in each of these States are primary laws. In addition, several local jurisdictions such as Chapel Hill, North Carolina, Chicago, Illinois, and Cheyenne, Wyoming, have enacted their own restrictions on cell phones. At present, no State restricts *hands-free* phone use for all drivers, although Alaska considered such legislation in 2011 (NCSL, 2012).

A number of States have recently passed, or are currently considering, laws that would prohibit text messaging while driving. As of July 2012, 39 States and the District of Columbia prohibit text messaging for all drivers (GHSA, 2012b; IIHS, 2012b). NHTSA has prepared a sample bill to assist States in crafting new legislation to prohibit texting while driving (NHTSA, 2010c).

Effectiveness: Evaluations in New York, Connecticut, the District of Columbia, and other countries consistently show that cell phone laws reduce hand-held phone use by about 50% shortly after the laws take effect (McCartt et al., 2006). Moreover, these reductions in hand-held cell phone use are maintained three to 7 years later (McCartt, Hellinga, Strouse, & Farmer, 2010). However, it is unknown whether these laws lead to increased use of hands-free devices.

The effectiveness of hand-held cell phone bans in reducing crashes is still unclear. Nikolaev, Robbins, and Jacobson (2010) examined driving injuries and fatalities in 62 counties in New York State both before and after a hand-held cell phone ban took effect. Forty-six counties showed a significant decrease in injury crashes following the ban, and 10 counties showed a decrease in fatal crashes. Although encouraging, the study did not include a control group to account for other factors that may have decreased crashes. A study by the Highway Loss Data Institute investigated State-level automobile insurance collision claims in California, Connecticut, New York and the District of Columbia. When compared to neighboring States, there was no change in collision claim frequency after these jurisdictions implemented hand-held cell phone bans (HLDI, 2009). However, the data from the Highway Loss Data Institute is proprietary and an independent analysis of the data has not been conducted. Also, not all crashes result in a collision claim, so collision claim rates may differ from crash rates.

Only one study has examined the effectiveness of laws prohibiting texting while driving. The Highway Loss Data Institute found States that enacted a texting ban showed a small *increase* in collision claim frequency compared to neighboring States without such bans (HLDI, 2010). One possible explanation is that texting drivers attempt to avoid detection by hiding their phones from view, which may result in more time with drivers' eyes off the roadway. Again, however, this analysis has not been independently verified and is based on collision claims, not crashes.

Costs: As with any law, costs are required to publicize and enforce it. A hand-held cell phone law can be enforced during regular traffic patrol because drivers who are using a hand-held

phone can be observed relatively easily. However, some States with cell phone bans allow drivers to use a phone for specific purposes while driving (e.g., navigation), which can make enforcement more challenging. As with other traffic safety laws, paid advertising supporting highly visible law enforcement may be necessary to achieve substantial effects (see Chapter 4, Section 1.3).

Time to implement: A cell phone law can be implemented quickly, as soon as it is publicized.

Other issues:

- **Cell phone blockers:** In recent years, several manufacturers have created systems that can block a cell phone from making (or receiving) calls while a person is driving. These systems detect when the phone is in motion. During that time, incoming calls are automatically diverted to voicemail and incoming texts are not shown until the driver reaches his or her destination. Typically, these systems allow exceptions for phone calls from pre-specified numbers, and all allow emergency calls to 911. Although these systems are potentially applicable to all drivers, they have largely been targeted to parents of teen drivers. Researchers at the Texas Transportation Institute tried to evaluate a cell phone disabling device for teens; however, they encountered large dropout rates and very strong resistance to the device (Benden, Fink, & Stafford, 2012). As of the publication cutoff date, there have been no other published evaluations of cell phone blockers.

1.3 High Visibility Cell Phone and Text Messaging Enforcement

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

Numerous studies demonstrate that high-visibility enforcement (HVE) can be effective in curbing alcohol-impaired driving and increasing seat belt use among drivers (see Chapter 1, Section 2.1 and Chapter 2, Section 2.1). Recently, NHTSA has examined whether the HVE model could be effective in reducing hand-held cell phone use and texting among drivers.

Similar to sobriety checkpoints, the object is to deter cell phone use by increasing the perceived risk of arrest. The HVE model combines dedicated law enforcement with paid and earned media supporting the enforcement activity. Enforcement officers actively seek out cell phone users through special roving patrols, or through spotter techniques where a stationary officer will radio ahead to another officer when a driver using a cell phone is detected. Officers report that higher vantage points, SUVs, and unmarked vehicles can assist in identifying violators (Cosgrove, Chaudhary, & Reagan, 2011). Both earned and paid media are critical to ensure the general public is aware of the enforcement activity, and to create the impression that violators will be caught.

NHTSA has conducted a high-visibility enforcement demonstration project aimed at reducing cell phone use among drivers. The message of the program is, "Phone in one hand. Ticket in the other." Pilot programs were tested in Hartford, Connecticut, and Syracuse, New York, in April 2010 through April 2011. Law enforcement officers conducted four waves of enforcement during the course of the year. Paid media (TV, radio, and online advertisements and billboards) and earned media (e.g., press events and news releases) supported the enforcement activity. For more details about the program, see Cosgrove, Chaudhary, and Reagan (2011).

Use: To date, only a handful of States, including California, Connecticut, and New York, have implemented high visibility enforcement programs to address talking and texting among drivers.

Effectiveness: Results from the NHTSA HVE program suggest hand-held cell phone use among drivers dropped 57% in Hartford and 32% in Syracuse (Cosgrove, Chaudhary, & Reagan, 2011). The percentage of drivers observed manipulating a phone (e.g., texting or dialing) also declined. Public awareness for distracting driving was already high before the program, but surveys suggest awareness of the program and enforcement activity increased in both Hartford and Syracuse. Surveys also showed most motorists supported the enforcement activity. Although the results are encouraging, the effect of the program on crashes is unknown. Note that the evidence for effectiveness is based on community programs that targeted hand-held cell phone use. There is no evidence available that statewide programs are equally effective or that HVE programs targeting texting will be as effective.

Costs: High-visibility enforcement campaigns are expensive. They require time from law enforcement officers to conduct the enforcement. In addition, time is needed from State highway safety office and media staff and often from consultants to develop, produce, and distribute publicity. In the NHTSA demonstration program, both Connecticut and New York received $200,000 to implement and evaluate the program, and each state contributed an additional $100,000 to the Federal funds. Paid media costs for the program were over $500,000.

Time to implement: A high-visibility enforcement program requires 4 to 6 months to plan and implement.

1.4 General Driver Drowsiness and Distraction Laws

Effectiveness: ★	Cost: Varies	Use: High†	Time: Short

† Included under reckless driving; use of explicit drowsiness and distraction laws is low

States implicitly prohibit driving while seriously distracted or drowsy through their reckless driving laws (NCHRP, 2005, Strategy C2). These existing laws in each State allow individuals to be cited and prosecuted if they cause a crash due to distracted or drowsy driving; however, the extent to which States currently *do* pursue cases of inattentive driving is currently unknown. Only one State, New Jersey, has a law specifically targeting the issue of drowsy drivers. In 2003, New Jersey enacted "Maggie's Law" under which drivers can be prosecuted for vehicular homicide if they have not slept in 24 hours and they cause a crash in which someone is killed (NCHRP, 2005, Strategy C2). In 2009, Maine enacted a general distracted driving law. Under the new law, a driver who is involved in a crash or who commits an infraction can be cited for distracted driving if a police officer believes that to be the underlying cause. The law defines distraction as an activity not necessary to the operation of the vehicle that impairs, or could impair, the ability to drive safely. Utah has a law that prohibits "careless driving," which is defined as committing a moving violation (other than speeding) while being distracted by one or more activities unrelated to driving (GHSA, 2012). Potentially distracting activities covered by the law include talking on a hand-held phone, searching for an item in the vehicle, or attending to personal hygiene or grooming.

No studies have evaluated whether general reckless driving laws or specific drowsy or distracted driving laws have any effect (except for cell phone laws: see Chapter 4, Section 1.2). Based on extensive experience in other traffic safety areas, it is likely that these laws will have little or no effect unless they are vigorously publicized and enforced. See Chapter 1, Sections 2.1 on alcohol-impaired driving, Chapter 2, Sections 2.1, 3.1, and 3.2 on seat belt use laws, and Chapter 3, Sections 2.2 and 4.1 on aggressive driving and speeding laws. Enforcement of drowsy or distracted driving laws is likely to be especially difficult because drowsiness and distraction often are difficult to observe, measure, and document. Nevertheless, these laws may increase the impact of communications and outreach efforts to reduce drowsy and distracted driving discussed in Chapter 4, Sections 2.1 and 2.2 (see also NCHRP, 2005, Strategy C2).

Use: New Jersey, Maine, and Utah are the only States with laws explicitly addressing drowsy driving or distractions other than cell phones (Chapter 4, Section 1.2). Other States include these conditions under their laws regarding reckless driving or similar offenses.

Effectiveness: The effects of any laws on reducing drowsy or distracted driving are unknown.

Costs: Costs are required for publicity and enforcement. Enforcement costs likely will be minimal, as most enforcement likely will be included under regular traffic patrols or combined with enforcement activities directed primarily at other offenses such as alcohol-impaired or aggressive driving.

Time to implement: A new drowsy or distracted driving law can be implemented quickly, as soon as it is publicized and law enforcement patrol officers are trained.

2. Communications and Outreach

2.1 Communications and Outreach on Drowsy Driving

Effectiveness: ★	Cost: $$	Use: Unknown	Time: Medium

Drowsy driving typically occurs because drivers don't get enough sleep. This apparently obvious statement is well-documented. In a NHTSA telephone survey, 66% of the drivers who reported they had nodded off while driving had 6 or fewer hours of sleep the previous night (Royal, 2003). Stutts, Wilkins, and Vaughn (1999) interviewed 467 crash-involved drowsy drivers (reported as "fatigued" or "asleep" by the investigating officer) and 529 other crash-involved drivers who were not drowsy. Half of the drowsy drivers had 6 or fewer hours of sleep the previous night compared to fewer than 10% of the other drivers.

States and national organizations such as the National Sleep Foundation have conducted drowsy driving communications and outreach campaigns directed to the general public (NCHRP, 2005, Strategy C1; NSF, 2004). Campaign goals usually include:

- raising awareness of the dangers of drowsy driving;
- motivating drivers to take action to reduce drowsy driving; and
- providing information on what drivers can do, either before they start out on a trip or if they become drowsy while driving.

NHTSA and NCSDR (NHTSA, 2001) identified three groups that are over-involved in drowsy driving crashes: drivers in their teens and 20s, shift workers, and people suffering from sleep apnea or narcolepsy. The joint NHTSA-NCSDR Report to Congress on drowsy driving recommended that communications and outreach on drowsy driving be directed to these groups, especially to young drivers (NHTSA, 1999). This information can be delivered in several ways. Driver education programs can include information on both drowsy and distracted driving, and the new model curriculum developed by NHTSA and the American Driver and Traffic Safety Education Association includes both. See Chapter 4, Sections 3.1 and 3.2, for additional discussion of shift workers and medical conditions, respectively.

The ultimate goal of drowsy driving communications and outreach is to change driver behavior; however, substantial obstacles are faced. As discussed in other chapters, communications and outreach by themselves rarely change driving behavior (Chapter 1, Section 5.2; Chapter 2, Sections 3.1 and 3.2; Chapter 3, Section 4.1; see also NCHRP, 2005, Strategy C1). To have any chance of success, stand-alone campaigns must be carefully pre-tested, communicate health information not previously known, be long-term, and have substantial funding (Williams, 2007b).

An additional barrier is that drowsy driving is a byproduct of busy lifestyles that do not include enough sleep. The only truly effective method to prevent drowsy driving crashes is to get enough sleep (Nguen, Jauregui, & Dinges, 1998; NHTSA, 2001). Traffic safety messages urging enough sleep may be overwhelmed by the other demands on a driver's time that are responsible for insufficient sleep. Focus group discussions with young men and shift workers, two groups at high risk of drowsy driving, supported this conclusion (Nelson, Isaac, & Graham, 2001). Most shift workers and many young men understood well the risks caused by lack of sleep. Many had

crashed or almost crashed after falling asleep at the wheel or had friends who had crashed. But neither their knowledge nor their crash experience changed their sleep habits. They sacrificed sleep for the demands of their work, families, and social lives. Campaigns directed to young drivers also must overcome the higher risk-taking behavior and overall immaturity of young drivers discussed in Chapter 6. No drowsy driving communications and outreach program for the general public has been evaluated (NCHRP, 2005, Strategies C1 and D2).

Use: Utah is the only State known to have conducted a drowsy driving campaign for the general public (see NCHRP, 2005, Strategy C1). NCHRP (2005, Strategy D2) gives examples of college programs.

Effectiveness: There are no studies of any campaign's effects on driver knowledge, attitudes, or behavior (NCHRP, 2005, Strategies C1 and D2).

Costs: A high-quality campaign will be expensive to develop, test, and implement.

Time to implement: A high-quality campaign will require at least 6 months to plan, produce, and distribute.

2.2 Communications and Outreach on Distracted Driving

Effectiveness: ★	Cost: $$	Use: High	Time: Medium

Distracted driving communications and outreach campaigns for the general public face different, but equally difficult, obstacles than drowsy driving campaigns. All drivers "know" at some level that they should be alert. However, as discussed in the Overview, distractions come in many forms. Distractions outside the car are not under the driver's control. Many distractions inside the car also cannot be controlled easily (conversations, children), or are intentional (listening to the radio or CD player, eating). They may in fact be useful, to keep drivers alert on a long trip.

There is strong public support for communications and outreach to reduce distracted driving. For example, 80% of respondents in a Canadian survey agreed that greater awareness and education efforts are needed to alert drivers to the problem of distracted driving (Vanlaar et al., 2007). Many organizations have developed or conducted distracted driving communications and outreach campaigns directed to the general public. Some carry a general "pay attention" message, while others are directed at specific behaviors such as cell phone use. Recently, the U.S. Department of Transportation launched a national campaign called "Put It Down" to discourage the public from driving distracted (www.distraction.gov). Other campaigns include Oprah Winfrey's "No Phone Zone," the National Safety Council's "On the Road, Off the Phone," and the American Academy of Orthopaedic Surgeons' "Decide to Drive."

Driving while distracted is a particular concern with teenage drivers (Goodwin, Foss, Harrell, & O'Brien, 2012; NHTSA, 2012). GDL passenger and cell phone restrictions directly address two sources of distractions, as discussed in Chapter 4, Section 1.1. Broader communications and outreach efforts for young drivers regarding distracted driving also have been proposed. For example, a growing number of states are including distracted driving as a required component of driver education, the State's driver license test, or information provided in the driver license manual (GHSA, 2010). Some States have also developed their own education materials and programs aimed at teen drivers. See GHSA (2010) for links to these materials.

The ultimate goal of these campaigns is to change driver behavior, but they face substantial obstacles. As discussed in other chapters, communications and outreach by themselves rarely change driving behavior (Chapter 1, Section 5.2; Chapter 2, Section 3.1; Chapter 3, Section 4.1; see also NCHRP, 2005, Strategy C1). To have any chance, stand-alone campaigns must be carefully pre-tested, communicate health information not previously known, be long-term, and have substantial funding (Williams, 2007b). A broad "stay alert" message may be too general to have any impact.

Use: A recent survey by GHSA found that 41 States and the District of Columbia have implemented public information/education campaigns to address distracted driving (GHSA, 2010). In addition, a number of States have developed distracted driving PSAs.

Effectiveness: There are no studies of any campaign's effects on driver knowledge, attitudes, or behavior (NCHRP, 2005, Strategies C1 and D2).

Costs: A high-quality campaign will be expensive to develop, test and implement.

Time to implement: A high-quality campaign will require at least 6 months to plan, produce and distribute.

Other issues:

- **Non-traditional communication channels:** Sixteen States as well as NHTSA now use social networking sites to educate motorists about distracted driving (GHSA, 2010). Sites such as Facebook, Twitter, and YouTube can effectively and inexpensively reach large numbers of people. Social networking sites are especially popular among young people, who are often a primary target of distracted driving campaigns.

3. Other Countermeasures

3.1 Employer Programs

Effectiveness: ★★	Cost: $	Use: Unknown	Time: Short

There are many ways States can work with employers to address distracted and drowsy driving. Some States, such as Delaware and Kentucky, have established corporate outreach programs related to distracted driving (GHSA, 2010). The programs usually involve dissemination of traffic safety materials to employers, or sometimes directly to the employees themselves. States can also assist employers in promoting and enforcing policies to reduce distracted driving. Legally, employers can be held accountable for employees who are using a cell phone (or otherwise distracted) and who are involved in a crash as part of their work (NSC, 2012). Employers can protect themselves by implementing policies that prohibit distracted driving and by monitoring compliance. New Jersey has developed a sample cell phone use policy for businesses, available at www.nj.gov/lps/hts/downloads/Sample_Cell_Phone_Policy.pdf. The National Safety Council has developed a policy kit to assist employers with implementing or strengthening a cell phone ban, available at http://shop.nsc.org/eProducts-Cell-Phone-Policy-Download-P252.aspx. Additionally, a sample employer policy is available at www.distraction.gov/content/get-involved/employers.html.

States can also work with employers to address the issue of drowsy driving. Shift workers are one employment group at high risk for drowsy-driving crashes. Shift workers include people who work long or irregular hours or who work at night, including many law enforcement officers (NCHRP, 2005, Strategy D6). Another at-risk group for drowsy driving crashes is medical interns, who frequently work extended shifts of 24 hours or more. Barger et al. (2005) collected monthly reports from 2,737 interns. Interns were 2.3 times more likely to report a crash and 5.9 times more likely to report a near miss after an extended shift than a shorter shift. Each extended shift in a month increased the monthly risk of a crash during the commute from work by 16%. NHTSA and NCSDR have produced a comprehensive workplace education program for shift workers. It includes information on sleep habits in general and drowsy driving in particular. Program material includes a video, posters, brochures for workers and their families, tip cards, a PowerPoint training session, and an administrator's guide are available at www.nhtsa.dot.gov/people/injury/drowsy_driving1/human/drows_driving/.

Use: Sixteen States and the District of Columbia work with employers in their State to develop distracted driving policies (GHSA, 2010). The number of employers who use the NHTSA/NCSDR program is not known.

Effectiveness: The NHTSA/NCSDR program was tested by more than 20 U.S. companies and was well received by workers and management. It has not been evaluated further (NCHRP, 2005, Strategy D3). No other employer distracted or drowsy driving program has been evaluated.

Costs: Since a comprehensive program is available at no cost, program costs will consist only of material production and employer time for training.

Time to implement: An employer program can be implemented within three months.

3.2 Education Regarding Medical Conditions and Medications

Effectiveness: ★	Cost: Variable	Use: Unknown	Time: Medium

A number of chronic medical conditions and sleep disorders can potentially compromise sleep and elevate feelings of fatigue (Smolensky, Di Milia, Ohayon, & Philip, 2011). Three disorders, in particular, can cause drivers to fall asleep at the wheel:

- Insomnia is the subjective experience of having difficulty falling asleep or staying asleep. It affects an estimated 11% of the U.S. population (NSF, 2008). People suffering from insomnia often report daytime sleepiness that interferes with their daily activities.
- Sleep apnea is a breathing disorder characterized by brief interruptions of breathing during sleep, perhaps as many as 20 to 60 per hour (NSF, 2009a). By fragmenting nighttime sleep, sleep apnea produces daytime sleepiness. NSF estimates that about 4% of men and 2% of women are affected by sleep apnea. It can be treated by physical or mechanical therapy or by surgery.
- Narcolepsy is a disorder of the central nervous system's sleep-wake mechanism that can cause narcoleptics to fall asleep suddenly at any time (NSF, 2009b). It is quite rare, affecting about one person in 2,000. It can be treated with medications.

Several studies suggest that people suffering from insomnia are 2 to 3 times more likely to be involved in motor vehicle crashes than those without insomnia (Smolensky et al., 2011). Similarly, research also shows that people with sleep apnea are up to 6 times more likely to be involved in a crash (Teran-Santos, Jiminez-Gomez, & Cordero-Guevara, 1999). It has been estimated that crashes among people with sleep apnea cost approximately 16 billion dollars each year (Sassani et al., 2004). The number of crashes resulting from narcolepsy is not known.

Most cases of sleep apnea or narcolepsy are undiagnosed and untreated (NCHRP, 2005, Strategy D6; NHTSA, 1998). Indeed, falling asleep at the wheel may be one of the main ways to raise the possibility of a sleep disorder and motivate a driver to seek medical attention (NHTSA, 1998). Once treated, people with sleep apnea have crash rates that are no higher than the general population (George, 2001).

There are many other medical conditions that can potentially compromise sleep or increase daytime feelings of fatigue such as asthma, chronic obstructive pulmonary disease, and rheumatoid or osteoarthritis. For a review of medical disorders and conditions that may affect sleep and driving risk, see Smolensky et al. (2011).

Many common prescription and over-the-counter medications can also cause drowsiness. Warning labels on the medications note this and caution users against driving or other activities that could be affected by drowsiness. For more information about how medications can impair drivers, see Chapter 1, Section 7.3.

The principal countermeasures to address sleep apnea, narcolepsy, and medication effects are (NCHRP, 2005, Strategy D6):

1. Communications and outreach on sleep disorders to increase overall awareness of their symptoms, consequences, and treatment.

2. Efforts with driver licensing medical advisory boards to increase their awareness of these conditions as they review driver fitness for licensing.
3. Efforts with physicians to increase their awareness of these conditions and their potential effects on driving, to treat these conditions as appropriate, and to counsel their patients to take steps to reduce the risk of drowsy driving.

Use and Effectiveness: There is no information available on how frequently these countermeasures are used or on how effective they have been in raising awareness, increasing knowledge, or affecting behavior.

Costs: Targeted communications and outreach to drivers (through driver licensing handbooks or flyers in license renewal material) or to physicians (through medical associations) would be relatively inexpensive. A communications and outreach campaign directed at all drivers will be expensive to develop, test and implement. See Chapter 1, Section 5.2 and Chapter 2, Sections 2.1 and 3.1, for additional discussion.

Time to implement: Either targeted or general communications and outreach activities will require at least 6 months to plan, produce, and distribute. Efforts with driver licensing medical advisory boards could be implemented quickly.

Distracted and Drowsy Driving References

AAA Foundation for Traffic Safety. (2009). *2009 Traffic Safety Culture Index*. Washington, DC: Author. Available at www.aaafoundation.org/pdf/2009TSCIndexFinalReport.pdf

AAAFTS (2010). *Asleep at the Wheel: The Prevalence and Impact of Drowsy Driving*. Washington, DC: Author. Available at www.aaafoundation.org/pdf/2010DrowsyDrivingReport.pdf

Barger, L. K., Cade, B. E., Ayas, N. T., Cronin, J. W., Rosner, B., Speizer, F. E., & Czeisler, C. A. (2005). Extended work shifts and the risk of motor vehicle crashes among interns. *New England Journal of Medicine, 352*, 125-134.

Beirness, D. J., Simpson, H. M., & Desmond, K. (2005). *The Road Safety Monitor 2004: Drowsy Driving.* Ottawa, ON: Traffic Injury Research Foundation. Available at www.tirf.ca/publications/PDF_publications/RSM_Drowsy_Driving_2004.pdf

Benden, M., Fink, R., & Stafford, J. (2012). *Teen Driver Cell Phone Blocker*. DOT Grant No. DTRT06-G-0044. Washington, DC: Department of Transportation. http://utcm.tamu.edu/publications/final_reports/Benden_10-15-47.pdf

Blanco, M., Bocanegra, J. L., Morgan, J. F., Fitch, G. M, Medina, A., et al. (2009). *Assessment of a Drowsy Driver Warning System for Heavy-Vehicle Drivers: Final Report*. (Report No. DOT HS 811 117). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2009/811117.pdf

Caird, J. K., Willness, C. R., Steel, P., & Scialfa, C. (2008). A meta-analysis of the effects of cell phones on driver performance. *Accident Analysis and Prevention*, *40*, 1282-1293.

Charlton, S. G. (2009). Driving while conversing: Cell phones that distract and passengers who react. *Accident Analysis and Prevention*, *41*, 160-173

Cosgrove, L., Chaudhary, N., & Reagan, I. (2011). *Traffic Safety Facts, Research Note: Four High-Visibility Enforcement Demonstration Waves in Connecticut and New York Reduce Hand-Held Phone Use*. (Report No. DOT HS 811 845). Washington, DC: National Highway Traffic Safety Administration. Available at www.distraction.gov/download/research-pdf/508-research-note-dot-hs-811-845.pdf

CTIA. (2010). *CTIA's semi-annual wireless industry survey results, December 1985-December 2009*. Washington, DC: Cellular Telecommunications and Internet Association. http://files.ctia.org/pdf/CTIA_Survey_Year_End_2009_Graphics.pdf

Donmez, B., Boyle, L. N, & Lee, J.D. (2007). Safety implications of providing real-time feedback to distracted drivers. *Accident Analysis and Prevention, 39*, 581-590.

Drews, F. A., Pasupathi, M., & Strayer, D. L. (2008). Passenger and cell phone conversations in simulated driving. *Journal of Experimental Psychology: Applied*, *14*, 392-400.

Drews, F. A., Yazdani, H., Godfrey, C. N., Cooper, J. M., & Strayer, D. L. (2009). Text messaging in simulated driving. *Human Factors*, *51*, 762-770.

Farmer, C. M., Braitman, K. A., & Lund, A. K. (2010). Cell phone use while driving and attributable crash risk. *Traffic Injury Prevention*, *11*, 466-470.

Federal Motor Carrier Safety Administration. (2005). *5-Year Strategic Plan, FY2005-FY2009.* Washington, DC: Author. Available at www.fmcsa.dot.gov/facts-research/research-technology/report/rt-5year-strategicplan.htm

FMCSA. (2008). *Hours-of-Service Regulations.* Washington, DC: Author. Available at www.fmcsa.dot.gov/rules-regulations/topics/hos/hos-2005.htm

Foss, R. D., Goodwin, A. H., McCartt, A. T., & Hellinga, L. A. (2009). Short-term effects of a teenage driver cell phone restriction. *Accident Analysis and Prevention*, *41*, 419-424.

George, C. F. P. (2001). Reduction in motor vehicle collisions following treatment of sleep apnoea with nasal CPAP. *Thorax*, *56*, 508-512.

Governors Highway Safety Association. (2010). *Curbing Distracted Driving: 2010 Survey of State Safety Programs*. Washington, DC: Author. Available at www.distraction.gov/files/research/GHSA-2010_distraction.pdf

GHSA. (2011). *Distracted Driving: What Research Shows and What States Can Do*. Washington, DC: Author. Available at www.ghsa.org/html/publications/pdf/sfdist11.pdf

GHSA. (2012a). *Graduated Licensing Laws.* Washington, DC: Author. Available at www.statehighwaysafety.org/html/stateinfo/laws/license_laws.html

GHSA. (2012b). *Cell Phone Restrictions - State and Local Jurisdictions.* Washington, DC: Author. Available at www.statehighwaysafety.org/html/stateinfo/laws/cellphone_laws.html

Goodwin, A. H., Foss, R. D., Harrell, S. S., & O'Brien, N. P. (2012). *Distracted Driving Among Newly Licensed Teen Drivers*. Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/DistractedDrivingAmongNewlyLicensedTeenDrivers.pdf

Goodwin, A. H., O'Brien, N. P., & Foss, R. D. (2012). Effect of North Carolina's restriction on teenage driver cell phone use two years after implementation. *Accident Analysis & Prevention, 48,* 363-367.

Grigo, J. A. L., & Baldock, M. R. J. (2011). *Sleepiness and Road Crashes: Challenges of Definition and Measurement*. Adelaide, South Australia: Centre for Automotive Safety Research. http://casr.adelaide.edu.au/casrpubfile/1097/CASR082.pdf

Hedlund, J., & Compton, R. (2005). Graduated driver licensing research in 2004 and 2005. *Journal of Safety Research, 36*, 109-119.

HLDI. (2009). *Hand-Held Cellphone Laws and Collision Claim Frequencies*. Highway Loss Data Institute Bulletin, Vol. 26, No. 17. Arlington, VA: Highway Loss Data Institute. Available at www.iihs.org/research/topics/pdf/HLDI_Cellphone_Bulletin_Dec09.pdf

Horrey, W. J., Lesch, M. F., & Garabet, A. (2008). Assessing the awareness of performance decrements in distracted drivers. *Accident Analysis and Prevention*, *40*, 675-682.

Hosking, S. G., Young, K. L., & Regan, M. A. (2009). The effects of text messaging on young drivers. *Human Factors*, *51*, 582-592.

Insurance Institute for Highway Safety. (2012a). *U.S. Licensing Systems for Young Drivers: Laws as of July 2010*. Arlington, VA: Author. Available at www.iihs.org/laws/graduatedLicenseIntro.aspx

IIHS. (2012b). *Cell Phone Laws*. Arlington, VA: Author. Available at www.iihs.org/laws/state_laws/cell_phones.html

Ishigami, Y., & Klein, R. M. (2009). Is a hands-free phone safer than a handheld phone? *Journal of Safety Research*, *40*, 157-164.

Klauer, S. G., Dingus, T. A., Neale, V. L., Sudweeks, J. D., & Ramsey, D. J. (2006). *The Impact of Driver Inattention On Near-Crash/Crash Risk: An Analysis Using the 100-Car Naturalistic Driving Study Data*. (Report No. DOT HS 810 594). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/Driver%20Distraction/810594.pdf

Klauer, S. G., Guo, F., Sudweeks, J., & Dingus, T. A. (2010). *An Analysis of Driver Inattention Using a Case-Crossover Approach on 100-Car Data: Final Report.* (Report No, DOT HS 811 334). Washington, DC: National Highway Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2010/811334.pdf

Marcoux, K. D., Valnaar, W. G. M., & Robertson, R. D. (2012). *The Road Safety Monitor 2012: Distracted Driving Trends*. Ottawa, Ontario: The Traffic Injury Research Foundation. Available at www.tirf.ca/publications/PDF_publications/RSM_2011_Distracted_Driving_Eng_3.pdf

May, J. F., & Baldwin, C. L. (2009). Driver fatigue: The importance of identifying causal factors of fatigue when considering detection and countermeasure technologies. *Transportation Research Part F*, *12*, 218-224.

McCartt, A. T., Hellinga, L. A., & Braitman, K. A. (2006). Cell phones and driving: review of research. *Traffic Injury Prevention, 7,* 89-106.

McCartt, A. T., & Hellinga, L. A., Strouse, L. M., & Farmer, C. M. (2010). Long-term effects of handheld cell phone laws on driver handheld cell phone use. *Traffic Injury Prevention, 11*, 133-141.

McEvoy, S. P. Stevenson, M. R., McCartt, A. T., Woodward, M., Haworth, C., Palamara, P., & Cercarelli, R. (2005). Role of mobile phones in motor vehicle crashes resulting in hospital attendance: A case-crossover study. *British Medical Journal*, *331,* 428-434.

NCHRP, Vol. 14. (2005). *A Guide for Addressing Collisions Involving Distracted or Fatigued Drivers.* Washington, DC: Transportation Research Board. Available at onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v14.pdf

NCHRP, Vol 19. (2007). *A Guide for Reducing Collisions Involving Young Drivers.* Washington, DC: Transportation Research Board. Available at onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v19.pdf

NCSL. (2012). *Traffic Safety and Public Health: State Legislative Action 2011*. Denver, CO: National Conference of State Legislatures. Available at www.ncsl.org/documents/transportation/2011trafficsafety.pdf

Nelson, T. F., Isaac, N. E., & Graham, J. D. (2001). *Development and Testing of Countermeasures for Fatigue Related Highway Crashes.* Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/drowsy_driving1/listening/title.htm#title

Nguen, L. T., Jauregui, B., & Dinges, D. F. (1998). *Changing Behaviors to Prevent Drowsy Driving and Promote Traffic Safety: Review of Proven, Promising, and Unproven Techniques.* Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/drowsydriving.pdf

NHTSA. (1998). *Drowsy Driving and Automobile Crashes.* (Report No. DOT HS 808 707). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/drowsy_driving1/Drowsy.html

NHTSA. (2001). *Drowsy Driving and Automobile Crashes.* Washington, DC: Author. Available at www.nhtsa.gov/people/injury/drowsy_driving1/Drowsy.html

NHTSA. (2010a). *Traffic Safety Facts, Research Note*: *Distracted Driving 2009*. (Report No. DOT HS 811 379). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811379.pdf

NHTSA. (2010b). *Overview of the National Highway Traffic Safety Administration's Driver Distraction Program*. (Report No. DOT HS 811 299). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/distracted_driving/pdf/811299.pdf

NHTSA. (2010c). *Sample Law to Prohibit Texting While Driving*. Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/rulemaking/pdf/Texting_Law_021910.pdf

NHTSA. (2011a). *U.S. Transportation Secretary LaHood Announces Lowest Level Of Annual Traffic Fatalities In More Than Six Decades*. Washington, DC: Author. Available at www.distraction.gov/content/press-release/2011/12-8.html

NHTSA. (2011b). *Traffic Safety Facts, Research Note: Driver Electronic Device Use in 2010*. (Report No. DOT HS 811 517). Washington, DC: Author. Available at www.distraction.gov/download/research-pdf/8052_TSF_RN_DriverElectronicDeviceUse_1206111_v4_tag.pdf

NHTSA. (2012). *Blueprint for Ending Distracted Driving*. (Report No. DOT HS 811 629). Washington, DC: Author. Available at www.distraction.gov/download/campaign-materials/8747-811629-060712-v5-Opt1-Web-tag.pdf

Nikolaev, A. G., Robbins M. J., & Jacobson, S. H. (2010). Evaluating the impact of legislation prohibiting hand-held cell phone use while driving. *Transportations Research Part A*, *44*, 182-193.

NSC. (2012). *Employer Liability and the Case for Comprehensive Cell Phone Policies*. Washington DC: National Safety Council. Available at www.nsc.org/safety_road/Distracted_Driving/Documents/CorpLiability_wp.pdf

National Sleep Foundation. (2004). *Drive Alert - Arrive Alive National Campaign.* Washington, DC: Author.

NSF. (2008). *2008 "Sleep in America" Poll.* Washington, DC: Author. Available at www.sleepfoundation.org/sites/default/files/2008%20POLL%20SOF.PDF

NSF. (2009a). *Obstructive Sleep Apnea and Sleep.* Washington, DC: Author. Available at www.sleepfoundation.org/article/sleep-related-problems/obstructive-sleep-apnea-and-sleep

NSF. (2009b). *Narcolepsy and Sleep.* Washington, DC: Author. Available at www.sleepfoundation.org/article/sleep-related-problems/narcolepsy-and-sleep

Olson, R. L., Hanowski, R. J., Hickman, J. S., and Bocanegra, J. (2009). *Driver Distraction in Commercial Vehicle Operations*. Report No. FMCSA-RRR-09-042. Blacksburg, VA: Virginia Tech Transportation Research Institute. Available at www.fmcsa.dot.gov/facts-research/research-technology/report/FMCSA-RRR-09-042.pdf

Papadelis, C., Chen, Z., Kourtidou-Papadeli, C., Bamidis, P. D., Chouvarda, I., Bekiaris, E., & Maglaveras, N. (2007). Monitoring sleepiness with on-board electrophysiological recordings for preventing sleep-deprived traffic accidents. *Clinical Neurophysiology*, *118*, 1906-1922.

Ranney, T. A. (2008). *Driver Distraction: A Review of the Current State-of-Knowledge*. (Report No. DOT HS 810 787). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/NRD/Multimedia/PDFs/Crash%20Avoidance/2008/810787.pdf

Redelmeier, D. A., & Tibshirani, R. J. Association between cellular telephone calls and motor vehicle collisions. *The New England Journal of Medicine*, *336*, 453-458.

Royal, D. (2003). *National Survey of Distracted and Drowsy Driving Attitudes and Behavior: 2002 Volume I: Findings.* (Report No. DOT HS 809 566). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/drowsy_driving1/survey-distractive03/index.htm

Sassani, A., Findley, L. J., Kryger, M., Goldlust, E., George, C., & Davidson, T. M. (2004). Reducing motor-vehicle collisions, costs, and fatalities by treating obstructive sleep apnea syndrome. *Sleep*, *27*, 453-458.

Smolensky, M. H., Di Milia, L., Ohayon, M. M., & Philip, P. (2011). Sleep disorders, medical conditions, and road accident risk. *Accident Analysis and Prevention*, *43*, 533-548.

Solomon, M. G., Chaudhary, N. K., & Cosgrove, L. A. (2003). *May 2003 Click It or Ticket Safety Belt Mobilization Evaluation Final Report.* Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/airbags/clickit_ticke03/ciot-report04/CIOT%20May%202003/index.htm

Stutts, J. C., Wilkins, J. W., & Vaughn, B. V. (1999). *Why Do People Have Drowsy Driving Crashes? Input from Drivers Who Just Did.* Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/Sleep.pdf

Tefft, B. C. (2012). Prevalence of motor vehicle crashes involving drowsy drivers, United States, 1999-2008. *Accident Analysis and Prevention*, *45*, 180-186.

Teran-Santos, J., Jiminez-Gomez, A., & Cordero-Guevara, J. (1999). The association between sleep apnea and the risk of traffic accidents. *The New England Journal of Medicine*, *340*, 847-851.

Traffic Injury Research Foundation. (2009). *The Facts about Fatigued Driving in Ontario: A Guidebook for Police*. Ottawa, Ontario: Author. Available at www.tirf.ca/publications/PDF_publications/2009_Facts_Fatigue_Driving_Ontario_Police_Guidebook.pdf

Tison, J., Chaudhary, N., & Cosgrove, L. (2011). *National Phone Survey on Distracted Driving Attitudes and Behaviors*. (Report No. DOT HS 811 555). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811555.pdf

WHO/NHTSA. (2011). *Mobile Phone Use: A Growing Problem of Driver Distraction*. Geneva, Switzerland: World Health Organization, and Washington, DC: National Highway Traffic Safety Administration. Available at www.who.int/violence_injury_prevention/publications/road_traffic/distracted_driving/en/index.html

Williams, A. F. (2007a). Contribution of the components of graduated licensing to crash reductions. *Journal of Safety Research, 38*, 177-184.

Williams, A. F. (2007b). Public Information and Education in the Promotion of Highway Safety. Research Results Digest 322). Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rrd_322.pdf

Young, R. A. (2012). Cell phone use and crash risk. *Epidemiology*, *23*, 116-118.

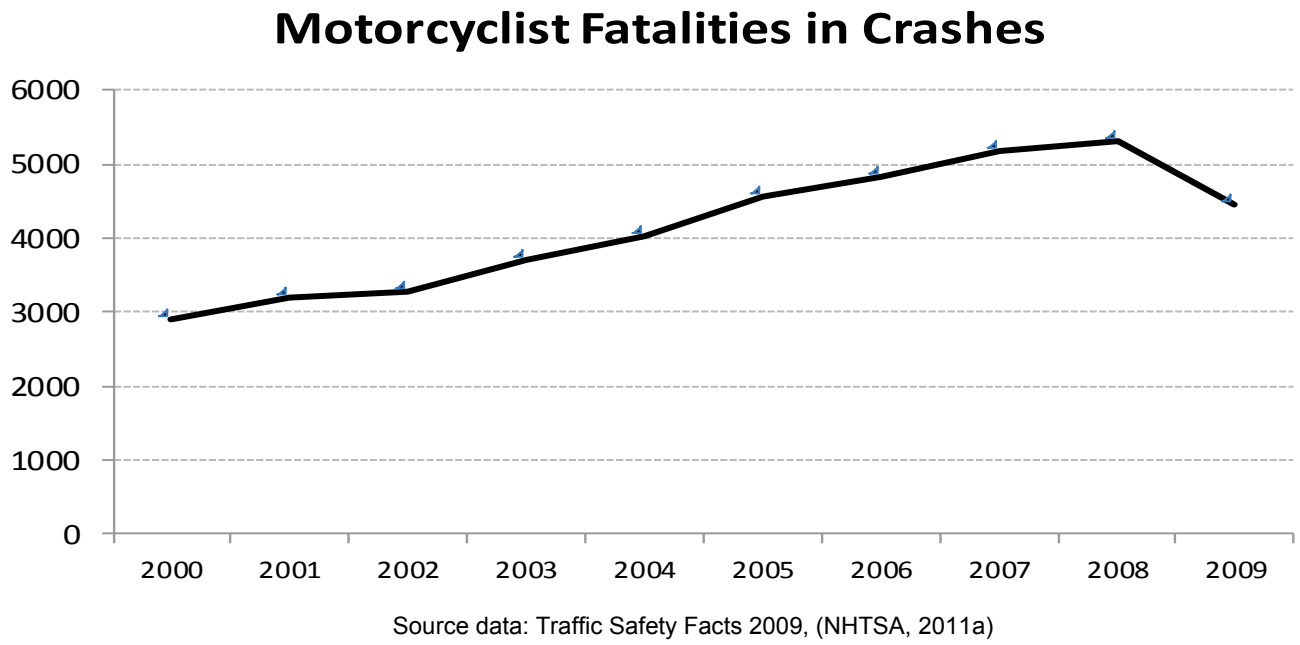
5. Motorcycle Safety

Overview

A motorcycle is inherently more difficult to operate than a passenger vehicle because it requires more physical skill. The relationship of speed and balance is also a critical consideration when riding a motorcycle, as the stability of a motorcycle is relative to speed. A motorcycle becomes more stable as speed increases, although it becomes less maneuverable. At very low speeds, the motorcycle rider must balance the motorcycle.

A motorcycle offers riders almost no protection in a crash. Crash data confirm these observations. NHTSA estimates that per vehicle mile traveled, motorcyclists are about 25 times more likely than passenger car occupants to die in traffic crashes. Motorcyclists are killed at a rate of 21.45 per 100 million vehicle miles traveled (VMT) as compared to 0.87 fatalities/VMT for passenger cars (NHTSA, 2011a).

Trends. Motorcycling has become increasingly popular over the last 10 years even as total vehicle miles traveled has declined. Not surprisingly, there has been a corresponding increase in crashes and fatalities involving motorcyclists. After drops in the 1980s and early 1990s, from 2000 to 2008, the number of motorcyclists killed in crashes increased by 83% and the number of motorcyclists injured increased by 92%. In 2008, motorcyclist fatalities increased for the 11th consecutive year to more than 5,000, a level not seen since 1980 (NHTSA 2009). However, in 2009 motorcyclist fatalities declined by 16% and motorcyclists injured declined by 7% accounting for 13% of total fatalities and 4% of total injured (NHTSA, 2011a).



In the 10-year period from 1998-2007, almost half of motorcyclists injured in crashes were injured in single-vehicle crashes. Approximately two-thirds of motorcyclist injuries during this

time period occurred during daylight hours, more than two-thirds occurred during the months from April to September, and slightly more than half occurred on weekdays. On average, about 85% of those injured were male and about 15% female. And about 10% of those injured were passengers (NHTSA, 2009). These trends have remained relatively consistent over this 10-year period, although there are year-to-year fluctuations.

One trend that is changing is an increase in fatalities and injuries among older motorcyclists. In 2009, 73% of the motorcyclists killed in crashes were 30 or older and 54% were 40 or older. The change in only 10 years is striking: in 2000, 65% were 30 or older and 41% were 40 or older (NHTSA, 2011a). Similarly, while the number of motorcyclists involved in injury crashes has increased among all age groups, injuries among motorcyclists 50 and older have increased at the fastest rate. Riders 50 and older were estimated to account for 21 to 22% of motorcyclists injured nationally during 2006 and 2007, compared with 11 to 15% during 1998 and 1999 (NHTSA, 2009).

Speeding is more prevalent in fatal crashes involving motorcycle operators than among other types of motor vehicle operators. Thirty-five percent of all motorcycle riders involved in fatal crashes in 2009 were speeding, compared to 23% of passenger car drivers (NHTSA, 2011a). Motorcycle riders involved in fatal crashes had worse prior driving records than other passenger vehicle drivers, including more DWI convictions, speeding convictions, and suspensions or revocations (NHTSA, 2011a, Figure 1). In 2009, 30% of the motorcycle riders killed in crashes had BACs of .08 g/dL or higher (NHTSA, 2011a). Forty-three percent of fatally injured motorcyclists were not wearing helmets (NHTSA, 2011a), although the percentage varies considerably from State to State. Additionally, 22% of the motorcycle riders involved in crashes in 2009 did not have a valid motorcycle operator's license (NHTSA, 2011a).

Other trends in motorcycle safety relate to the types of motorcycles being produced and purchased. While registrations of all types of motorcycles have increased between 2000 and 2005, registrations for supersport type motorcycles, which are built on a racing bike frame and reach speeds of nearly 190 mph, have climbed even faster. Whereas combined registrations for all motorcycle styles were 51% higher in 2005 than in 2000, supersport registrations were 83% higher (IIHS, 2007). Fatalities are three to four times higher among registered supersport owners as well, but these rates do not control for other possible risk factors (IIHS, 2007; Teoh & Campbell, 2010). The more recent IIHS analysis by Teoh and Campbell of 6 years of data also found that fatally injured supersport-style motorcycle riders were about twice as likely as standard/cruiser riders to have been speeding and half as likely to have been alcohol-impaired, after accounting for rider age and gender. These results suggest that the types of risks taken may vary in association with the style of bike chosen (Teoh & Campbell, 2010). Supersport riders also tend to be younger. In 2005, the average age was 27 among those fatally injured while riding these bikes, compared to an average age of 44 for cruiser and standard motorcycles (IIHS, 2007).

Strategies to Improve Motorcycle Safety

There are various existing strategies to improve motorcycle safety. Motorcycle riders should be properly trained and licensed. They should be alert and aware of the risks they face while riding; in particular, they should not be impaired by alcohol. All motorcycle riders should wear motorcycle helmets that meet Federal Motor Vehicle Safety Standard (FMVSS) 218 and clothing that provides both protection and visibility. These and other strategies are discussed in the National Agenda for Motorcycle Safety (NAMS), a comprehensive, collaborative, and multidisciplinary blueprint for motorcycle safety (NHTSA, 2000a). See also the NAMS Implementation Guide (NHTSA, 2006a), NHTSA's Motorcycle Safety Program Plan (NHTSA, 2006b), the U.S. DOT Action Plan to Reduce Motorcycle Fatalities (U.S. DOT, 2007), the Centers for Disease Control and Prevention's Motorcycle Safety Guide (CDC, 2011). In addition, a review of State Motorcycle Safety Program Technical Assessments summarizes program recommendations, implementations, and barriers to implementation from 9 State motorcycle safety program technical assessments conducted by NHTSA (Baer & Skemer, 2009).

Unfortunately, many motorcyclists do not take these straightforward precautions. The most important objectives for improving motorcycle safety are to increase helmet use, reduce alcohol-impaired motorcycle riding, increase proper licensing and the promotion of lifelong learning through the completion of rider training courses. These objectives are all difficult to accomplish. Universal helmet laws are extremely effective in assuring that virtually all motorcycle riders use helmets, but they also are politically difficult to enact and retain. Strategies using only communications and outreach to promote helmet use, reduce impaired motorcycling, and increase licensing appear to have been no more successful with motorcycle riders than with other drivers.

Another objective is to increase other drivers' awareness of motorcyclists by increasing the visibility of motorcyclists and by educating other drivers on the importance of sharing the road with motorcycles. Daytime running lights for motorcycles improve motorcycle conspicuity. Most motorcycles on the road have headlights that turn on automatically when the engines are started (NCHRP, 2008, Strategy 11.1 D2). In addition, 23 States require daytime headlight use for all motorcycles manufactured since 1980 (and Pennsylvania requires daytime headlight use for motorcycles manufactured since 1986; MSF, 2011). Modulating headlights, which cause the headlight to move from high- to low beam rapidly, also increase motorcycle visibility (Olson, Halstead-Nussloch, & Sivak, 1979), but use of these devices has been low thus far. Vehicle technologies such as antilock brakes also have the potential to enhance motorcycle safety (Bayly, Regan, & Hosking, 2006). For example, a study by IIHS found that motorcycles with antilock brakes had a 28% lower fatal crash involvement than motorcycles without antilock brakes (Teoh, 2011).

Resources

Many environmental factors can also affect motorcycle safety. Slippery roadway surfaces and markings, surface irregularities and debris, unpaved shoulders, and unforgiving roadway barriers all can be dangerous. These issues are not included in this guide because State Highway Safety Offices have little or no authority or responsibility for them.

See National Cooperative Highway Safety Research Report 500, Volume 22 Guide for Addressing Collisions Involving Motorcycles, for a thorough discussion of environmental and other
strategies: www.trb.org/Publications/Public/Blurbs/A_Guide_for_Addressing_Collisions_Involving_Motorc_160626.aspx

For a broad set of resources for State safety agencies and on-going research efforts, see:
NHTSA's Web pages:

- Motorcycles - www.nhtsa.gov/Safety/Motorcycles
- Research and Evaluation - www.nhtsa.gov/Research/Behavioral+Research
- Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm

Countermeasures That Work

Countermeasures to improve motorcycle safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Motorcycle Helmets

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Universal coverage state motorcycle helmet use laws	★★★★★	$	Medium	Short
1.2 Helmet use promotion programs	★	Varies	Unknown	Varies
1.3 Helmet law enforcement; noncompliant helmets	★	$	Unknown	Medium

2. Alcohol Impairment

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Alcohol impairment: detection, enforcement, and sanctions	★★★	Varies	Unknown	Varies
2.2 Alcohol impairment: communications	★	$$	Medium	Medium

3. Motorcycle Rider Licensing and Training

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Motorcycle rider licensing	★	$	High	Medium
3.2 Motorcycle rider training	★	$$	High	Varies

4. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Conspicuity and protective clothing	★	Varies	High	Medium
4.2 Other driver awareness of motorcyclists	★	Varies	High	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities

Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:

Long: more than one year

Medium: more than three months but less than one year

Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Motorcycle Helmets

1.1 Universal Coverage State Motorcycle Helmet Use Laws

Effectiveness: ★★★★★	Cost: $	Use: Medium	Time: Short

Motorcycle helmets are highly effective in protecting motorcycle riders' heads in a crash. Research indicates that helmets reduce motorcycle rider fatalities by 22 to 42% and brain injuries by 41 to 69% (Coben, Steiner, & Miller, 2007; Cummings, Rivara, Olson, & Smith, 2006; Deuterman, 2004; Liu, Ivers, Norton, Blows, & Lo, 2008; NHTSA, 2003; NHTSA, 2006a). A Cochrane Collaboration review of 61 studies concluded that risk reductions were on the high end of the ranges mentioned above, with higher quality studies indicating that the protective effect of helmets was about a 42% reduction in risk of fatality in a crash and 69% for risk of a head injury in a crash. This review found that there was insufficient evidence to determine the effect on neck or facial injuries, or the effects of various types of FMVSS 218 compliant helmets on injury outcomes (Liu et al., 2008). Others have found no evidence that helmets increase the risk of neck injuries (NCHRP, 2008, Strategy E1; NHTSA, 2000a; Ulmer & Preusser, 2003).

State universal helmet-use laws are effective at increasing helmet use. In 2011, observed compliant helmet use was 84% across States with universal helmet laws that cover all riders, and 50% across States with no law or laws covering only young riders (NHTSA, 2012a). DOT-compliant helmet use increased nationally from 54% in 2010 to 66% in 2011, and use of noncompliant helmets decreased from 14% in 2010 to 8% in 2011(NHTSA, 2012a). Additionally, helmet non-use decreased from 32% in 2010 to 26% in 2011 (NHTSA, 2012a).

The first universal helmet law was enacted in 1966. Universal laws were in effect in 47 States and the District of Columbia by 1975. After Federal penalties were eliminated in 1975 for States failing to have a universal law, about half the States repealed their laws. Several States have enacted or repealed helmet laws since then. The IIHS (2012b) summarizes the helmet law history in each State.

Use: As of June 2012, 19 States, the District of Columbia, Puerto Rico, and the U.S. Virgin and Northern Mariana Islands had helmet laws covering all riders. Three States (Illinois, Iowa, and New Hampshire) did not have motorcycle helmet laws (GHSA, 2012; IIHS, 2012a). Guam and most other States had laws covering only riders under a specified age, typically 18 or 21 (IIHS, 2012a).

Effectiveness: Studies in States that enacted universal helmet laws observed use rates of 90% or higher immediately after the laws became effective, compared to 50% or lower before the laws (Ulmer & Preusser, 2003, Section II). States that repealed universal helmet laws saw the opposite effect, as use rates dropped from above 90% to about 50% (Kyrychenko & McCartt, 2006; Preusser, Hedlund, & Ulmer, 2000, Section V; Ulmer & Preusser, 2003, Sections IV and V). Reenactment of a universal law in Louisiana (after a cycle of repeals and reenactments since 1968) resulted in an increase in use among riders involved in crashes, from 42% before reenactment to 87% following (Gilbert, Chaudhary, Solomon, Preusser, & Cosgrove, 2008).

The U.S. General Accountability Office (GAO) reviewed 46 methodologically sound studies of State helmet laws published before 1990. GAO concluded that motorcycle rider fatality rates were 20 to 40% lower with universal helmet laws (GAO, 1991; Ulmer & Preusser, 2003, Section II). Studies since 1990 confirm these results (Cummings et al., 2006; Houston & Richardson, 2008; Kyrychenko & McCartt, 2006; Morris, 2006; Ulmer & Northrup, 2005; Ulmer & Preusser, 2003, Section II).

Some States have helmet laws that only cover young riders. Helmet use is generally low in these States (GAO, 1991), and non-comprehensive laws do not translate into meaningful reductions in young rider fatalities rates (Brooks, 2010; Houston, 2007). Additionally, Weiss, Agimi, and Steiner (2010) compared the risk of traumatic brain injury among youth in States with limited-age helmet laws and States with universal helmet laws. They found a 37% increase in risk of traumatic brain injury requiring hospitalization for youth in States with partial coverage helmet laws compared to States with universal helmet laws. A reduction in fatality rates among all ages was estimated for partial coverage laws compared to no law by Houston & Richardson (2008), but the effect was much smaller (7% to 8%) than that for universal coverage (22% to 33%). Moreover, when Florida eliminated the requirement that all motorcycle riders 21 and older wear helmets, there was an 81% increase in motorcyclist fatalities (Ulmer & Northrup, 2005). Fatalities even increased among riders under 21 who were still covered by the helmet law.

Hospital admissions and treatment costs have also increased following repeal of universal helmet laws (Derrick and Faucher, 2009; GAO, 1991). Almost half of all motorcyclists admitted to hospitals lacked sufficient health care insurance or were covered by government services, so the public ultimately shares many of these costs, as well as a greater long-term burden of care (Derrick and Faucher, 2009; GAO, 1991). Hence, the preponderance of evidence is that universal coverage laws provide greater safety and cost benefits than laws that cover only a specific age group.

Costs: Once legislation requiring helmet use has been enacted, implementation costs are minimal. The inevitable controversy surrounding the legislation will help to publicize the new law extensively. Motorcycle helmet laws can be enforced during regular traffic patrol operations because helmet use is easily observed.

Time to implement: A universal helmet use law can be implemented as soon as the law is enacted.

Other issues:

- **Opposition to motorcycle helmet laws:** Any effort to enact a universal helmet law can expect immediate, well-coordinated, and highly political opposition (NHTSA, 2003). Helmet law opponents claim that helmet laws impinge on individual rights. They also claim that helmets interfere with motorcycle riders' vision or hearing, though research shows that these effects are minimal (NHTSA, 1996). See Jones and Bayer (2007) for a history of opposition to helmet laws in the United States. Derrick and Faucher (2009) also discuss national policy, organized opposition, and helmet law changes over the past four decades.

- **Noncompliant helmets:** Some riders in States with universal helmet laws wear helmets that do not comply with FMVSS 218 (NHTSA, 2012a). See the discussion in Chapter 5, Section 1.3.

1.2 Motorcycle Helmet Use Promotion Programs

Effectiveness: ★	Cost: Varies	Use: Unknown	Time: Varies

A few States without universal motorcycle helmet use laws have attempted to promote helmet use through communications and outreach campaigns. Thus far there is no evidence of effectiveness for efforts to educate and promote helmet use among motorcyclists in the absence of universal helmet laws, unless the publicity helps to gain enactment of such laws (NCHRP 2008). A parallel experience is evident in the efforts to increase seat belt use through educational and promotional efforts prior to the enactment of laws requiring seat belt use. Years of educational and promotional campaigns did little to increase seat belt use. It was only after laws requiring use were enacted that seat belt use began to rise substantially (NCHRP, 2008).

The MSF, GHSA, NHTSA, and other groups encourage helmet use. NHTSA has developed helmet use promotion brochures, flyers and public service announcements suitable for television and radio that are available online. NCHRP (2008) describes elements that should be included in a campaign should one be undertaken.

Use: Baer, Ayotte, and Baldi (2010) distributed self-report surveys to States on their motorcycle safety programs and received responses from 45 States. Thirty-three of the 43 States that responded to a question on helmet use promotion, both with and without helmet laws, indicated they actively promote helmet use, but the nature and extent of these promotions is unknown. Only one State reported using paid broadcast media spots.

Effectiveness: There appear to be no formal evaluations of the effect of helmet use promotion programs in States without universal helmet laws (NCHRP, 2008). However, helmet use remains substantially lower in States without universal helmet laws than in States with such laws (NHTSA, 2012a).

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Helmet use promotion material is available from various sources including MSF, NHTSA (2003), and from States that have conducted these campaigns.

Time to implement: A good campaign, including market research, material development, and message placement, will require at least 6 months to plan and implement. If material from NHTSA or elsewhere are used, less time may be required.

1.3 Motorcycle Helmet Law Enforcement: Noncompliant Helmets

Effectiveness: ★	Cost: $	Use: Unknown	Time: Medium

Law enforcement officers in universal helmet law States easily can observe and cite motorcycle riders who are not wearing helmets. This likely explains why helmet use rates are high in universal helmet law States (Chapter 5, Section 1.1). In addition, many States motorcyclists to wear helmets that comply with FMVSS 218, and Federal regulations require all motorcycle helmets sold in the United States to meet or exceed the FMVSS 218 standards. Helmets that do not meet the FMVSS 218 performance requirements are considered noncompliant. Use of noncompliant helmets by all riders decreased from 14% in 2010 to 8% in 2011 according to a nationally representative observational survey of helmet use (NHTSA 2012a). Simultaneously, use of compliant helmets increased from 54% to 66%.

Motorcycle riders wearing noncompliant helmets are essentially no safer than if they wore no helmets at all (NHTSA, 2007b). In addition to offering no energy-absorbing materials, a noncompliant helmet often covers only a portion of the rider's head and has inadequate or unused chin straps so the helmet is not likely to stay on the rider's head in a crash (NHTSA, 2007b). Some noncompliant helmets also have spikes or other protrusions, making them fairly easy to identify as noncompliant. A NHTSA brochure discusses how to identify noncompliant helmets (NHTSA, 2004).

The challenge of motorcycle helmet law enforcement in States requiring FMVSS 218-compliant helmets is to actively identify and cite motorcycle riders wearing noncompliant helmets. Identifying a noncompliant helmet is easier than proving that it is noncompliant. Compliant helmets are formally identified by a DOT sticker on the back of the helmet. However, counterfeit DOT stickers are easily available and are found on many noncompliant helmets (although some noncompliant helmets may have labels that say they are novelty helmets and not motorcycle helmets). As a result, it is difficult to obtain a conviction for a noncompliant helmet citation in some courts (NHCRP, 2008, Strategy E1). In May 2011, NHTSA issued a Final Rule (effective May 2013) to strengthen helmet labeling requirements and to make it easier to prove that a helmet is noncompliant. NHTSA also prepared a video clip for motorcyclists and law enforcement demonstrating how to identify compliant and noncompliant helmets and how to choose a helmet that fits properly (NHTSA, 2006b).

Use: Sixteen of 43 States that reported to Baer et al. (2010) indicated that they conduct law enforcement activities to identify and cite noncompliant-helmet wearers, but only States having universal helmet laws would implement such programs (19 states and Washington DC as of June 2012). In 2007, the New York State Police piloted a motorcycle safety checkpoint enforcement program. In the pilot effort, 225 motorcycles of 280 passing through the checkpoint were inspected. Traffic citations were issued to 104 motorcyclists; the most common citation (41 issued) was for operating with a non-compliant helmet (Salmon, 2008).

Effectiveness: The effectiveness of an active helmet law enforcement program on noncompliant helmet use has not been evaluated.

Costs: Since helmet laws can be enforced during regular traffic patrols, the only costs will be for training law enforcement officers, prosecutors, and judges to identify noncompliant helmets.

Time to implement: An active helmet-law enforcement program requires planning of an effective enforcement strategy, training for law enforcement to identify noncompliant helmets and carry out the enforcement, and communications and training for prosecutors and judges to assure that citations will be prosecuted and adjudicated. This training will require 4 to 6 months to implement**.** Publications are available to help with non-compliant helmet identification, but other program aspects and training may need to be developed or adapted. These elements may require 6 months or longer.

2. Alcohol Impairment

2.1 Alcohol-Impaired Motorcyclists: Detection, Enforcement, and Sanctions

Effectiveness: ★★★	Cost: Varies	Use: Unknown	Time: Varies

Alcohol impairment is a substantial problem for motorcycle riders, even more than for drivers of other motor vehicles. In 2009, 29% of motorcycle riders involved in fatal crashes had BACs of .08 or higher, compared to 23% for passenger car drivers and 23% for light-truck drivers (NHTSA, 2011a). Even higher proportions of fatally injured 35- to 49-year-old riders had BACs of .08 or higher (36% for riders 35 to 39, 41% for riders 40 to 44, 38% for riders 45 to 49; NHTSA, 2011a). An additional 7% of motorcycle riders in fatal crashes had at least some measurable level of alcohol in their blood (BAC .01 to .07 g/dL). Fatally injured motorcycle riders with BAC levels .08 g/dL or higher were less likely to wear helmets than were sober riders (NHTSA, 2011a). Furthermore, in 2009 42% of riders killed in single-vehicle crashes had BACs of .08 or above, and on weekend nights this figure climbed to 63% (NHTSA, 2012b). The 2007 National Roadside Survey similarly found that 5.6% of motorcycle riders on weekend nights had BACs of .08 or above, as compared to 2.3% of passenger vehicle drivers (Lacey et al., 2009a).

Motorcyclists are included in and affected by the comprehensive strategies to reduce alcohol-impaired driving discussed in detail in Chapter 1. However, some law enforcement and sanction strategies may be especially useful for motorcyclists, while others may be less effective.

Law enforcement officers on traffic patrol use characteristic driving behaviors, or cues, to identify drivers who may be impaired by alcohol. Some of the cues for motorcycle riders, such as trouble maintaining balance at a stop, are different from those for cars and trucks. Stuster (1993) identified and validated 14 cues useful for identifying alcohol-impaired motorcycle riders. NHTSA prepared a brochure, a law enforcement training video, and a pocket detection guide discussing the cues (NHTSA, 2000b). The cues for motorcycle riders are part of the Standardized Field Sobriety Tests training given to all law enforcement officers.

Vehicle impoundment or forfeiture can be an effective deterrent to drinking and driving for all drivers (see Chapter 1, Section 4.3). It may be even more effective for motorcyclists. Research by Becker, McKnight, Nelkin, and Piper (2003) confirmed earlier findings that many motorcyclists do not find traditional impaired driving sanctions such as fines and license suspension to be effective deterrents, although self-reported beliefs may not reflect actual effectiveness of these other sanctions. However, motorcyclists tended to be highly concerned for the safety and security of their motorcycles.

These findings suggest a potentially effective strategy to reduce alcohol-impaired motorcycling: highly publicized enforcement using officers trained in identifying impaired motorcycle riders and other motor vehicle drivers, with offender sanctions including vehicle impoundment or forfeiture. This strategy would treat motorcyclists on an equal footing with other vehicle drivers in impaired-driving enforcement and publicity.

Use: Thirty-two of 43 responding States reported having programs to focus on spotting impaired motorcyclists or on enforcing laws related to operating motorcycles while impaired (Baer et al., 2010). NHTSA (2006a) provides examples and links of State programs that distribute the NHTSA cue cards and brochures widely to law enforcement (Illinois), present this information in a Web-based seminar for officers (Minnesota), and regularly establish high-visibility law enforcement presence at major rider events (Ohio, Wisconsin).

Effectiveness: Some agencies have reported some success in using the cues for identifying alcohol-impaired motorcycle riders, but no evaluation data on the extent of their use are available (NCHRP, 2008, Strategy B3). Although evidence is lacking for effects of enforcement and sanctions on impaired motorcycle riding, sobriety checkpoints, and saturation patrols have proven to be effective for reducing impaired driving and crashes generally. See Chapter 1 for more information on enforcement strategies and other tools.

Costs: Law enforcement training costs are low and training material is available. Enforcement itself can be carried out during regular traffic patrol and as part of all impaired driving enforcement programs. A major campaign including alcohol-impaired motorcyclists may require additional costs for publicity.

Time to implement: Law enforcement training can be conducted quickly. A major campaign will require 4 to 6 months to plan and implement.

Other issues:

- **BAC limits:** BAC levels as low as .05 g/dL caused some detectable levels of impairment, primarily in reaction time, among experienced riders in tests on controlled courses (Creaser et al., 2007). Puerto Rico passed a law in 2007 lowering the BAC limit for motorcyclists to .02.
- **Drugs other than alcohol:** Drugs other than alcohol can impair motorcycle riders. Potentially impairing drugs include over-the-counter and prescription medications as well as illegal drugs. The 2007 National Roadside Survey reported that 31.9% of nighttime weekend motorcycle riders who provided oral fluid and/or blood samples tested positive for drugs (illegal drugs or medications), as compared to 16.5% of passenger car drivers (Lacey et al., 2009b). The extent to which various drugs impair driving performance or contribute to crashes is not well understood, however, for either four-wheeled vehicles or for motorcycles. Furthermore, individual differences in metabolism of drugs and level of impairment, as well as multiple-drug use complicate the issue (Compton, Vegega, & Smither, 2009). (See Compton et al.'s [2009] Report to Congress on drug-impaired driving for a discussion of current knowledge and recommendations for improving States data and records systems and statutes.) Law enforcement should consider drugs as potential impairing agents for motorcycle riders just as for other vehicle operators. See also Chapter 1, Section 7 on drug-impaired driving.
- **Targeted enforcement:** As with other crash problems, better identification of problem areas (either impaired riding or impaired riding crashes) and targeting enforcement to such locations, events, or times could improve enforcement effectiveness.

2.2 Alcohol-Impaired Motorcyclists: Communications and Outreach

Effectiveness: ★	Cost: $$	Use: Medium	Time: Medium

Many States have conducted communications and outreach campaigns directed at drinking and riding. See NHTSA (2006a) and NCHRP (2008, Strategy B1) for more information and links. Organizations including AMA and MSF have produced campaigns and material on drinking and riding. Again, see NHTSA (2006a) and NCHRP (2008) for strategies for implementation, examples, and links to materials. There are few evaluations of the effectiveness of any of these campaigns at any level, from awareness to knowledge and attitude change to any effect on motorcyclists' drinking and riding behavior. The experience of drinking and driving campaigns directed at all drivers suggests that they are unlikely to have a positive effect unless they are carefully researched and planned, well funded, well executed, achieve high levels of target audience exposure (perhaps using paid advertising), use high-quality messages that are pre-tested for effectiveness, and are conducted in conjunction with enforcement activities directed at impaired motorcyclists. See Chapter 1, Section 5.2, for further discussion.

A focus group study (Becker et al., 2003) examined motorcyclists' attitudes, beliefs, and behaviors regarding drinking and riding. It concluded that many motorcyclists have strong feelings of freedom, independence, and individual responsibility and believe that drinking motorcyclists endanger only themselves. Consequently, they believe that government efforts to discourage drinking and riding are inappropriate. These beliefs also limit some motorcyclists' willingness to take actions to prevent others from riding while impaired.

A program, "Riders Helping Riders," targets the expressed willingness of some motorcycle riders to help other riders by encouraging them to intervene to prevent other motorcycle riders from riding impaired and to create a stronger safety culture among motorcyclists. This program is based on the beliefs and attitudes of riders from focus group research (McKnight & Becker 2007a, 2007b; McKnight, Becker, & Tippetts, 2008), and is available on a CD for individual and group use. The material was pilot-tested in Georgia. Riders' attitudes and intentions toward intervening seemed to improve based on surveys taken before and immediately after training. Longer-term evidence of attitude change, interventions actually carried out, or definitive safety effects from behavioral changes will require exposure to large numbers of riders and longer follow-up of crashes (McKnight et al., 2008).

Another program called "Green-Yellow-Red" was recently developed and tested in Wisconsin (Aguilar & Delehanty, 2009). The campaign sought to educate motorcycle riders about the dangers of drinking and riding, encourage them to make safer choices, and provide impaired motorcycle riders with secure storage of their motorcycles so that they could find safe transport home. A coalition was established that included motorcycle riders, tavern owners, law enforcement, and local businesses, and substantial media attention was obtained at the program kick-off. While there is evidence that riders were willing to leave their motorcycles in secure storage containers, only small changes in rider behavior and alcohol-related motorcycle crashes were observed following the program (Aguilar & Delehanty, 2009).

Rider groups can play critical roles in planning and implementing activities to reduce drinking and riding. Some State and local rider groups sponsor alcohol-free events or adopt alcohol-free policies. As examples, the Fox Valley, Wisconsin, Harley Owners Group (H.O.G.) chapter has an alcohol-free policy for all organized rides and Illinois American Bikers Aimed Toward Education (ABATE) sponsors alcohol-free rides (NHTSA, 2006a, Section 1).

Use: Many States have conducted anti-drinking-and-riding campaigns (NHTSA, 2006a; NCHRP, 2008, Strategy C1), but the total number of States that have done so is not known. Some examples of States campaigns include Connecticut's "Open the Throttle, Not the Bottle" and Minnesota's "Drinking and Riding: A Really Bad Idea." Many other States have brochures and other material. It also is not known how many States have included messages directed to motorcyclists in their overall alcohol-impaired driving campaigns. However, motorcycle riders are now included in the "Drunk Driving. Over the Limit. Under Arrest" paid media spots.

Effectiveness: There are no evaluations of the safety effectiveness of any drinking and riding campaigns.

Costs: A good campaign will require substantial funds to conduct market research, design and test messages, and place campaign material where it will reach motorcyclists frequently.

Time to implement: A good campaign will require at least 6 months to research, design, test, and implement.

3. Motorcycle Rider Licensing and Training

3.1 Motorcycle Rider Licensing

Effectiveness: ★	Cost: $	Use: High	Time: Medium

All 50 States the District of Columbia, and Puerto Rico require motorcycle riders to obtain a motorcycle operator license or endorsement before they ride on public highways (MSF, 2010). The goal of licensing is to assure that motorcycle riders have the minimum skills needed to operate motorcycles safely (NHTSA, 2000a).

Operator licensing faces three issues.

- Many motorcycle riders are not properly licensed. In 2009, 22% of motorcycle riders involved in fatal crashes did not have valid motorcycle licenses, compared to 12% of passenger vehicle drivers who were not properly licensed (NHTSA, 2011a). Licensing systems in some States provide no incentive to become fully licensed because learner's permits may be renewed indefinitely (NCHRP, 2008, Strategy C3).
- State motorcycle licensing practices vary substantially. Most States have learner's permits requiring only vision and knowledge tests. A motorcycle rider with a learner's permit can ride only in restricted circumstances, typically some combination of no passengers, only during daylight hours, and only with the supervision of a fully licensed motorcyclist. A skill test is required for full licensure. Two-thirds of the States use one of three tests developed by the MSF and American Association of Motor Vehicle Administrators, while one-third use their own tests. Most States will waive the skill test, and sometimes the knowledge test, for motorcyclists who have completed approved motorcycle rider training courses. See Motorcycle Safety Foundation (2010) for a summary of each State's licensing requirements and procedures and NCHRP (2008, Strategy C1) for brief summaries of the major skill tests currently in use.
- The goal of motorcycle operator licensing is to assure that motorcyclists have basic riding skills, but its effectiveness is not known. This is perhaps not surprising given the variability of licensing tests and procedures. NAMS recommends research to "ensure that licensing tests measure skill and behaviors required for crash avoidance" (NHTSA, 2000a). NCHRP (2008, Strategies C2 and C3) describes strategies to couple training and licensing to help ensure that riders are both trained and obtain the necessary endorsements, but notes that there are no evaluations of whether increasing the proportion of motorcycle riders who are validly licensed would reduce motorcycle crashes or injuries.

Baer, Cook, and Baldi (2005) reviewed and summarized each State's motorcycle education and licensing programs and practices. A companion report (Baer, Baldi, & Cook, 2005) describes training and licensing programs and actions to promote training and licensing. Under a cooperative agreement with NHTSA, AAMVA has updated its *Motorcycle Operator Licensing System* and *Integrating Motorcycle Rider Education and Licensing* manuals, by publishing the *Guidelines for Motorcycle Operator Licensing* (GMOL). The GMOL provides guidelines for State motorcycle licensing programs (Hanchulak & Robinson, 2009).

States should encourage all motorcycle riders to be validly licensed. The NAMS (NHTSA, 2000a) recommends that States:

- provide enough convenient testing times and locations to accommodate the demand, for example by offering testing during evening hours;
- waive skill and knowledge tests for graduates of approved motorcycle rider training courses;
- actively enforce motorcycle operator licensing requirements;
- promote motorcycle rider licensing; and
- provide motorcycle-specific training to licensing examiners.

The NCHRP (2008, Strategy C3) describes how Maryland and Minnesota used some of these strategies to increase proper licensing for motorcycle riders. Maryland used the additional strategy of comparing their vehicle registration and driver licensing files. A letter was sent to each owner of a registered motorcycle who did not have a motorcycle operator's license. The letter reminded each registered owner that a motorcycle endorsement was required of anyone operating the registered motorcycle. This quick and inexpensive strategy caused 1,700 owners to become licensed within 4 months. A randomized controlled experiment of this intervention suggested that while the method did increase licensure, a large percentage remained unlicensed (Braver et al., 2007). Effective July 22, 2007, the State of Washington added an authorization to impound vehicles operated by drivers without a proper endorsement (including, but not limited to, motorcycles).

Maryland and Pennsylvania have "one-stop shops" that provide a motorcycle endorsement immediately upon successful completion of a State-approved motorcycle rider training course or test, without having to wait after receiving a permit. For Pennsylvania's procedures, see www.pamsp.com/CourseInfo_Basic.aspx.

Use: All States require motorcycle riders to obtain a motorcycle license or endorsement to ride on public highways. Less than half of responding States indicated that they enforce laws relating to improperly licensed motorcyclists (Baer et al., 2010).

Effectiveness: The effectiveness of current licensing and testing on crashes and safety has not been evaluated.

Costs: Most States charge a small fee for the motorcycle licensing tests (MSF, 2010). The costs of changing the licensing tests and procedures depend on the extent of changes and the amount of retraining needed for licensing examiners as well as what portion of costs are covered by licensing fees.

Time to implement: Developing new policies to encourage higher rates of full motorcycle licensure (including limiting the number of times a provisional license may be renewed, administrative practices such as adding testing times and locations, or training motorcycle license examiners), or procedures such as waiving the skills test for those who have passed an approved training course, would likely require 6 to 12 months to implement. Enforcement of motorcycle licensing requirements could occur more readily, if requirements for full licensure are clear enough to enforce.

Other issues:

- **Graduated driver licensing (GDL):** The NAMS recommended that States enhance motorcycle licensing practices by incorporating and evaluating use of GDL concepts. Most States employ graduated driver licensing for beginning automobile drivers. Under GDL, new drivers must pass through learner's permit and provisional license stages before becoming fully licensed. A learner's permit allows driving only while supervised by a fully licensed driver and a provisional license allows unsupervised driving under certain conditions, such as limiting the number of passengers and prohibiting driving at night. Many States place restrictions similar to these on motorcycle riders with a learner's permit or younger than a specified age (MSF, 2010). Mayhew and Simpson (2001) describe motorcycle rider GDL programs in California, Maryland, and South Dakota. For example, the California GDL prohibits passengers or nighttime riding during the learner permit stage, and requires all people under 25 who are seeking a motorcycle license or endorsement to take the State-sponsored motorcycle rider training course. According to the Motorcycle Safety Foundation (2010), 5 of the 31 States responding to their 2010 survey had some form of graduated licensing. GDL programs for automobile drivers have been shown to be effective in reducing crashes (Hedlund, Shults, & Compton, 2003, 2006). Evaluations in New Zealand and evidence from Quebec suggest that they may do the same for motorcyclists (Mayhew & Simpson, 2001). NHTSA's *Guidelines for Motorcycle Operator Licensing* includes a model graduated licensing program for motorcycle riders (Hanchulak & Robinson, 2009). In Utah, motorcycle endorsements are restricted to motorcycles no larger than the size of the motorcycle used for the skills test, or used during the approved State training course (substitute). The endorsement can be changed by testing on a larger size motorcycle.

3.2 Motorcycle Rider Training

Effectiveness: ★	Cost: $$	Use: High	Time: Varies

Motorcycle rider education and training has been thoroughly integrated into all aspects of motorcycle safety. The National Agenda for Motorcycle Safety encourages training (NHTSA, 2000a, Rider Education and Training). NHTSA's Motorcycle Safety Program Plan states that "motorcycle rider education provides an opportunity for novice riders to learn the basic skills necessary to operate a motorcycle safely and for experienced riders to refresh and refine their techniques" (p.17) and recommends that States conduct frequent and timely education and training at sites that are accessible throughout the State (NHTSA, 2006b). Congress established grants to States to support rider training and motorcyclist awareness programs under Section 2010 of SAFETEA-LU (NHTSA, 2006b). NCHRP (2008, Strategy C2) further recommends that States evaluate crash experience, compare data and crash scenarios with training and licensing practices, and make adjustments as needed to ensure practices are effectively targeting crash problems. This requires cooperation on the part of multiple agencies, including those responsible for collecting and analyzing crash data and those responsible for training and licensing.

Forty-seven States have State-operated and legislated education and training programs and the other 3 have privately operated programs (Baer, Cook, & Baldi, 2005). Sixty percent of the 44 States that responded to a survey question from Baer et al. (2010) reported they were able to accommodate all riders seeking training within a calendar year. Training also is provided by some rider organizations (for example, some ABATE and Gold Wing groups), manufacturers (Harley-Davidson), and other private providers. Many States encourage training either by requiring it for all motorcycle operators or those under a specified age, or by waiving some testing requirements for motorcycle riders who complete an approved training course (Baer, Cook, and Baldi, 2005). Most entry-level training uses the *Basic RiderCourse* curricula developed by MSF. The *Experienced RiderCourse* suite (ERC) is offered to riders with some previous experience or for seasoned riders who want additional training; however, the ERC represents a very small part of total training provided.

However, it is not at all clear what constitutes good rider education and training, nor whether current training reduces crashes. As to content, the National Agenda concluded that "it is assumed, yet unknown, that the current [rider training] programs are teaching necessary skills to survive in traffic" (NHTSA, 2000a, Rider Education and Training). It recommended that a "uniform, educationally sound" curriculum be adopted. NHTSA (2003, p. 13) reported wide differences in training program content and administration from State to State. Baer, Cook, and Baldi (2005) summarize the curricula offered in each State. Emerging evidence suggests that in addition to teaching motorcycle control skills, better programs would also train riders to recognize potentially hazardous riding situations and encourage riders to assess their own risks and limitations, and ride within those constraints (e.g., Clarke, Ward, Bartle, & Truman, 2007; Elliott, Baughan, & Sexton, 2007). In response to this situation, NHTSA supported the development of Model National Standards for Entry Level Rider Training, released in August 2011. These Model Standards detail content that should be included in all motorcycle rider training courses. States are encouraged to go beyond the standards to address State-specific crash needs (NHTSA 2011b).

States should do their best to provide motorcycle training on a timely basis to all who wish to take it. See Baer, Baldi, and Cook (2005) and NHTSA (2006a) for examples of successful methods to use training capacity more effectively, including creative scheduling, centralized on-line registration systems, and use of private providers. Under Section 2010 of SAFETEA-LU, Congress established grants to States to support rider training (NHTSA, 2006b).

Use: Most States offer training to both experienced and beginning motorcycle riders. For more information about the features of training and education programs offered by the States, see Baer, Ayotte, and Baldi (2010).

Effectiveness: Kardamanidis et al. (2010) evaluated the results of 23 studies for a Cochrane Review and found conflicting evidence with regard to the effectiveness of motorcycle rider training in reducing crashes or offenses. Due to the poor quality of available studies (most of the studies had likely selection and detection bias) the authors were unable to draw any conclusions about its effectiveness. However, data suggests that having mandatory pre-license training for motorcyclists may reduce crashes and offenses by discouraging motorcycle riding, thus limiting exposure.

Costs: Rider training programs are funded in part by the States and in part by fees paid by the students who take them. State costs per student in 2008 ranged from less than $19 to $250, and averaged $129 for State-sponsored basic courses according to data available from 14 States responding to the most recent SMSA survey. Costs to students in the form of tuition or fees ranged from zero to $340 and averaged $150 (SMSA, 2008). Many States offset some or all of their costs through motorcycle license or student registration fees.

Time to implement: Rider training currently is conducted in all States. Training capacity is limited by the number of available training sites (a broad expanse of paved surface is required), qualified instructors, and motorcycles for students to use during training. Some measures to increase capacity can be implemented quickly while others may take 6 to 12 months. See the SMSA Annual Surveys for information on capacity, numbers of students trained, and other program information, by State (SMSA, 2008).

Other issues:

- **Training for experienced motorcyclists:** Many States offer the ERC suite (*Experienced RiderCourse*) for experienced motorcycle riders. Some States, such as Idaho and Oregon, offer their own experienced rider courses. The courses have not been evaluated.
- **Training for other motorcycle configurations (three-wheeled motorcycles and motorcycles pulling trailers**): Several motorcycle organizations offer courses addressing these special motorcycle configurations. The courses have not been evaluated.

4. Communications and Outreach

4.1 Communications and Outreach: Conspicuity and Protective Clothing

Effectiveness: ★	Cost: Varies	Use: High	Time: Medium

Motorcycle riders should wear clothing that provides both protection and visibility. FMVSS 218 helmets (Chapter 5, Sections 1.1-1.3) with face shields protect the eyes from wind and foreign objects in addition to protecting the head in a crash. Well-constructed jackets, pants, boots, and gloves can prevent abrasions and bruises. If made of impact-resistant material, they even may prevent arm and leg fractures or serious torso and spinal cord injuries (NHTSA, 2000a). The benefits of protective clothing, in particular protective clothing equipped with body armor, was further confirmed by a series of studies of Australian motorcyclists involved in crashes (de Rome et al., 2011; de Rome et al., 2012).

A common perception among riders is that a frequent cause of motorcycle crashes involving other vehicles is that other vehicle drivers do not see the motorcycle. The 1981 Hurt et al. (1981) study from the United States and a 2007 study from the U.K. (Clarke et al., 2007) report that right-of-way collisions involving other motorists are more frequently the fault of the other motorist. Failure of the other motor vehicle driver to perceive the motorcyclist seems to occur in a significant portion of these types of crashes (Clarke et al., 2007).One easy way to increase motorcycle conspicuity is through lighted headlights. Most motorcycles manufactured since 1979 have headlights that turn on automatically when the vehicle is started (NCHRP, 2008, Strategy D2). Additionally, 23 States require daytime headlight use for all motorcycles manufactured since 1980 (Pennsylvania requires daytime headlight use for motorcycles manufactured since 1986; MSF, 2011).

A second way to increase conspicuity is to wear brightly colored clothing, use white or bright-colored helmets (for increased visibility during daylight), and incorporate retro-reflective materials or devices (for increased visibility at night). Research studies confirm that motorcyclists wearing conspicuous clothing or helmets are less likely to be involved in a crash (Wells et al., 2004; NCHRP, 2008, Strategy D1).

Other methods mentioned in the introduction of this chapter include auxiliary head and brake lights, flashing headlights, and other vehicle technologies that enhance conspicuity, but effects on crashes have not been studied. Adoption of these technologies might be usefully promoted among the motorcycling community, may require changes in laws if visibility enhancing technologies are restricted by States, and may also involve working with manufacturers and producers of motorcycles and auxiliary devices (NCHRP, 2008).

There are no data on how many motorcycle riders wear various types of protective clothing (other than helmets) or use auxiliary devices. Helmet manufacturers and distributors report that more than half the helmets sold for street use are black and the predominant color of motorcycle clothing is black (NCHRP, 2008, Strategy D1).

Communications and outreach campaigns promoting protective and conspicuous clothing have been conducted by States and by motorcyclist organizations. NCHRP (2008, Strategy D1) provides examples of material from Oregon and the MSF and references to additional material from the SMSA, and the Gold Wing Road Riders Association.

Use: Of the 44 States responding to a survey question, 33 reported encouraging conspicuity-enhancing clothing and helmets to enhance motorcyclists' visibility (Baer et al., 2010). The extent or nature of these efforts is unknown.

Effectiveness: The use of high-visibility clothing and protective gear enhances safety, but there are no known evaluations of the effectiveness of campaigns to increase the use of protective and conspicuous clothing.

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Information promoting protective and conspicuous clothing is available from various sources including MSF, other motorcyclist organizations, and States that have conducted these campaigns (NCHRP, 2008, Strategy D1).

Time to implement: A good campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

4.2 Communications and Outreach: Other Driver Awareness of Motorcyclists

Effectiveness: ★	Cost: Varies	Use: High	Time: Medium

When motorcycles crash with other vehicles, the other vehicle driver usually violates the motorcyclist's right-of-way (Clarke et al., 2007; Elliott et al., 2007; NCHRP, 2008, Strategy F3; NHTSA, 2000a). Motorcycles and motorcyclists are smaller visual targets than cars or trucks, resulting in low conspicuity (see Chapter 5, Section 4.1). Also, drivers may not expect to see motorcycles on the road (NCHRP, 2008, Strategy F3; NHTSA, 2000a). Clarke et al (2007) reported that even when motorcyclists were using headlights and high-conspicuity clothing, drivers sometimes failed to notice them.

Several States have conducted communications and outreach campaigns to increase other drivers' awareness of motorcyclists. Typical themes are "Share the Road" or "Watch for Motorcyclists." Some States build campaigns around "Motorcycle Awareness Month," often in May, early in the summer riding season. Many motorcyclist organizations, including MSF, SMSA, the Gold Wing Road Riders Association, and State and local rider groups, have driver awareness material available. See NHTSA (2006a, Section 5) and NCHRP (2008, Strategy F3) for links and references. Some organizations also make presentations on drivers' awareness of motorcyclists to driver education classes.

Congress established grants to States to support motorcyclist awareness programs and rider training under Section 2010 of SAFETEA-LU (NHTSA, 2006b). As required by SAFETEA-LU, NHTSA developed model language on sharing the road safely with motorcyclists. The model language is appropriate for traffic safety education courses, driver manuals, and other communication and outreach activities (NHTSA, 2007a). NHTSA developed a "Share the Road" program planner for use by States, communities, and the motorcycling community (see www.trafficsafetymarketing.gov/motorcycles/ShareTheRoad/index.cfm).

Use: Thirty-six of 44 States that responded to a survey question reported that they communicate about ways for drivers to increase their awareness of motorcycles and motorcyclists (Baer et al., 2010). NHTSA (2006a, Section 5) and NCHRP (2008, Strategy F3) provide examples or links to campaigns from a dozen States.

Effectiveness: There are no evaluations of the effectiveness of campaigns to increase driver awareness of motorcyclists (NCHRP, 2008, Strategy F3).

Costs: Good communications and outreach campaigns can be expensive to develop and implement: see Chapter 2, Section 3.1. Motorcyclist awareness material is available from various sources including the MSF, other motorcyclist organizations, and States that have conducted these campaigns (NCHRP, 2008, Strategy F3).

Time to implement: A good campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

Motorcycle Safety References

Aguilar, M., & Delehanty, H. (2009). *A Social Marketing Initiative to Reduce Impaired Motorcycle Operation*. (Report No. DOT HS 811 095). Washington, DC: National Highway Traffic Safety Administration. Available at www.ridesmartflorida.com/images/projectgreenyellowred.pdf

Baer, J. D., Ayotte, K., & Baldi, S. (2010). *Evaluation of State Motorcycle Safety Programs*. (Report No. DOT HS 811 269). Washington, DC: National Highway Traffic Safety Administration.
Available at www-nrd.nhtsa.dot.gov/Pubs/811269.PDF

Baer, J. D., Baldi, S., & Cook, A. L. (2005). *Promising Practices in Motorcycle Rider Education and Licensing*. (Report No. DOT HS 809 922). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/MotorcycleRider/

Baer, J. D., Cook, A. L., & Baldi, S. (2005). *Motorcycle Rider Education and Licensing: A Review of Programs and Practices.* (Report No. DOT HS 809 852). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/McycleRiderWeb/pages/index.htm

Baer, J., & Skemer, M. (2009). *Review of State Motorcycle Safety Program Technical Assessments.* (Report No. DOT HS 811 082). Washington, DC: National Highway Traffic Safety Administration. Available at www-nrd.nhtsa.dot.gov/Pubs/811082.PDF

Bayly, M., Regan, M., & Hosking, S. (2006). *Intelligent Transport Systems and Motorcycle Safety*. (Report No. 260). Victoria, Australia: Monash University Accident Research Centre. Available at www.monash.edu.au/muarc/reports/muarc260.pdf

Becker, L. R., McKnight, A. S., Nelkin, V. S., & Piper, D. L. (2003). *Drinking, Riding, and Prevention: A Focus Group Study.* (Report No. DOT HS 809 490). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/people/injury/pedbimot/motorcycle/drinkrideprevent/DrinkRidePrevention.pdf

Braver, E. R., Kufera, J. A., Volpini, K. D., Lawpoolsri, S., Joyce, J. J., Alexander, M. T., & Ellison-Potter, P. (2007). Persuasion and licensure: A randomized controlled intervention trial to increase licensure rates among Maryland motorcycle owners. *Traffic Injury Prevention, 8*, 39-46.

Brooks, E., Naud, S., & Shapiro, S. (2010). Are youth-only motorcycle helmet laws better than none at all? *American Journal of Forensic Medicine and Pathology, 31,* 125-129.

Centers for Disease Control and Prevention. (2011). *Motorcycle Safety: How to Save Lives and Save Money*. Atlanta, GA: Author. Available at www.cdc.gov/motorvehiclesafety/pdf/mc2012/MotorcycleSafetyBook.pdf

Clarke, D. D., Ward, P., Bartle, C., & Truman, W. (2007). The role of motorcyclist and other driver behaviour in two types of serious accident in the UK. *Accident Analysis and Prevention*, *39,* 974-981.

Coben, J. H., Steiner, C. A., & Miller, T. R. (2007). Characteristics of motorcycle-related hospitalizations: Comparing states with different helmet laws. *Accident Analysis and Prevention, 39*, 190-196.

Compton, R., Vegega, M., & Smithers. D. (2009) *Drug-Impaired Driving: Understanding the Problem and Ways to Reduce It: A Report to Congress*. (Report No. HS 811 268). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/staticfiles/nti/pdf/811268.pdf

Creaser, J. I., Ward, N. J., Rakauskas, M. E., Boer, E., Shankwitz, C., & Nardi, F. (2007). *Effects of Alcohol on Motorcycle Riding Skills.* (Report No. DOT HS 810 877). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/HS810877.pdf

Cummings, P., Rivara, F. P., Olson, C. M., & Smith, K. M. (2006). Changes in traffic crash mortality rates attributed to use of alcohol, or lack of a seat belt, air bag, motorcycle helmet, or bicycle helmet, United States, 1982-2001. *Injury Prevention, 12*, 148-154.

Derrick, A. J. & Faucher, L. D. (2009). Motorcycle helmets and rider safety: A legislative crisis. *Journal of Public Health Policy, 30,* 226-242.

De Rome, L., Ivers, R., Fitzharris, M., Du, W., Haworth, N., Heritier, S., & Richardson, D. (2011). Motorcycle protective clothing: Protection from injury or just the weather? *Accident Analysis & Prevention 43*, 1893-1900.

De Rome, L., Ivers, R., Fitzharris, M., Haworth, N., Heritier, S., & Richardson, D. (2012). Effectiveness of motorcycle protective clothing: Riders' health outcomes in the six months following a crash. *Injury, 43,* 2035-2015.

Deuterman, W. (2004). *Motorcycle Helmet Effectiveness Revisited*. (Report No. DOT HS 809 715). Washington, DC: National Highway Traffic Safety Administration.
Available at www-nrd.nhtsa.dot.gov/Pubs/809715.PDF

Elliott, M. A., Baughan, C. J., & Sexton, B. F. (2007). Errors and violations in relation to motorcyclists' crash risk. *Accident Analysis and Prevention, 39*, 491-499.

General Accounting Office. (1991). *Highway Safety: Motorcycle Helmet Laws Save Lives and Reduce Costs to Society.* Washington, DC: U.S. General Accounting Office (now the General Accountability Office).

Governors Highway Safety Association. (2012). *Helmet Laws.* Washington, DC: Author. Available at www.ghsa.org/html/stateinfo/laws/helmet_laws.html

Gilbert, H., Chaudhary, N., Solomon, M., Preusser, D., & Cosgrove, L. (2008). *Evaluation of the Reinstatement of the Helmet Law in Louisiana*. (Report No. DOT HS 810 956). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810956.pdf

Hanchulak, D., & Robinson, B. (2009). *Guidelines for Motorcycle Operator Licensing*. (Report No. DOT HS 811 141). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811141.pdf

Hedlund, J., Shults, R. A., & Compton, R. (2003). What we know, what we don't know, and what we need to know about graduated driver licensing. *Journal of Safety Research, 34*, 107-115.

Hedlund, J., Shults, R. A., & Compton, R. (2006). Graduated driver licensing and teenage driver research in 2006. *Journal of Safety Research, 37*, 107-121.

Houston, D. J. (2007). Are helmet laws protecting young motorcyclists? *Journal of Safety Research, 38*, 329-336.

Houston, D. J., & Richardson, L. E. (2008). Motorcyclist fatality rates and mandatory helmet-use laws. *Accident Analysis and Prevention*, 40, 200-208.

Hurt, H. H., Ouellet, J. V., & Thom, D. R. (1981). *Motorcycle Accident Cause Factors and Identification of Countermeasures, Volume 1: Technical Report.* (Report No. DOT HS-5-01160). Washington, DC: National Highway Traffic Safety Administration.

Insurance Institute for Highway Safety. (2007). These machines are designed for the racetrack. *Insurance Institute for Highway Safety Status Report* 42: no. 9.

IIHS. (2012a). *Current US Motorcycle and Bicycle Helmet Laws, June, 2012*. Arlington, VA: Author. Available at www.iihs.org/laws/HelmetUseCurrent.aspx

IIHS. (2012b). *Motorcycle helmet laws history.* Arlington, VA: Author. Available at www.iihs.org/laws/helmet_history.aspx

Jones, M. M., & Bayer, R. B. (2007). Paternalism & its discontents: Motorcycle helmet laws, libertarian values, and public health. *American Journal of Public Health, 97*, 208-217.

Kardamanidis, K., Martiniuk, A., Stevenson, M.R., & Thistlethwaite, K. (2010). Motorcycle rider training for the prevention of road traffic crashes. *Cochrane Database of Systematic Reviews* 2010, Issue 10. Art. No.: CD005240. DOI: 10.1002/14651858.CD005240.pub2

Kyrychenko, S. Y., & McCartt, A.T. (2006). Florida's weakened motorcycle helmet law: Effects on death rates in motorcycle crashes. *Traffic Injury Prevention* 7, 55-60.

Lacey, J. H., Kelley-Baker, T., Furr-Holden, D., Voas, R. B., Romano, E., Torres, P., Tippetts, A. S., Ramirez, A., Brainard, K., & Berning, A. (2009a). *2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Alcohol Results*. (Report No. DOT HS 811 248). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811248.pdf

Lacey, J.H., Kelley-Baker, T., Furr-Holden, D., Voas, R.B., Romano, E., Ramirez, A., Brainard, K., Moore, C., Torres, P., and Berning, A. (2009b). 2007 National Roadside Survey of Alcohol and Drug Use by Drivers: Drug Results. (Report No. DOT HS 811 249). Washington, DC: National Highway Traffic Safety Administration.
Liu, B. C., Ivers, R., Norton, R., Blows, S., & Lo, S. K. (2008). Helmets for Preventing Injury in Motorcycle Riders. *The Cochrane Database of Systematic Reviews: Issue 1*. Art No.: CD004333.

Mayhew, D. R., & Simpson, H. M. (2001). *Graduated Licensing for Motorcyclists*. Ottawa, ON: Traffic Injury Research Foundation.

McKnight, A. S., & Becker, L. R. (2007a). *Impaired Motorcycle Operation, Final Report Volume II: Riders Helping Riders Instructor's Guide*. (Report No. DOT HS 810 907). Washington, DC: National Highway Traffic Safety Administration.
Available from: Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810907.pdf

McKnight, A. S., & Becker, L. R. (2007b). *Impaired Motorcycle Operation, Final Report, Volume III: Riders Helping Riders Student Manual*. (Report No. DOT HS 810 908). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810908.pdf

McKnight, A. S., Becker, L. R., & Tippetts, A. S. (2008). *Impaired Motorcycle Operation, Final Report Volume I: Riders Helping Riders Evaluation.* (Report No. DOT HS 811 023). Washington, DC, National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811023.pdf

Morris, C. C. (2006). Generalized linear regression analysis of association of universal helmet laws with motorcyclist fatality rates. *Accident Analysis and Prevention* 38, 142-147.

Motorcycle Safety Foundation. (2010). *State Motorcycle Operator Licensing - 2010.* Irvine, CA: Author. Available at http://msf-usa.org/downloads/State_Motorcycle_Operator_Licensing_CSI_2010_2.pdf

MSF. (2011). *State On-Highway Motorcycle Equipment Requirements*. Irvine, CA: Author. http://msf-usa.org/downloads/Equipment_Chart_2011-MSFlogo.pdf

NCHRP. (2008). *Guidance for Implementation of the AASHTO Strategic Highway Safety Plan, Volume 22: A Guide for Addressing Collisions Involving Motorcycles.* (NCHRP Report 500). Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v22.pdf

National Highway Traffic Safety Administration. (1996). *Do Motorcycle Helmets Interfere with the Vision and Hearing of Riders?* Traffic Tech No. 127 Washington, DC:Author. Available at www.nhtsa.gov/DOT/NHTSA/Communication%20&%20Consumer%20Information/Studies%20&%20Reports/Associated%20Files/tt127.pdf

NHTSA. (2000a). *National Agenda for Motorcycle Safety*. (Report No. DOT HS 809 156). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/00-NHT-212-motorcycle/index.html

NHTSA. (2000b). *The Detection of DWI Motorcyclists.* Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/610DWIMotorcyWeb/pages/index.htm

NHTSA. (2003). *The National Highway Traffic Safety Administration Motorcycle Safety Program*. (Report No. DOT HS 809 539). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/pedbimot/motorcycle/motorcycle03/index.htm

NHTSA. (2004). *How to Identify Unsafe Motorcycle Helmets.* (Report No. DOT HS 807 880 (revised)). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/pedbimot/motorcycle/UnsafeHelmetID/images/UnsafeHelmets.pdf

NHTSA. (2006a). *Implementation Guide for the National Agenda for Motorcycle Safety*. (Report No. DOT HS 810 680). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/NAMS2006/images/ImplementationGuide.pdf

NHTSA. (2006b). *2006 Motorcycle Safety Program Plan*. (Report No. DOT HS 810 615). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/pedbimot/motorcycle/MotorcycleSafety.pdf

NHTSA. (2007a). *Share the Road with Motorcycles*. (Report No. DOT HS 809 713. NHTSA. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/ShareTheRoad/

NHTSA. (2007b). *Traffic Safety Facts, Research Note: Summary of Novelty Helmet Performance Testing*. (Report No. DOT HS 810 752). Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Studies%20&%20Reports/Associated%20Files/Novelty_Helmets_TSF.pdf

NHTSA. (2009). *Traffic Safety Facts: Research Note. Motorcyclists Injured in Motor Vehicle Traffic Crashes*. (Report No. DOT HS 811 149). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811149.pdf

NHTSA. (2011a). *Traffic Safety Facts, 2009 Data: Motorcycles*. (Report No. DOT HS 811 389). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811389.PDF

NHTSA (2011b). *Model National Standards for Entry-Level Motorcycle Rider Training.* (Report No. DOT HS 811 503). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/pdf/811503.pdf

NHTSA. (2012a). *Motorcycle Helmet Use in 2011 – Overall Results.* (Report No. DOT HS 811 610). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811610.pdf

NHTSA (2012b). Data retrieved from the Fatality Analysis Reporting System.

Olson, P. L., Halstead-Nussloch, R., & Sivak, M. (1979). *Development and Testing of Techniques for Increasing the Conspicuity of Motorcycles and Motorcycle Drivers.* Washington, DC: National Highway Traffic Safety Administration. http://deepblue.lib.umich.edu/bitstream/2027.42/487/2/43121.0001.001.pdf

Preusser, D. F., Hedlund, J. H., & Ulmer, R. G. (2000). *Evaluation of Motorcycle Helmet Law Repeal in Arkansas and Texas*. (Report No. DOT HS 809 131). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/EvalofMotor.pdf

Salmon, D.A. (2008). Reducing motorcycle fatalities through checkpoints and education: The New York State experience. *The Police Chief*, vol. LXXV, no. 7. Available at www.policechiefmagazine.org/magazine/index.cfm?fuseaction=display_arch&article_id=1536&issue_id=72008

National Association of State Motorcycle Safety Administrators. (2008). *Annual SMSA State Motorcycle Program Surveys*. Centennial, Colorado: Author.

Stuster, J. (1993). *The Detection of DWI Motorcyclists.* (Report No. DOT HS 807 839). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25800/25868/DOT-HS-807-839.pdf

Teoh, E. R. (2011). Effectiveness of antilock braking systems in reducing motorcycle fatal crashes. *Traffic Injury Prevention, 12*, 169-173.

Teoh, E. R., & Campbell, M. (2010). Role of Motorcycle Type in Fatal Motorcycle Crashes. *Journal of Safety Research,* 41, 507-512.

Ulmer, R. G., & Preusser, D. F. (2003). *Evaluation of the Repeal of Motorcycle Helmet Laws in Kentucky and Louisiana.* (Report No. DOT HS 809 530). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/kenturky-la03/TecDoc.htm

Ulmer, R. G., & Northrup, V. S. (2005). *Evaluation of the Repeal of the All-rider Motorcycle Helmet Law in Florida*. (Report No. DOT HS 809 849). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/pedbimot/motorcycle/FlaMCReport/images/FloridaMCReportscr1.pdf

U.S. Department of Transportation. (2007). *U.S. Department of Transportation Action Plan to Reduce Motorcycle Fatalities*. (Report No. DOT HS 810 855). Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Communication%20&%20Consumer%20Information/Articles/Associated%20Files/4640-report2.pdf

Weiss, H., Agimi, Y., & Steiner, C. (2010). Youth motorcycle-related brain injury by state helmet law type: United States, 2005-2007. *Pediatrics, 126*, 1149-1155.

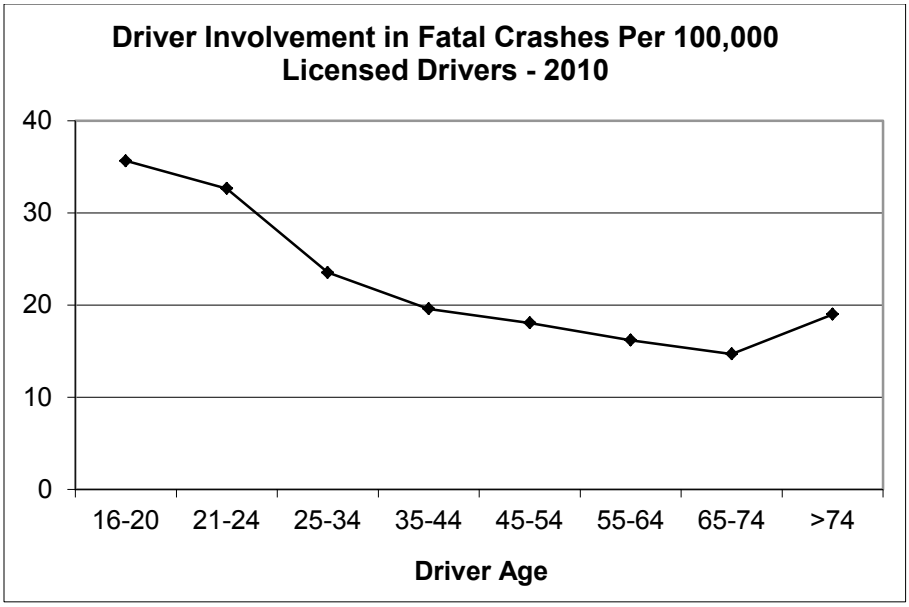
Wells, S., Mullin, B., Norton, R., Langley, J., Connor, J., Lay-Yee, R., & Jackson, R. (2004). Motorcycle rider conspicuity and crash-related injury: case-control study. *British Medical Journal*, *328*, 857.

6. Young Drivers

Overview

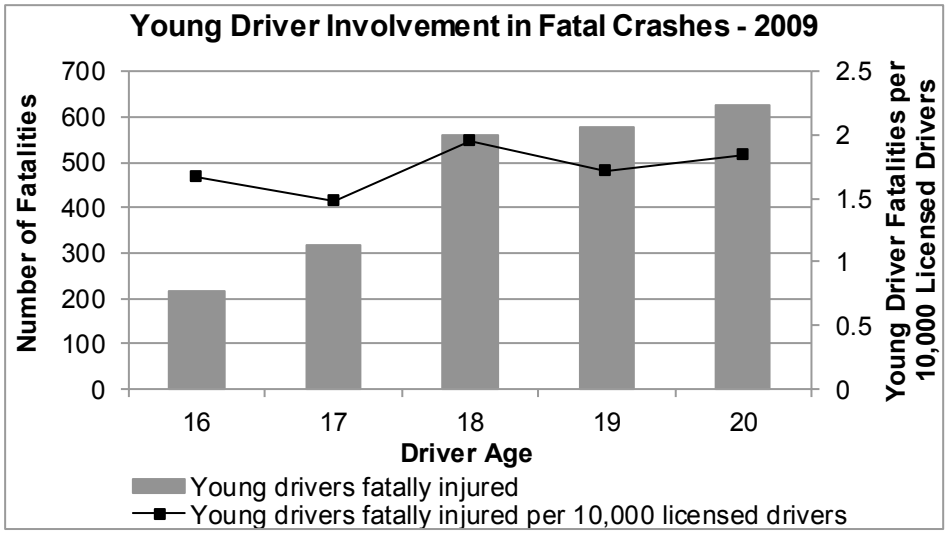
Motor vehicle crashes are the leading cause of death for teenagers in the United States. In 2010, 1,963 drivers 15 to 20 years old were killed and another estimated 187,000 were injured in motor vehicle crashes (NHTSA, 2012a). In comparison with adult drivers, young drivers are substantially over-involved in crashes. In 2010, drivers 15 to 20 made up 6.4% of licensed drivers in the United States, yet they made up 10% of total drivers in fatal crashes, and 14% of drivers in all crashes (NHTSA, 2012a).

Young drivers have the highest involvement in fatal crashes of any age group. As shown in the figure below, fatal crash involvement of drivers 16 to 20 is approximately twice that of adult drivers.



Source: Traffic Safety Facts 2010 (NHTSA, 2012b, Table 62). FARS data.

As shown in the figure below, young driver involvement in fatal crashes increases almost linearly with age. However, the rate of young driver involvement in fatal crashes per 10,000 licensed drivers appears to peak with 18-year-old drivers showing the most involvement.



Sources: Traffic Safety Facts 2009 Data – Young Drivers (NHTSA, 2010a); The 2012 Statistical Abstract (U.S. Census Bureau, 2012)

Per mile driven, young drivers are even more over-involved. In 2008,16- to 19-year-old drivers were involved in 4.6 fatal crashes per 100 million miles of travel, compared to 3.8 for drivers 20 to 24 and 1.2 for drivers 30 to 59 years old (IIHS, 2011). Only 37% of the people killed in young driver crashes are the teen driver themselves; the majority of fatalities in young driver crashes (63%) are passengers of the teen driver, occupants of other vehicles, or nonmotorists (Shults & Ali, 2010).

Trends. Between 1996 and 2010, there was a 68% decrease in the fatal crash rate for 16-year-old drivers per population, and a 59% decrease for 17-year-old drivers. By comparison, fatal crash rates declined by 35% among adult drivers 30 to 59 (IIHS, 2012a). There was a similarly large decrease in police reported crashes during the same time period. Police-reported crashes per population fell 63% for 16-year-olds and 51% for 17-year-olds (IIHS, 2012a). The reasons for the dramatic reductions in fatal and police-reported crashes among 16- and 17-year-olds are not entirely known; however, it is noteworthy that most States implemented new, multi-stage licensing systems during this time period.

Young-driver characteristics. Young drivers have high crash risks for two main reasons, as documented by extensive research (summarized in Hedlund, Shults, & Compton, 2003). First, they are inexperienced, just learning to drive. The mechanics of driving require much of their attention, so safety considerations frequently are secondary. They do not have experience in recognizing potentially risky situations or in reacting appropriately and controlling their vehicles in these situations. Second, they are immature, sometimes seeking risks for their own sake, often not able or willing to think ahead to the potentially harmful consequences of risky actions. In fact, research on adolescent development suggests that key areas of the brain involved in judgments and decision making are not fully developed until the mid-20s (Dahl, 2008; Keating, 2007; Steinberg, 2007).

Inexperience and immaturity combine to make young drivers especially at-risk in five circumstances:

- At night: Driving is more difficult and dangerous at night for everyone, but particularly for teenagers. Young drivers have less experience driving at night than during the day, and drowsiness and alcohol may be more of a factor at night (Lin & Fearn, 2003; Williams, 2003).
- After drinking alcohol: Young drivers' inexperience with both driving and drinking means that they have a higher crash risk at all BAC levels than older drivers (Williams, 2003).
- With passengers: Teenage passengers can distract young drivers and encourage them to take risks (Lin & Fearn, 2003; Williams, 2003).
- When unbelted: Seat belts reduce the risk of injury or fatality in a crash (see Chapter 2, Overview), but teenage drivers and passengers have lower belt use rates than older drivers and passengers (Ferguson, 2003).
- When using cell phones: All drivers are at higher risk when talking or texting (see Chapter 4, Section 1.2); however, young drivers use cell phones more frequently than older drivers and have more difficulty handling distractions (Lee, 2007).

Strategies to Reduce Crashes Involving Young Drivers

Graduated driver licensing addresses both the inexperience and immaturity of young drivers. GDL provides a structure in which beginning drivers gain substantial driving experience in less-risky situations. GDL raises the minimum age of full licensure and helps parents manage their teenage drivers. GDL's effectiveness in reducing crashes has been demonstrated many times (Russell, Vandermeer, & Hartling, 2011; Shope, 2007; Simpson, 2003; Williams, Tefft, & Grabowski, 2012).

Driver education was developed to teach both driving skills and safe driving practices. Based on evaluations to date, school-based driver education for beginning drivers does a good job at teaching driving skills, but does not reduce crashes. Rather, some research has suggested that it lowers the age at which teenagers become licensed, and therefore increases exposure, so its overall effect is to *increase* crashes (Roberts et al., 2006; Thomas, Blomberg, & Fisher, 2012; Vernick et al., 1999). Current research is investigating ways to integrate driver education with GDL and is developing second-level programs for drivers who have acquired basic driving skills and have been, or are nearing, licensure.

Parents play a key role in their teenagers' driving. In many States a parent or guardian must sign the driver's license application for a teenager under 18 and parents can withdraw their approval at any time. Parents can set limits on their teenagers' driving. In addition, parents can be involved explicitly and formally through GDL requirements such as minimum hours of supervised driving practice, or they can be involved voluntarily and informally. Several parent-teen driving guide programs can provide assistance. At least one driving guide program has successfully encouraged parents to impose more driving restrictions on their teens (Simons-Morton, 2007) Recently, technologies have become available to assist parents in monitoring their newly licensed teen driver. When combined with a comprehensive system for providing feedback to parents and teens, these technologies have been highly promising in reducing the incidence of risky driving behaviors among teens (Carney, McGehee, Lee, Reyes, & Raby, 2010;

McGehee, Raby, Carney, Lee, & Reyes, 2007). Finally, several States are now requiring parent involvement in driver education, usually in the form of a mandatory parent orientation class. All of these approaches are promising, though none have been shown as of yet to reduce young driver crashes or fatalities.

Young drivers are subject to two traffic laws that apply only to them: GDL and the zero-tolerance BAC laws discussed in Chapter 1. In addition, they are subject to all other traffic laws. Enforcement is critical if these laws are to have any effect. The law enforcement system faces several problems when dealing with young drivers. In deciding whether to make a traffic stop, it can be difficult for law enforcement officers to determine a person's age to know whether GDL and zero-tolerance laws apply. It has been suggested that a vehicle decal identifying a driver as "young" and subject to GDL requirements, may be beneficial for enforcement reasons. New Jersey is the first State to pass legislation requiring young drivers subject to GDL restrictions to be identified via a vehicle decal. A recent study examining the effectiveness of the decal requirement in New Jersey found that citations for violations of licensing restrictions sharply increased the year after the decal requirement went into effect; however, telephone surveys suggested most parents and teens disapproved of the decal requirement (McCartt, Oesch, Williams, & Powell 2012). Even if the driver is young, in many States GDL violations are secondary, and the teen may only be stopped for a primary violation first. Once stopped, there may be a tendency for officers in some situations not to make arrests or for prosecutors to dismiss charges because the offender is "just a kid." Finally, the legal system imposes additional requirements for people under the age of legal adulthood (18 in most States). See NHTSA and NIAAA (1999) for a discussion of these requirements and processes for alcohol-related offenses.

Young drivers are discussed in other chapters of this guide. See in particular:

- Chapter 1, Alcohol-Impaired Driving, Sections 6.1-6.4 (minimum-drinking-age-21 laws, zero-tolerance BAC laws, school and youth alcohol programs).
- Chapter 4, Distracted and Drowsy Driving, Sections 1.1, 2.1, 2.2, and 3.1 (GDL requirements, communications and outreach, and employer programs).
- Chapter 5, Motorcycle Safety, Section 3.1 (GDL for motorcyclists).

Except for GDL requirements applying to automobile drivers, these discussions are not repeated in this chapter.

Environmental and vehicular strategies can improve safety for young drivers, as they can for all drivers. However, these types of countermeasures are not included because State Highway Safety Offices do not have authority or responsibility in these areas.

Resources

The agencies and organizations listed below can provide more information on young drivers and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Teen Drivers - www.nhtsa.gov/Teen-Drivers
  - Driver Safety Research Reports: New Drivers - http://www.nhtsa.gov/Driving+Safety/Research+&+Evaluation/Driver+Safety+Research+Reports:+New+Drivers+and+Older+Drivers
  - Behavioral Safety Research Reports - http://ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention: www.cdc.gov/Motorvehiclesafety/Teen_Drivers/index.html
- Governors Highway Safety Association: http://www.ghsa.org/html/issues/teens/index.html
- Insurance Institute for Highway Safety: www.iihs.org/research/topics/teenagers.html
- National Safety Council: www.nsc.org/safety_road/TeenDriving/Pages/teen_driving.aspx
- American Automobile Association: http://exchange.aaa.com/safety/teen-driver-safety/

For an overview of young-driver issues and research, see the papers in the June 2006 Supplement of *Injury Prevention* (ip.bmjjournals.com/content/vol12/suppl_1/), the special issue of the 2007 *Journal of Safety Research* (www.sciencedirect.com/science/journal/00224375), or the special issue of the 2008 American Journal of Preventive Medicine (www.bocyf.org/AJPM_TOC_SEPT_2008.html). See also Williams et al. (2012) for a summary of much of the research on young driver issues. Additionally, an NCHRP Report 500 guide for the American Association of Motor Vehicle Administrators' Strategic Highway Safety Plan provides a detailed discussion of strategies for reducing crashes involving young drivers (NCHRP, 2007).

Countermeasures That Work

Countermeasures to improve young-driver safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Graduated Driver Licensing

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Graduated driver licensing (GDL)	★★★★★	$	High	Medium
1.2 Learner's permit length, supervised hours	★★★★★	$	High	Medium
1.3 Intermediate - nighttime restrictions	★★★★★	$	High	Medium
1.4 Intermediate - passenger restrictions	★★★★★	$	High	Medium
1.5 Cell phone restrictions	★★	$	Medium	Medium
1.6 Belt use requirements	★★	$	Low	Medium
1.7 Intermediate - violation penalties	★	$	High	Medium

2. Driver Education

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Pre-licensure driver education	★	$$$	Medium	Long
2.2 Post-licensure driver education	★	$$$	Low	Long

3. Parents

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Parent roles in teaching and managing	★★	$	Medium	Short

4. Traffic Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Enforcement of GDL and zero-tolerance laws	★★★	$$	Unknown	Short

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources

$$: requires some additional staff time, equipment, facilities, and/or publicity

$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities

Medium: between one-third and two-thirds of States or communities

Low: fewer than one-third of the States or communities

Unknown: data not available

Time to implement:

Long: more than one year

Medium: more than three months but less than one year

Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Graduated Driver Licensing

1.1 Graduated Driver Licensing

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

GDL is a three-phase system for beginning drivers, consisting of a learner's permit, an intermediate license, and a full license. A learner's permit allows driving only while supervised by a fully licensed driver. An intermediate license allows unsupervised driving under certain restrictions. These usually include limits on driving at night or with teenage passengers. The learner's permit and the intermediate license each must be held for a specified minimum period of time.

GDL serves two functions: reducing risk and reducing exposure. GDL allows beginning drivers to acquire driving experience in less-risky situations, under direct supervision during the learner's permit phase. It helps young drivers avoid dangerous conditions such as late-night driving or driving with teenage passengers in the vehicle during the intermediate phase. GDL delays full licensure by requiring a minimum time in both the learner's permit and intermediate phases. Compared to earlier requirements in many jurisdictions, where beginning drivers could receive a full license at age 16 (and sometimes earlier) by passing a minimal driving test, GDL reduces the amount of driving by 16-year-olds. GDL also assures that young drivers are more mature when they receive their first unrestricted license. In surveys, both parents and teenagers strongly support GDL overall (Williams, Ferguson, Leaf, & Preusser, 1998). Based on a recent national survey, the majority of parents support GDL policies that are as strong as, or even stronger, than policies currently in place in the United States (Williams, Braitman, & McCartt, 2011).

All States now have some form of GDL in place. GHSA (2012a) and IIHS (2012b) document GDL laws in each State. These Web sites are updated monthly. The papers in the special issue of the 2007 *Journal of Safety Research* describe GDL's history, components, effectiveness, parental roles, potential enhancements, and research needs. Strategies for implementing or improving GDL systems are described in NCHRP's *Guide for Reducing Collisions Involving Young Drivers* (NCHRP, 2007, strategies A1 through A5). See also NHTSA's *Traffic Safety Facts* on GDL (NHTSA, 2008) and Report to Congress (Compton & Ellison-Potter, 2008).

Use: All States and the District of Columbia had some GDL components in place as of July 2012. In addition, all States had a three-phase GDL system in place (GHSA, 2012a; IIHS, 2012b).

Effectiveness: GDL's effectiveness in reducing young driver crashes and fatalities has been well-documented (Baker, Chen, & Li, 2007; Fell, Jones, Romano, & Voas, 2011; Lyon, Pan, & Li, 2012; McCartt, Teoh, Fields, Braitman, & Hellinga, 2010; Masten, Foss, & Marshall, 2011; Russel et al, 2011; Shope, 2007; Simpson, 2003). The most restrictive GDL programs – those with at least a 6-month holding period during the learner stage, a night restriction beginning no later than 10 p.m., and restrictions allowing no more than one teen passenger – are associated with a 38% reduction in fatal crashes and a 40% reduction in injury crashes among 16-year-old

drivers (Baker et al., 2007). In addition to reducing crashes, GDL is associated with declines in hospitalization rates and charges for 16-year-old drivers (Margolis, Masten, & Foss, 2007; Pressley, Benedicto, Trieu, Kendig, & Barlow, 2009).

Costs: GDL's primary costs result from the intermediate license, which adds to licensing agency workload by requiring each beginning driver to receive three licenses in succession rather than two. These costs are typically covered by small fees charged by the licensing agency.

Time to implement: Licensing changes typically require up to a year to plan, publicize, and implement.

Other issues:

- **Age of licensure:** In recent years, there has been discussion about the most appropriate age for allowing teenagers to drive independently (Williams, 2009; Williams, McCartt, Mayhew, & Watson, 2012). Licensing ages vary from State to State, from a low of 14½ in South Dakota to a high of 17 in New Jersey. Delaying licensure, either through higher entry ages or GDL requirements such as extended learner stages, can reduce young driver crashes. For example, New Jersey's GDL system has eliminated most crashes among 16-year-old drivers, and has reduced crashes among 17-year-olds by 16% (Williams, Chaudhary, Tefft, & Tison, 2010). A survey from three States suggests parents support older licensing ages (McCartt, Hellinga, & Haire, 2007). However, the licensing age represents a balance between safety and mobility. Before raising the licensing age, consideration must be given to what is politically feasible, and the fact that teens will need safe and attractive alternatives for mobility.

1.2 GDL Learner's Permit Length, Supervised Hours

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

With a learner's permit, novices can drive when accompanied by an adult supervisor. The learner's permit allows and encourages beginning drivers to acquire substantial driving experience. To aid this, most States require the learner's permit to be held for a minimum period of time and most require a minimum number of supervised driving hours. Surveys show that parents and teenagers strongly support the learner's permit holding period and supervised driving requirements (Block & Walker, 2008; Mayhew, 2003; McKay, Coben, Larkin, & Shaffer, 2008).

Use: As of July 2012, 48 States and the District of Columbia required learner's permits to be held for at least 6 months, with 8 of these States requiring a minimum holding period of a full year. Forty-six States and the District of Columbia required some minimum number of supervised driving hours, about half of them requiring 50 hours. Forty-one States plus DC required that at least some of these hours be obtained at night. In addition, a few States required additional supervised hours to be completed during the intermediate license phase (IIHS, 2012b). Some States reduced or eliminated supervised driving requirements for driver education graduates. This is not recommended, since evidence suggests this practice results in *higher* crash rates among young drivers (Mayhew, 2007).

Effectiveness: Since learner's permit drivers are being supervised, it is not surprising that crash rates during the learner's permit period are very low. For young drivers holding their first unsupervised license, the limited available evidence suggests that crash rates decreased after jurisdictions with no learner's permit holding requirement implemented a 6-month requirement (Mayhew, 2003). Moreover, longer permit holding periods appear to result in even larger crash reductions. Masten (2011) found that a 9- to 12-month leaner's permit holding period resulted in 26% lower fatal crash incidence among 16-year-old drivers and 17% lower incidence among 17-year-olds.

However, the effect of supervised hours is currently unclear. Some studies have found supervised hours requirements lead to reductions in fatal crashes, when hourly requirements are combined with a mandatory learner's permit holding period (Baker, Chen & Li, 2006; Lyon et al., 2012). However, two recent national evaluations found no relationship between the number of required supervised driving hours and fatal crash involvement among young drivers (Foss, Masten, Goodwin & O'Brien, 2012; McCartt et al., 2010). Based on telephone interviews with parents in 5 States, only 32% knew the correct number of supervised driving hours their teen was required to complete (Foss et al., 2012; O'Brien, Foss, Goodwin, & Masten, 2012). Thus, the lack of parental knowledge of the supervised driving requirements may help explain the lack of effect on fatal crash outcomes.

Costs: Once GDL is in place, requirements for the learner's permit can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.3 GDL Intermediate License Nighttime Restrictions

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

Driving at night increases the fatal crash risk per mile of travel for all drivers, and especially for teenage drivers (Hedlund et al., 2003; Williams, 2003; Tefft, Williams, & Grabowski, 2012). A recent study found that the rate of driver fatalities was 5 times higher among 16- and 17-year-olds from 10 p.m. to 5:59 a.m. compared to driving during the day (Tefft et al, 2012). At night, driving is more difficult, driver drowsiness is more common, and alcohol is more likely to be used. Many intermediate license drivers have limited experience driving at night. For all of these reasons, a night driving restriction helps reduce risk for intermediate level drivers.

The restricted hours vary widely, from 6 p.m. to 6 a.m. in the most restrictive State, to 1 a.m. to 5 a.m. in the least restrictive (GHSA, 2012a; IIHS, 2012b). The most common hours are 11 p.m. or midnight to 5 or 6 a.m. However, a starting time earlier than midnight will prevent more crashes, especially since teenage driver crashes occur more frequently before midnight than after (Foss & Goodwin, 2003; Williams, 2003). NHTSA's Motor Vehicle Occupant Safety Survey found that 73% of the general public believe teenagers should not be allowed to drive unsupervised after 9 p.m. (Block & Walker, 2008). Another national survey of parents found 90% support a nighttime driving restriction, with 77% saying it should be 10 p.m. or earlier (Williams et al., 2011).

Use: As of July 2012, 49 States and the District of Columbia restricted intermediate license drivers from driving during specified nighttime hours. (The exception is Vermont.) Many States allowed driving during the restricted hours for work or school-related activities (GHSA, 2012a; IIHS, 2012a).

Effectiveness: The effectiveness of nighttime driving restrictions in reducing both nighttime driving and nighttime crashes has been demonstrated conclusively (Fell et al., 2011; Hedlund et al., 2003; Hedlund & Compton, 2005; Lin & Fearn, 2003; Lyon et al., 2012; Masten, 2011; McCartt et al., 2010). The earlier a night restriction begins, the greater the reduction in crashes. For example, night restrictions that begin at 9 p.m. are associated with an 18% reduction in fatal crashes compared to no restriction. The reduction is only 9% when the night restriction begins at 1 a.m. (McCartt et al., 2010).

Costs: Once GDL is in place, a nighttime driving restriction can be implemented or modified at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.4 GDL Intermediate License Passenger Restrictions

Effectiveness: ★★★★★	Cost: $	Use: High	Time: Medium

Young passengers substantially increase the crash risk for teenage drivers. Each additional passenger produces an additional increase in crash risk. In contrast, passengers decrease crash risk for drivers 30 to 59 years old (Tefft et al., 2012; Williams, 2003). Crash risks are highest when young male drivers carry same age passengers, especially if those passengers are also male (Ouimet et al., 2010).

To reduce this risk, most States include a passenger restriction in their GDL requirements for intermediate licensees. According to NHTSA's Motor Vehicle Occupant Safety Survey, 86% of the general public believe that teenagers should have a restriction on the number of teenage passengers they can carry (Block & Walker, 2008). Also, in a recent national survey 89% of parents say they support passenger restrictions; 82% think the passengers limit should be one or less (Williams et al., 2011).

Use: As of July 2012, 45 States and the District of Columbia restricted in some way the number of passengers who can be carried by an intermediate license driver (GHSA, 2012a; IIHS, 2012b). The most common passenger restrictions limit teenage drivers to zero or just one passenger. Some restrictions apply to all passengers and some only to passengers younger than a specified age. A few States allow exceptions for transporting family or household members.

Effectiveness: There is growing evidence that passenger restrictions are effective in reducing young driver crashes, though the restrictions sometimes are violated (Carpenter & Pressley, 2012; Fell et al., 2011; Goodwin & Foss, 2004; Lyon et al., 2012; Masten, 2011; McCartt et al., 2010; Williams, 2007). California allows no passengers younger than 20 for teenagers who hold intermediate licenses. Four studies demonstrate the positive effects of this restriction. For example, one study showed a 38% decrease in 16-year-old-driver crashes in California in which a teen passenger was killed or injured (Williams, 2007). A NHTSA study evaluated passenger restrictions in three States, California, Massachusetts, and Virginia. Results showed 16-year-old-driver crashes were reduced in all three States, as were motor-vehicle-related injuries among 15- to 17-year-olds (Chaudhary, Williams, & Nissen, 2007). In North Carolina, a teen passenger restriction was enacted independent of any other changes to the State's GDL system. Subsequent to this restriction, 16-year-old-driver crashes involving multiple passengers decreased by 32% (Foss, 2009). Recent national studies have also found large crash rate reductions for passenger restrictions. For example, McCartt et al. (2010) found a 21% reduction in fatal crashes among 15- to 17-year-olds when no passengers were permitted and a 7% reduction when one passenger was allowed.

Costs: Once GDL is in place, a passenger restriction can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.5 GDL Cell Phone Restrictions

Effectiveness: ★★	Cost: $	Use: Medium	Time: Medium

Cell phones may distract drivers, as discussed in Chapter 4, Section 1.2. Cell phones are more commonly used by young drivers than adult drivers (NHTSA, 2011b), and they may pose greater risks for young drivers for the reasons outlined in the Overview (see also Ferguson, 2003). To reduce this risk, a growing number of States include cell phone restrictions in their GDL laws. See Chapter 4, Section 1.2 for a discussion of cell phone laws applying to all drivers.

Use: As of July 2012, 32 States and the District of Columbia prohibit cell phone use for young drivers. These bans cover *all* cell phone use, not just hand-held phones. In some States the cell phone restrictions cover teenagers holding a learner's permit and intermediate license; in other States the restrictions cover all drivers under a certain age, such as 18 or 19 (GHSA, 2012b; IIHS 2012c). California, Connecticut, Delaware, Maryland, Nevada, New Jersey, New York, Oregon, Washington, West Virginia, and the District of Columbia prohibit hand-held cell phone use for all drivers. In addition, 39 States and the District of Columbia prohibit text messaging for all drivers and 5 States (Mississippi, Missouri, New Mexico, Oklahoma, and Texas) ban text messaging among young drivers (see Chapter 4, Section 1.2).

Effectiveness: In 2009, a study examined the short-term effects of a teenage driver cell phone restriction (Foss, Goodwin, McCartt, & Hellinga, 2009). In North Carolina, teenage driver cell phone use was observed one month before and 5 months after a ban on cell phones took effect. The proportion of teens using cell phones while driving was unchanged following the law. Telephone interviews with parents and teens found that support for the restriction was high among both parents (95%) and teens (74%), but awareness for the restriction was only moderate. There was also very little perceived (and actual) enforcement of the law. A follow-up study evaluated the long-term effect of North Carolina's cell phone restriction two years after the law went into effect (Goodwin, O'Brien, & Foss, 2011). Teenagers were observed at high schools in North Carolina and also in South Carolina, which did not have a cell phone restriction. In both States, there was a decrease in cell phone use. However, the decrease in cell phone use did not significantly differ between the two States, despite increased awareness of the restriction among licensed teens in North Carolina (Goodwin et al., 2011). In addition, 45% of the teens surveyed who had an intermediate driver's license reported using a cell phone the last time they drove (O'Brien, Goodwin, & Foss, 2010). Thus, despite increased awareness; the findings suggest North Carolina's cell phone restriction has had no long-term effect on the behavior of teenage drivers.

Costs: Once GDL is in place, a cell phone restriction can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.6 GDL Belt Use Requirements

Effectiveness: ★★	Cost: $	Use: Low	Time: Medium

Properly worn seat belts can dramatically reduce the risk of injury or death to vehicle occupants in the event of a crash (NHTSA, 1999). Seat belts are particularly important for teenage drivers because of their elevated crash risk. Nonetheless, teenage drivers and passengers have lower seat belt use rates than older drivers and passengers (Ferguson, 2003). Belt use is particularly low among teenagers who are male, drive pickup trucks, and live in rural areas (Kim, Depue, Spence, & Reine, 2009).

Young drivers are covered by seat belt laws in all States (with the exception of New Hampshire, which only requires seat belts for people under 18) (Williams, 2007). Three States have primary enforcement belt use laws for passengers under 18 or 19 but secondary enforcement for older passengers (IIHS, 2012d; see also Chapter 2, Sections 1.1 and 1.4). Some States explicitly require belt use under their GDL laws. An explicit belt use requirement in a State's GDL law may have more influence on beginning drivers than the State's overall belt use law, especially in States with primary enforcement for young drivers and in States where seat belt violations result in delayed graduation to the next GDL stage.

Use: In 2005, GDL laws in 15 States explicitly required seat belt use (AAA, 2005). Sanctions for violating this requirement varied across the States.

Effectiveness: To date, there has been only one evaluation of the effects of explicit seat belt use requirements in GDL laws. Tennessee and Wisconsin both have a seat belt restriction within their States' GDL program. Evaluations of the restrictions in these two States found little, if any, effect on teen driver belt use (Freedman & Levi, 2008). One problem is that teens (and parents) may not be aware when seat belt laws are part of a State's GDL system. For example, surveys in North Carolina have shown very high awareness for the State's nighttime and passenger restrictions, but only 3% of teens and 5% of parents were aware of the special GDL provision concerning seat belts (Goodwin & Foss, 2004).

Costs: Once GDL is in place, a belt use requirement can be implemented at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

1.7 GDL Intermediate License Violation Penalties

Effectiveness: ★	Cost: $	Use: High	Time: Medium

Probationary licensing preceded graduated licensing. Probationary licensing had no intermediate phase, so that beginning drivers received a full and unrestricted license after their learner's permit. However, the initial full licensure period was probationary in that the license could be revoked or suspended, or some driver improvement actions could be required, at a lower threshold than for drivers with a standard non-probationary license (Simpson, 2003).

The probationary feature has been included in the intermediate phase of graduated licensing, typically by delaying full licensure until the intermediate licensee has demonstrated a good driving record.

Use: Almost all States penalize some GDL or traffic law violations by delaying full licensure (IIHS & TIRF, 2004).

Effectiveness: The few evaluations of early stand-alone probationary license systems generally found no substantial benefits (McKnight & Peck, 2003; Simpson, 2003). No recent evaluations have attempted to separate out the effect of penalties for GDL or other traffic law violations from the overall effects of GDL.

An enforcement/education program dubbed "*Ticket Today = License Delay*" (the equals sign is not pronounced) highlighted the resulting delay in licensure for teenagers who are convicted of a moving violation, seat belt violation or GDL violation. Although teens and their parents clearly perceived the increased enforcement, the program had only minimal effects on seat belt use and compliance with GDL restrictions (Goodwin, Wells, Foss, & Williams, 2006). In general, it appears that awareness of penalties for license violations among parents and teens is relatively low, enforcement is rare, and licensing delays are not always applied even when violations are enforced (Goodwin & Foss, 2004; Steenbergen et al., 2001; Williams, 2007).

Costs: Once GDL is in place, penalties for violating its provisions can be changed at very little cost.

Time to implement: GDL requirement changes typically require about 6 months to notify the public and implement the changes.

2. Driver Education

2.1 Pre-Licensure Driver Education

Effectiveness: ★	Cost: $$$	Use: Medium	Time: Long

Driver education has long been advocated and used to teach both driving skills and safe driving practices. Driver education in high schools grew in popularity in the 1950s, using a standard curriculum of at least 30 hours classroom instruction and 6 hours on-the-road driving practice. By about 1970, approximately 14,000 high schools taught driver education to about 70% of all eligible teenagers. Many States and insurance companies encouraged driver education: States licensed graduates at an earlier age and insurance companies reduced auto insurance premiums for graduates. During the 1980s driver education offerings decreased as State and Federal funding for driver education decreased. By the early 1990s fewer than half of all high schools offered driver education and the majority of beginning drivers did not take driver education. See Smith (1994), Mayhew (2007), or Williams, Preusser, and Ledingham (2009) for a concise review of the history of driver education in the United States.

The evaluations to date find that driver education does not decrease crash rates. Roberts et al. (2006) concluded from three well-designed evaluations in Australia, New Zealand, and the United States that driver education may lower the age at which teenagers become licensed but does not affect their crash rates once they do become licensed. The net effect of driver education may increase crashes because it puts more young drivers on the road. Vernick et al. (1999) reached the same conclusion from a review of 9 studies, 8 from the United States and 1 from Australia. It has been suggested that crash outcomes are not appropriate or fair measures for driver education, and are unrealistic to expect (Waller, 2003).

The study most familiar in the United States is the extensive NHTSA-sponsored study in DeKalb County, Georgia, in the late 1970s. Over 16,000 students were randomly assigned to three groups: standard driver education; an 80-hour long course including classroom, simulation, driving range, and on-the-road components; and a control group of no formal driver education. The initial analysis found no significant difference in crashes or traffic violations among the three groups (Smith, 1994). A second analysis, which tracked the students' driving records for a longer period of time, found a slight crash reduction for standard course graduates during their first months of driving only, and no difference between the long course and no course graduates (Smith, 1994). See Vernick (1999) or Williams et al. (2009) for brief summaries of all DeKalb study analyses.

Based primarily on these results, NHTSA dropped driver education from its list of priority highway safety program areas for States (Smith, 1994). NHTSA concluded that driver education should be integrated into a GDL program (Compton & Ellison-Potter, 2008; Thomas et al., 2012). It also concluded that driver education should be "distributed over time." NHTSA proposed a two-stage driver education system, both pre-licensure and post-licensure. (See Chapter 6, Section 2.2 for further discussion.) In addition, NHTSA and the driver education community has developed national administrative standards to enhance driver education delivery

in the States (NHTSA, 2010). A NHTSA State assessment program began in 2011 to assist States in meeting those standards.

Many States offer incentives for taking driver education. Twenty-five States encourage driver education by allowing teens to get unrestricted licenses at an earlier age if they complete driver education, and 18 States offer other incentives such as reducing the required number of supervised driving hours, waiving portions of licensing tests, or lowering the minimum permit age (Thomas et al., 2012). Research shows that driver education "discounts" increase, rather than reduce, crashes (Mayhew, 2007). For example, a study in British Columbia found that crash rates were 27% higher for driver education graduates who reduced their learner's permit holding period by three months, than for non-graduates (Wiggins, 2004).

Use: NHTSA recently completed an investigation of driver education requirements in the United States (Thomas et al., 2012). Presently, 23 States and the District of Columbia require some form of driver education before licensure for anyone younger than 18. Most commonly this includes 30 hours of classroom instruction and 6 hours of behind-the-wheel practice, although requirements vary considerably across States. Most States offer both commercial and high school driver education programs (Thomas et al., 2012).

Effectiveness: Driver education leads to earlier licensure in some States and does not reduce crash rates (Mayhew, 2007; Roberts et al, 2006; Thomas et al., 2012; Vernick et al., 1999; Williams et al., 2009). Nonetheless, there has been a growing interest in improving and evaluating driver education. Future directions for driver education were summarized in a research circular by the Transportation Research Board (TRB, 2006). In addition, the AAA Foundation for Traffic Safety has produced a series of publications that provide practical information on how to conduct evaluations of driver education (Clinton & Lonero, 2006), and NHTSA conducted a feasibility study on evaluating driver education curriculum (Williams et al., 2009).

In addition, there have been recent advances in the development in new types of driver education programs (summarized in Thomas et al., 2012). Given that visual scanning, attention maintenance, and speed management are likely responsible for many crashes among young drivers, a number of new programs have been developed that focus on teaching these higher-order knowledge and skills, generally using computer simulation. Although many of these programs have demonstrated short-term training effects, it is still unknown how long the training effects are maintained. More importantly, it is unknown if the training effects will carry over into real world driving environments and result in crash reductions among young drivers (Thomas et al., 2012).

Costs: Even a minimal driver education course of 30 hours in the classroom and 6 hours on the road requires extensive funds. Driver education also requires students to find time for it in their schedules of high school classes, extracurricular and summer activities, and jobs.

Time to implement: A driver education course requires at least a year to plan and implement.

Other issues:

- **Parent involvement:** There has been a growing interest in integrating parents into driver education. For example, Virginia passed legislation in 2009 requiring a minimum of 90 minutes of parent participation in the in-classroom portion of driver education. Similarly, Connecticut requires a parent to attend a 2-hour driver education orientation course while the teen gets a learner's permit. Parents appear to support these requirements. In a recent national survey, a majority (70%) of parents reported that orientation courses should be required (Williams et al., 2011). Nonetheless, research has not yet determined the most effective way to involve parents. One recent study delivered the *Checkpoints* program in driver education classes (Zakrajsek, Shope, Ouimet, Wang, & Simons-Morton, 2009). Relative to a comparison group, parents who participated in the *Checkpoints* program showed greater awareness of teen driving risks, and they were more likely to complete a parent-teen driving agreement. However, participation in the program was voluntary and, despite diligent recruitment efforts, parent attendance was low. For more information about the *Checkpoints* program, see Chapter 6, Section 3.1.

2.2 Post-Licensure or Second-Tier Driver Education

Effectiveness: ★	Cost: $$$	Use: Low	Time: Long

As discussed in Chapter 6, Section 2.1, standard pre-licensure driver education leads to earlier licensure but does not reduce crash rates. Based on this conclusion, driver education research has sought to develop post-licensure driver education curricula and to integrate driver education with GDL (Smith, 1994). These "second-tier" post-licensure courses teach safety-related information, building on the on-road experience that the students have acquired in their initial months of driving. They should not be confused with "advanced driving performance" courses that teach driving skills such as panic braking, skid control, and evasive lane-changing maneuvers.

Previous post-licensure driver education courses were remedial, directed at drivers who had accumulated enough violations or crashes to warrant some attention. For this audience, post-licensure driver education had no effect (Ker et al., 2005, 2006).

Initiatives in Australia and Europe may provide insight on potential approaches for post-license training for beginning drivers (Senserrick, 2007; Twisk & Stacey, 2007). Christie and colleagues have developed a model "best practice" curriculum for intermediate license drivers with at least 6 months of driving experience in Australia (Christie, Harrison, & Johnston, 2004). The 8-hour curriculum consists of eight modular sessions with a mentor or coach, including one-on-one driving and discussion, group observation and discussion of driving behavior, and telephone follow-up. A trial involving 14,000 intermediate drivers in New South Wales and Victoria, funded by a consortium of government bodies, insurers, industry groups, and automobile clubs, was slated to begin in 2007, but has been delayed.

NHTSA has completed a feasibility study in anticipation of a major evaluation of the benefits of an integrated driver education and GDL program (Hedlund & Compton, 2005).

Use: Post-licensure driver education is still under development. Michigan is the only State that has adopted a two-stage system of driver education (Mayhew, 2007).

Effectiveness: Post-licensure driver education has not yet been evaluated.

Costs: If a post-licensure driver education program proves to be effective, it likely will require substantial funds to implement.

Time to implement: Any course requires at least a year to plan and implement.

3. Parents

3.1 Parental Role in Teaching and Managing Young Drivers

Effectiveness: ★★	Cost: $	Use: Medium	Time: Short

Most parents are heavily involved in teaching driving skills to their beginning teenage drivers and supervising their driving while they have a learner's permit. Parents are in the best position to enforce GDL restrictions for intermediate drivers, and many parents impose additional driving restrictions on their teenagers. Parents strongly support GDL; however, many parents do not understand the dangers of high-risk situations, such as driving with teenage passengers. Parents could use guidance and assistance in teaching and managing their teenage drivers (Hedlund et al., 2003; NCHRP, 2007, Strategies C1-C3). For summaries of the research on parent involvement in teen driving, see Simons-Morton and Ouimet (2006), or Simons-Morton, Ouimet, and Catalano (2008).

Many programs to assist parents and beginning drivers have been developed. Six examples follow. Three programs, *Checkpoints*, *Green Light for Life* and *The Novice Driver's Road Map* have been evaluated.

The central feature of the *Checkpoints* program, developed by Simons-Morton and colleagues at the National Institute of Child Health and Human Development, is a written agreement that parents and teens sign. The agreement limits teens' driving under various higher-risk situations, such as driving at night, with other teens in the car, or in bad weather. A supporting video and periodic newsletters explain the risks that new drivers face and reinforce the need for parents to limit their newly licensed teens' driving under these risky conditions (Simons-Morton & Hartos, 2003).

Green Light for Life (GLL) is a program that has been implemented in Israel since 2005 (Taubman & Lotan, 2011; Toledo, Lotan, Taubman, & Grimberg, 2012). From 2005-2008 approximately 130,000 families have participated in the program. GLL consists of an in-person 45 minute meeting with a parent and their young driver prior to entering the accompanied driving phase, otherwise known as the learner's permit stage in the U.S. During the meeting, parents and teens are encouraged to get as much supervised driving practice as possible in a variety of conditions. Parents are encouraged to share their hazard perception knowledge and skills with their teen driver. Strategies for dealing with in-vehicle dynamics between the teen and parent are also discussed. Families are given a booklet and CD to take home.

Driving Skills for Life, developed by Ford and GHSA, emphasizes four skills: hazard recognition, vehicle handling, space management, and speed management (Ford & GHSA, 2003). The program's educational kit includes a video, guide, and brochure, and the Web site contains online learning material, parental tips and a coaching guide. It has been sent to every public high school in the United States and has reached an estimated 4 million teenagers and their parents.

Road Ready Teens, developed by DaimlerChrysler together with AAA, MADD, and the National Safety Council, provides a parent's guide, a parent-teen contract, and a video game and Road Ready Reality Check quiz for teens (DaimlerChrysler, 2003).

The National Safety Council, with input from young driver experts, developed a 68-page book, *Teen Driver: A Family Guide to Teen Driver Safety* (NSC, 2004). The book provides information and advice to parents and teens on crash risks, how to develop a family plan and written agreement for beginning drivers, and GDL components and restrictions.

Finally, *The Novice Driver's Road Map*, produced by the Network of Employers for Traffic Safety, describes eight driving situations of increasing difficulty, from driving in an empty parking lot to driving at night and in inclement weather. Parents complete a checklist when practice has been obtained in each driving situation. *The Road Map* also includes a brief insert, called *The Coach's Gamebook*, with advice for parents of beginning drivers and a parent-teen driving contract.

Use: *Checkpoints*, *Driving Skills for Life*, and *Road Ready Teens* are available on the Web. *Teen Driver* and *The Road Map* can be provided to individual families upon request. *Green Light for Life* is not currently available in the U.S.

Effectiveness: Results from testing in several States show the *Checkpoints* program produces modest increases in parents' restrictions on teen driving (Simons-Morton & Hartos, 2003; Simons-Morton, Hartos, Leaf, & Preusser, 2005). However, a study in Connecticut found no differences in violations or crashes for families who participated in the *Checkpoints* program when compared with families who did not participate in the program (Simons-Morton, Hartos, Leaf, & Preusser, 2006).

To date, *Green Light for Life* has undergone two evaluations. Taubman and Lotan (2011) examined the effectiveness of the GLL program by comparing self-reports of 362 teenagers who participated in the program with 376 teens who did not. They found no difference in the amount of accompanied driving teens obtained during the supervised driving phase or the level of reckless driving reported. However, teenagers who participated in the program reported more positive attitudes about the supervised driving phase and reported less crash involvement. A recent national study evaluated injury crash involvement between teens who participated in the GLL program during 2005-2007 compared to teens that did not participate in the program. Based on analysis of injury crash data during the first two years after licensing, teens who participated in GLL had 10% lower injury crash rates (Toledo et al., 2012). Nonetheless, both studies suffered from the possible effects of self-selection bias. A follow-up study is underway to examine behavior and crash data of young drivers at the individual level, in an attempt to address this potential bias.

Two separate evaluations of *The Road Map* found the material had little effect on parents. In each study, *The Road Map* was provided to parents of teens who had just received their learner's permits. Although parents said that the information was helpful, they used the guidance material in only a general way. The information had no effect on the amount or type of supervised driving

during the learner's stage or on parental restrictions on driving after licensure (Chaudhary, Ferguson, & Herbel, 2004; Goodwin, Waller, Foss, & Margolis, 2006).

Although evaluations of programs to assist parents have not yet shown reductions in young driver crashes, there is still reason to be optimistic. Programs such as *Checkpoints* have increased parent limit setting, and several studies show that teenagers whose parents impose more strict driving limits report fewer risky driving behaviors, traffic violations and crashes (see Simons-Morton, 2007, for a review). Educational programs alone are unlikely to produce changes in behavior. However, education in combination with other strategies may deliver stronger results.

Costs: *Driving Skills for Life* and *Road Ready Teens* are available on the Web at no cost. *Teen Driver* and *The Road Map* are available to parents and teenagers at minimal cost.

Time to implement: *The Green Light for Life* program has not been released for use in the U.S. The other five programs are available immediately.

Other issues:

- **Electronic monitoring:** Various technologies have been developed to aid parents in monitoring their teenage drivers. For example, many GPS companies offer "teen tracking" services that will notify parents if their teens go beyond boundaries, or are speeding at any given time. Video-based devices, such as DriveCam, can provide visual monitoring of teen drivers. When these technologies are combined with weekly report cards to parents, they can reduce the incidence of risky driving behaviors among teens (Carney et al., 2010; Farmer, Kirley, & McCartt, 2010; McGehee et al., 2007; Musicant & Lampel, 2010). However, more research is needed to determine the impact of electronic monitoring on crashes and fatalities among young drivers.

4. Traffic Law Enforcement

4.1 Enforcement of GDL and Zero-Tolerance Laws

Effectiveness: ★★★	Cost: $$	Use: Unknown	Time: Short

Two traffic laws apply only to young drivers: GDL laws and zero-tolerance laws that set a maximum BAC of .02 or less for drivers under 21. As discussed in Chapter 1, Section 6.2, zero-tolerance laws are not actively publicized or enforced. It's likely that increased publicity and enforcement would reduce teenage drinking and driving.

GDL laws, discussed in Chapter 6, Sections 1.1-1.7, also appear not to be enforced vigorously. Some GDL provisions such as nighttime driving restrictions are inherently difficult to enforce because violations are difficult to detect (Hedlund et al, 2003). A study in one State found that intermediate license drivers and their parents were quite aware of their GDL law's nighttime and passenger restrictions. Both restrictions were violated, though not frequently. Teenagers expressed little concern regarding GDL enforcement. Although surveys of law enforcement officers found that most were supportive of GDL, officers were not familiar with GDL details and considered GDL enforcement a low priority (Goodwin & Foss, 2004). Another recently completed study found that teen drivers reported frequently violating passenger restrictions, with and/or without their parents' knowledge/permission, because local police did not routinely enforce GDL restrictions (Chaudhary et al., 2007).

Parents are in the best position to enforce GDL requirements (Chapter 6, Section 3.1). However, some law enforcement support for GDL nighttime driving and teenage passenger restrictions may be useful to emphasize that the requirements are important. GDL law violations are penalized by driver license actions, such as suspension or revocation of the learner's permit or intermediate license or an extension of the time before full licensure. This means they can be applied administratively and do not involve criminal court proceedings. As noted in Chapter 1, Section 6.2, administrative penalties for zero-tolerance laws are far easier to enforce than criminal penalties. Another issue with enforcement concerns the difficulties in identifying drivers that qualify as falling under the GDL system in a given State. It has been suggested, and is one of NHTSA's GDL recommendations, that young drivers should be required to affix a vehicle decal identifying them as qualifying for the GDL program to make them more readily identifiable. New Jersey is the first State to implement this potential countermeasure.

Use: The amount of enforcement of zero-tolerance and GDL laws is unknown but probably is low.

Effectiveness: Zero-tolerance law publicity and enforcement likely will reduce teenage drinking and driving, as discussed in Chapter 1, Section 6.2. Similarly, high-visibility enforcement of GDL provisions should encourage compliance with nighttime and passenger restrictions. One study investigated whether well-publicized enforcement, including checkpoints near high schools, could increase compliance with seat belt laws and GDL provisions. The study found only modest increases in seat belt use and compliance with the GDL passenger restriction,

although levels of compliance prior to the enforcement efforts were already high (Goodwin, Wells, Foss, & Williams, 2006).

A recent study evaluated the effectiveness of vehicle decals in New Jersey. The study found that citations for violations of licensing restrictions doubled in the year after the requirement went into effect; however, teenagers self-reports of violations did not decrease (McCartt et al., 2012). In addition, a large majority of parents and teenagers in New Jersey opposed the use of decals by probationary license holders and many teenagers do not use them when they drive.

Costs: See Chapter 1, Section 6.2, for zero-tolerance law enforcement strategies and costs. GDL law enforcement costs will depend on how the enforcement is conducted. Enforcement through regular patrols will require moderate costs for training. Special patrols or checkpoints will require additional staff time. All enforcement will require good publicity to both teens and parents. Publicity to teens can be delivered through high schools, colleges, recreational venues attended by youth, and media directed to youth.

Time to implement: Enforcement programs can be implemented within three or four months, as soon as appropriate training, publicity, and equipment are in place.

Other issues:

- **Compliance with restrictions:** Several studies have shown that teenagers do not always comply with GDL restrictions (Goodwin & Foss, 2004; Williams, Nelson & Leaf, 2002). To the extent that teens do not adhere to restrictions, the effectiveness of GDL may be reduced. It should be noted, however, that GDL has been shown to be effective even in the absence of police enforcement. For example, focus groups with parents and teen drivers conducted in California, Massachusetts, and Virginia revealed that passenger restrictions were frequently violated in all three States, but even incomplete adherence to the restrictions had a positive impact on teen driver crashes (Chaudhary et al., 2007). In general, compliance with restrictions will be higher in States that have well-designed GDL systems with restrictions that are considered reasonable by parents and teens (Foss & Goodwin, 2003).

Young Driver References

AAA Public Affairs. (2005). *GDL Laws.* Heathrow, FL: AAA.

Baker, S. P., Chen, L-H., & Li, G. (2006). *National Evaluation of Graduated Driver Licensing Programs.* (Report No. DOT HS 810 614). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/NewDriver/GDLReport/images/GDLReport.pdf

Baker, S. P., Chen, L-H., & Li, G. (2007). *Nationwide Review of Graduated Driver Licensing.* Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/NationwideReviewOfGDL.pdf

Block, A. W., & Walker, S. (2008). *2007 Motor Vehicle Occupant Safety Survey: Driver Education and Graduated Driver Licensing*. (Report No. DOT HS 811 047). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811047.pdf

Carney, C., McGehee, D. V., Lee, J. D., Reyes, M. L. & Raby, M. (2010). Using an event-triggered video intervention system to expand the supervised learning of newly licensed adolescent drivers. *American Journal of Public Health, 100,* 1101-1106.

Carpenter, D., & Pressley, J. C. (2012). Graduated driver licensing nighttime compliance in U.S. teen drivers involved in fatal motor vehicle crashes. *Accident Analysis & Prevention*, in press.

Christie, R., Harrison, W., & Johnston, D. (2004). *Development of a Novice Driver Education Curriculum for the ATSB.* Report CR 222. Canberra, Australia: Australian Transport Safety Bureau. Available at www.infrastructure.gov.au/roads/safety/publications/2004/Edu_Nov_Dr.aspx

Chaudhary, N. K., Ferguson, S.A., & Herbel, S. B. (2004). Tennessee's novice driver safety project: A program to increase parental involvement. *Traffic Injury Prevention, 5*, 356-361.

Chaudhary, N. K., & Williams, A. F. (2010). *Parents' Attitudes About Connecticut's Required Driver Orientation Course for Parents*. Trumbull, CT: Connecticut Department of Motor Vehicles . Available at www.ct.gov/dmv/lib/dmv/parentsurvey.pdf

Chaudhary, N., Williams, A., & Nissen, W. (2007). *Evaluation and Compliance of Passenger Restrictions in a Graduated Driver Licensing Program.* (Report No. DOT HS 810 781). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810781Scr.pdf

Clinton, K. M., & Lonero, L. (2006). *Guidelines for Evaluating Driver Education Programs*. Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/EvaluatingDriverEducationProgramsGuidelines.pdf

Compton, R. P., & Ellison-Potter, P. (2008). *Teen Driver Crashes: A Report to Congress*. (Report No. DOT HS 811 005). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811005.pdf

Dahl, R. E. (2008). Biological, developmental, and neurobehavioral factors relevant to adolescent driving risks. *American Journal of Preventive Medicine*, *35(3S)*, S278-S284.

DaimlerChrysler. (2003). *Road Ready Teens.* Auburn Hills, MI: Author. Available at www.roadreadyteens.org/index.html

Farmer, C. M., Kirley, B. B., & McCartt, A. T. (2010). Effects of in-vehicle monitoring on the driving behavior of teenagers. *Journal of Safety Research*, *41*, 39-45.

Fell, J. C., Jones, K., Romano, E., & Voas, R. (2011). An evaluation of graduated driver licensing effects on fatal crash involvements of young drivers in the United States. *Traffic Injury Prevention*, *12*, 423-431.

Ferguson, S. A. (2003). Other high-risk factors for young drivers - how graduated licensing does, doesn't, or could address them. *Journal of Safety Research, 34*, 71-77.

Ford & GHSA. (2003). *Driving Skills for Life.* Dearborn, MI: Ford Motor Company. Available at www.drivingskillsforlife.com/

Foss, R. D. (2009). *Effect of Adding a Passenger Restriction to an Already Effective GDL System*. Presentation at the TRB ANB30(1) Young Driver Mid-year Meeting. Washington, DC.

Foss, R., & Goodwin, A. (2003). Enhancing the effectiveness of graduated driver licensing legislation. *Journal of Safety Research, 34*, 79-84.

Foss, R. D., Goodwin, A. H., McCartt, A. T., & Hellinga, L. A. (2009). Short-term effects of a teenage driver cell phone restriction. *Accident Analysis and Prevention*, *41*, 419-424.

Foss, R. D., Masten, S. V., Goodwin, A. H., & O'Brien, N. P. (2012). *The Role of Supervised Driving Requirements in Graduated Driver Licensing Programs.* (Report No. DOT HS 811 550). Washington, DC: National Highway Traffic Safety Administration.

Freedman, M., & Levi, S. (2008, April). *Evaluation of a Seat Belt Restriction in a Graduated Driver Licensing Program*. Presentation at the 2008 Lifesavers Conference. Portland, OR.

Governors Highway Safety Association. (2012a). *Graduated Licensing Laws.* Washington, DC: Author. Available at www.statehighwaysafety.org/html/stateinfo/laws/license_laws.html

GHSA. (2012b). *Cell Phone Driving Laws.* Washington, DC: Author. Available at www.statehighwaysafety.org/html/stateinfo/laws/cellphone_laws.html

Goodwin, A. H., & Foss, R. D. (2004). Graduated driver licensing restrictions: awareness, compliance, and enforcement in North Carolina. *Journal of Safety Research, 35*, 367-374.

Goodwin, A. H., Waller, M. W., Foss, R. D., & Margolis, L. H. (2006). Parental supervision of teenage drivers in a graduated licensing system. *Traffic Injury Prevention, 7*, 224-231.

Goodwin, A. H., Wells, J. K., Foss, R. D., & Williams, A. F. (2006). Encouraging compliance with graduated driver licensing restrictions. *Journal of Safety Research, 37*, 343-351.

Goodwin, A. H., O'Brien, N. P., & Foss, R. D. (2011). Effect of North Carolina's restriction on teenage driver cell phone use two years after implementation. *Accident Analysis & Prevention, 48,* 363-367.

Hedlund, J., & Compton, R. (2005). Graduated driver licensing research in 2004 and 2005. *Journal of Safety Research 36*, 109-114.

Hedlund, J., Shults, R. A., & Compton, R. (2003). What we know, what we don't know, and what we need to know about graduated driver licensing. *Journal of Safety Research, 34*, 107-115.

Insurance Institute for Highway Safety. (2011). *Fatality Facts 2010: Teenagers.* Arlington, VA: Author. Available at www.iihs.org/research/fatality_facts_2010/teenagers.html

IIHS (2012a). *Q & A: Teenagers as of May 2012.* Arlington, VA: Author. Available at www.iihs.org/research/qanda/teens.aspx

IIHS. (2012b). *U.S. Licensing Systems for Young Drivers: Laws as of July 2012* Arlington, VA: Author. Available at www.iihs.org/laws/graduatedLicenseIntro.aspx

IIHS. (2012c). *Cellphone Laws, July 2012*. Arlington, VA: Author. Available at www.iihs.org/laws/cellphonelaws.aspx

IIHS (2012d). *Safety belt use laws, July 2012*. Arlington, VA: Author. Available at www.iihs.org/laws/SafetyBeltUse.aspx

IIHS & TIRF. (2004). *Graduated Licensing: A Blueprint for North America*. Arlington, VA: Insurance Institute for Highway Safety.

Keating, D. P. (2007). Understanding adolescent development: Implications for driving safety. *Journal of Safety Research, 38,* 147-157.

Ker, K., Roberts, I., Collier, T., Beyer, F., Bunn, F., & Frost, C. (2005). Post-license driver education for the prevention of road traffic crashes: a systematic review of randomised controlled trials. *Accident Analysis and Prevention, 37,* 305-313.

Ker, K., Roberts, I., Collier, T., Beyer, F., Bunn, F., & Frost, C. (2006). Post-license driver education for the prevention of road traffic crashes. *The Cochrane Database of Systematic Reviews* 2006, Issue 2. Available at www.cochrane.org/reviews/en/ab003734.html

Kim, S., Depue, L., Spence, L., & Reine, J. (2009). Analysis of teenage seat belt use: From the 2007 Missouri high school seat belt survey. *Journal of Safety Research*, *40*, 311-316.

Lee, J. D. (2007). Technology and teen drivers. *Journal of Safety Research*, *38*, 203-213.

Lin, M-L., & Fearn, K. T. (2003). The provisional license: nighttime and passenger restrictions -- a literature review. *Journal of Safety Research, 34*, 51-61.

Lyon, J. D., Pan, R., & Li, J. (2012). National evaluation of the effect of graduated licensing laws on teenager fatality and injury crashes. *Journal of Safety Research*, *43*, 29-37.

Margolis, L. H., Masten, S. V., & Foss, R. D. (2007). The effects of graduated driver licensing on hospitalization rates and charges for 16- and 17-year-olds in North Carolina. *Traffic Injury Prevention, 8,* 35-38.

Masten, S. V. (2011). *National study of teen driver licensing systems and graduated driver licensing program core components*. Ph.D. thesis, University of North Carolina, Chapel Hill.

Masten, S. V., Foss, R., & Marshall, S. (2011). Graduated driver licensing and fatal crashes involving 16-to 19-year-old drivers. *Journal of the American Medical Association*, *306*, 1099-1103.

Mayhew, D. R. (2003). The learner's permit. *Journal of Safety Research, 34,* 35-43.

Mayhew, D. R. (2007). Driver education and graduated licensing in North America: Past, present, and future. *Journal of Safety Research, 38*, 229-235.

McCartt, A. T., Hellinga, L. A., & Haire, E. R. (2007). Age of licensure and monitoring teenagers' driving: Survey of parents of novice teenage drivers. *Journal of Safety Research*, *38*, 697-706.

McCartt, A. T., Oesch, N. J., Williams, A. F., & Powell, T. C. (2012). New Jersey's license plate decal requirement for graduated driver licenses: Attitudes of parents and teenagers, observed decal use, and citations for teenage driving violations. *Traffic Injury Prevention,* doi:10.1080/15389588.2012.701786

McCartt, A. T., Teoh, E. R., Fields, M., Braitman, K. A., & Hellinga, L. A. (2010). Graduated licensing laws and fatal crashes of teenage drivers: A national study. *Traffic Injury Prevention*, *11*, 240-248.

McGehee, D. V., Raby, M., Carney, C., Lee, J. D., & Reyes, M. L. (2007). Extending parental mentoring using an event triggered video intervention in rural teen drivers. *Journal of Safety Research, 38,* 215-227.

McKay, M. P., Coben, J. H., Larkin, G. L., & Shaffer, A. (2008). Attitudes of Teenagers and Their Parents to Pennsylvania's Graduated Driver Licensing System. *Traffic Injury Prevention*, *9*, 217-223.

McKnight, A. J., & Peck, R. C. (2003). Graduated driver licensing and safer driving. *Journal of Safety Research 34,* 85-89.

Musicant, O., & Lampel, L. (2010). *When Technology Tells Novice Drivers How to Drive*. Transportation Research Board Annual Meeting, Paper #10-1489. 13p.
NCHRP. Vol 19 (2007). *A Guide for Reducing Collisions Involving Young Drivers.* Washington, DC: Transportation Research Board. onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v19.pdf

National Highway Traffic Safety Administration. (1999). *Fourth report to Congress: Effectiveness of occupant protection systems and their use*. (Report No. DOT HS 808 919). Washington, DC:Author.

NHTSA. (2008). *Traffic Safety Facts, Laws: Graduated Driver Licensing System*. (Report No. DOT HS 810 888W). Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Teen%20Driver/files/810888GradDriverLicense.pdf

NHTSA. (2010). *Novice Teen Driver Education and Training Administrative Standards*. Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Teen%20Driver/files/TeenDriverETAS-1.pdf

NHTSA. (2011a). *Traffic Safety Facts 2009.* (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.pdf

NHTSA. (2011b). *Traffic Safety Facts, Research Note: Driver Electronic Device Use in 2010*. (Report No. DOT HS 811 372). Washington, DC: Author. Available at www.distraction.gov/download/research-pdf/8052_TSF_RN_DriverElectronicDeviceUse_1206111_v4_tag.pdf

NHTSA. (2012). *Traffic Safety Facts, 2010 Data: Young Drivers*. (Report No. DOT HS 811 622). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811622.pdf

NHTSA & NIAAA. (1999). *Sentencing and Dispositions of Youth DUI and Other Alcohol Offenses: A Guide for Judges and Prosecutors.* (Report No. DOT HS 808 891). Washington, DC: Author.

National Safety Council. (2004). *Teen Driver: A Family Guide to Teen Driver Safety.* Itasca, IL: Author. Available at http://downloads.nsc.org/pdf/family_guide_teen.pdf

O'Brien, N. P., Foss, R. D., Goodwin, A. H., & Masten, S. V. (2013). Supervised hours requirements in graduated driver licensing: Effectiveness and parent awareness. *Accident Analysis & Prevention*, *50,* 330-335.

O'Brien, N. P., Goodwin, A. H., Foss, R. D. (2010). Talking and texting among teenage drivers: A glass half empty or half full? *Traffic Injury Prevention, 11,* 549-554.

Ouimet, M. C., Simons-Morton, B. G., Zador, P. L., Lerner, N. D., Freedman, M., Duncan, G. D., & Wang, J. (2010). Using the U.S. National Household Travel Survey to estimate the impact of passenger characteristics on young drivers' relative risk of fatal crash involvement. *Accident Analysis and Prevention*, *42*, 689-694.

Pressley, J. C., Benedicto, C. B., Trieu, L., Kendig, T., & Barlow, B. (2009). Motor vehicle injury, mortality, and hospital charges by strength of Graduated Driver Licensing laws in 36 states. *The Journal of Trauma: Injury Infection, and Critical Care*, *67(1 Supp.)*, S43-S53.

Roberts, I., Kwan, I., and the Cochrane Injuries Group Driver Education Reviewers (2006). School based driver education for the prevention of traffic crashes. *The Cochrane Database of Systematic Reviews* 2006, Issue 2. Available at www.cochrane.org/reviews/en/ab003201.html

Russell K. F., Vandermeer, B., Hartling, L. (2011). Graduated driver licensing for reducing motor vehicle crashes among young drivers. *Cochrane Database of Systematic Reviews* 2011, Issue 10. Art. No.: CD003300. DOI: 10.1002/14651858.CD003300.pub3

Senserrick, T. M. (2007). Recent developments in young driver education, training and licensing in Australia. *Journal of Safety Research, 38,* 237-244.

Shope, J. T. (2007). Graduated driver licensing: Review of evaluation results since 2002. *Journal of Safety Research, 38,* 165-175.

Shults, R. A., & Ali, B. (2010). Drivers aged 16 or 17 years involved in fatal crashes - United States, 2004-2008. *MMWR Morbidity and Mortality Weekly Report*, *59(41)*, 1329-1334.

Simons-Morton, B.G. (2007). Parental involvement in novice teen driving: Rationale, evidence of effects, and potential for enhancing graduated driver licensing effectiveness. *Journal of Safety Research, 38*, 193-202.

Simons-Morton, B. G., & Hartos, J. L. (2003). How well do parents manage young driver crash risks? *Journal of Safety Research, 34*, 91-97.

Simons-Morton, B. G., Hartos, J. L., Leaf, W. A., & Preusser, D. (2005). The persistence of effects of the Checkpoints program on parental restrictions of teen driving privileges. *American Journal of Public Health, 95*, 447-452.

Simons-Morton, B. G., Hartos, J. L., Leaf, W. A., & Preusser, D. (2006). The effects of the Checkpoints program on parent-imposed driving limits and crash outcomes among Connecticut novice teen drivers at 6-months post-licensure. *Journal of Safety Research, 37*, 9-15.

Simons-Morton, B. G. & Ouimet, M. C. (2006). Parent involvement in novice teen driving: a review of the literature. *Injury Prevention, 12*, i30-i37.

Simons-Morton, B. G., Ouimet, M. C., & Catalano, R. F. (2008). Parenting and the young driver problem. *American Journal of Preventive Medicine, 35(3S)*, S294-S303.

Simpson, H. M. (2003). The evolution and effectiveness of graduated licensing. *Journal of Safety Research, 34*, 25-34.

Smith, M. F. (1994). *Research Agenda for an Improved Novice Driver Education Program.* Report to Congress, May 31, 1994. (Report No. DOT HS 808 161). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/pub/drive-ed.pdf

Steenbergen, L. C., Kidd, P. S., Pollack, S., McCoy, C., Pigman, J. G., & Agent, K. R. (2001). Kentucky's graduated licensing program for young drivers: barriers to effective local implementation. *Injury Prevention, 7*, 286-291.

Steinberg, L. (2007). Risk taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science, 16*, 55-59.

Taubman-Ben-Ari, O. & Lotan, T. (2011). The contribution of a novel intervention to enhance safe driving among young drivers in Israel. *Accident Analysis and Prevention, 43,* 352-359.

Tefft, B. C., Williams, A. F., & Grabowski, J. G. (2012) *Teen driver risk in relation to age and number of passengers*. Washington DC: AAA Foundation for Traffic Safety.

Thomas, F. D. III., Blomberg, R. D., & Fisher, D. L. (2012). *A fresh fook at driver education in America*. (Report No. DOT HS 811 543)). Washington, DC: National Highway Traffic Safety Administration.

Toledo, T., Lotan, T., Taubman-Ben-Ari, O., & Grimberg, E. (2012). Evaluation of a program to enhance young drivers' safety in Israel. *Accident Analysis and Prevention, 45,* 705-710.

Transportation Research Board. (2006). *Driver education: The path ahead*. Transportation research circular, Vol. E-C101. Washington, DC:
Author. http://onlinepubs.trb.org/onlinepubs/circulars/ec101.pdf

Twisk, D. A. M., & Stacey, C. (2007). Trends in young driver risk and countermeasures in European countries. *Journal of Safety Research, 38*, 245-257.

Vernick, J. S., Li, G., Ogaitis, S., MacKenzie, E. J., Baker, S. P., & Gielen, A. C. (1999). Effects of high school driver education on motor vehicle crashes, violations, and licensure. *American Journal of Preventive Medicine, 16*, 40-46.

Waller, P. F. (2003). The genesis of GDL. *Journal of Safety Research*, *34*, 17-23.

Wiggins, S. (2004). *Graduated Licensing Program: Interim Evaluation Report - Year 3*. Victoria, BC: Insurance Corporation of British Columbia.

Williams, A. F. (2003). Teenage drivers: patterns of risk. *Journal of Safety Research, 34*, 5-15.

Williams, A. F. (2009). Licensing age and teenage driver crashes: A review of the evidence. *Traffic Injury Prevention*, *10*, 9-15.

Williams, A. F., Braitman, K. A., & McCartt, A. T. (2011). Views of parents of teenagers about licensing policies: A national survey, *Traffic Injury Prevention, 12*, 1-8

Williams, A. F., Chaudhary, N. K., Tefft, B. C., & Tison, J. (2010). Evaluation of New Jersey's graduated driver licensing program. *Traffic Injury Prevention*, *11*, 1-7.

Williams, A. F., Ferguson, S. A., Leaf, W. A., & Preusser, D. F. (1998). Views of parents of teenagers about graduated licensing system. *Journal of Safety Research*, *29*, 1-7.

Williams, A. F., McCartt, A. T., Mayhew, D. R., & Watson, B. (2012). Licensing age issues: deliberations from a workshop devoted to this topic. *Traffic Injury Prevention*, in press.

Williams, A. F., Nelson, L. A., & Leaf, W. A. (2002). Responses of teenagers and their parents to California's graduated licensing system. *Accident Analysis and Prevention*, *34*, 835-842.

Williams, A. F., Preusser, D. F. & Ledingham, K. A. (2009). *Feasibility Study on Evaluating Driver Education Curriculum*. (Report No. DOT HS 811 108). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811108.pdf

Williams, A. F., Tefft, B. C., & Grabowski, J. G. (2012). Graduated driver licensing research, 2010-present. *Journal of Safety Research,* in press.

Zakrajsek, J. S., Shope, J. T., Ouimet, M. C., Wang, J., & Simons-Morton, B. G. (2009). Efficacy of a brief group parent-teen intervention in driver education to reduce teenage driver injury risk. *Family& Community Health*, *32*, 175-188.

7. Older Drivers

Overview

In 2010, more than 16% of licensed drivers in the United States were 65 or older. By 2030 this proportion is expected to rise to at least 20%. As drivers age, their physical and mental abilities, driving behaviors, and crash risks all change, though age itself does not determine driving performance. Many features of the current system of roads, traffic signals and controls, laws, licensing practices, and vehicles were not designed to accommodate older drivers. Older Americans are increasingly dependent on driving to maintain their mobility, independence, and health. The challenge is to balance mobility for older drivers with safety for all road users.

Trends. From 1982 to 2010, the proportion of licensed drivers 65 and older rose from 11.2% to 16.1% while the proportion of these older drivers in fatal crashes rose more rapidly, from 7.0% to 17.0%.

People 65 and older; number and proportion of total populations

65 & up	resident population		licensed drivers		drivers in fatal crashes	
year	million	%	million	%		%
1982	26.8	11.6%	16.8	11.2%	3,894	7.0%
2010	40.3	12.7%	33.7	16.1%	5,560	12.5%
2030	72*	19.3%*	57- 61**	> 20%**	?	?

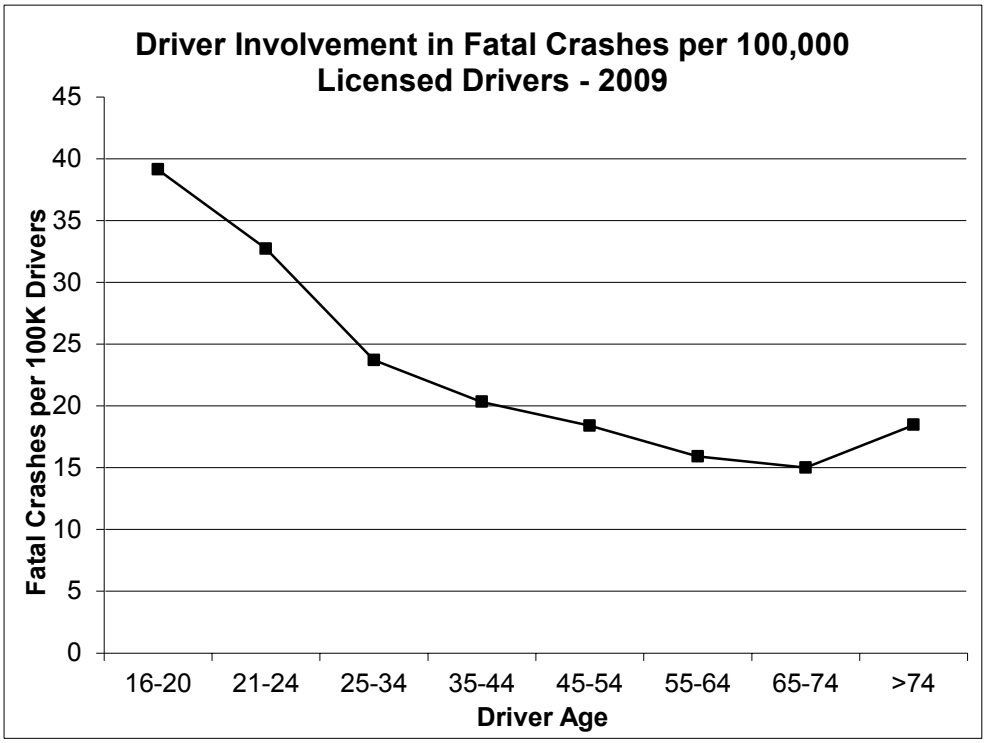
Resident population: U.S. Census Bureau (2008, 2011) * estimated
Licensed drivers: FHWA Highway Statistics (1995, 2011) ** see discussion
Fatal crashes: NHTSA Traffic Safety Facts (2012)

The United States population 65 and older increased at a much faster rate (15.1%) than the total population (9.7%) between the years 2000 and 2010 (U.S. Census Bureau,,2011). By 2030, the Census Bureau estimates that the resident population over 65 will double, to over 72 million, and will comprise 19.3% of the total population (U.S. Census Bureau, 2008). The licensed driver population likely will grow even faster. The proportion of people 65 or older who held a driver's license rose from 63% in 1982 to 83% in 2008. If the licensure rate remains the same, by 2030 there will be nearly twice as many older drivers in the United States as there are today. As of 2008, 94% of people 65 to 69 are licensed, as are 89% of people 70 to 74, 84% of people 75 to 79, 77% of people 80 to 84, and 56% of people 85 and older (FHWA, 2010). The licensure rate probably will increase because tomorrow's older people likely will be healthier and more accustomed to driving than today's. By 2030, if 85% of older people are licensed there will be close to 61 million licensed drivers at least 65 years old.

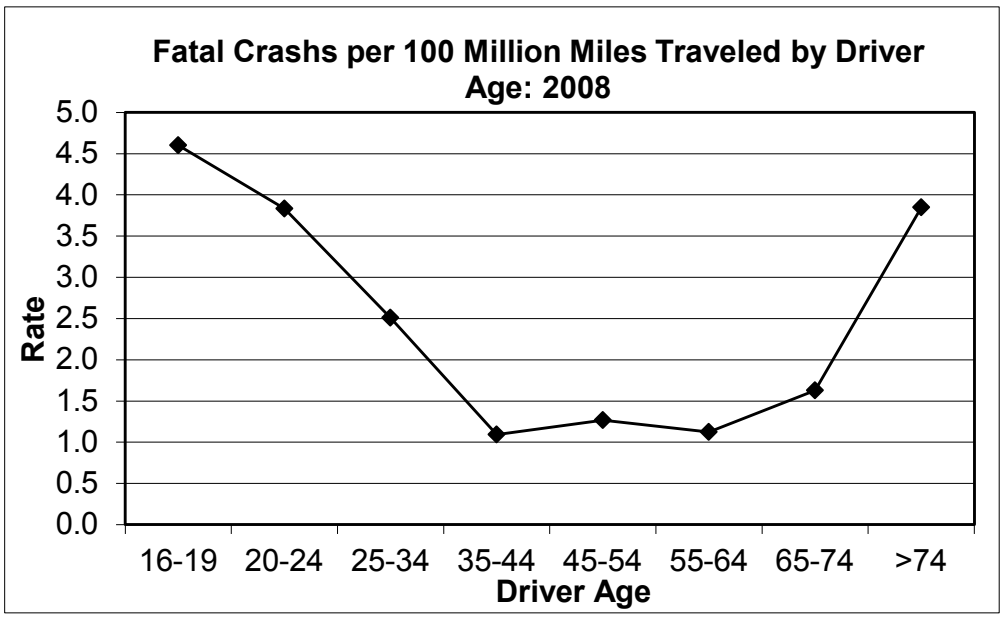
Older driver characteristics. Certain changes are inevitable as drivers age (Potts et. al, 2004; National Cooperative Highway Research Program [NCHRP], 2004, Section III).

- Physical capabilities diminish. Hearing, muscle tone, reaction time, and vision (especially at night) all decline, though at very different rates for different people.

- Fragility increases. The same force produces more serious injuries to a 70-year-old than to a 20-year-old. Injuries take longer to heal.
- Cognitive capabilities can diminish. Driving is a complex activity that requires a variety of high-level cognitive skills that can diminish through changes that occur with normal aging and/or as a result of dementia.
- Many older drivers use medications. These may be necessary to control disease or health conditions but also may cause drowsiness or otherwise affect driving. Older drivers are less likely than younger people to drive after drinking or using recreational drugs.
- Older drivers rarely drive aggressively or speed. However, they may exhibit other risky behaviors such as driving more slowly than prevailing traffic or failing to detect or accurately judge the speed of an oncoming vehicle while making a left turn.
- Most older drivers reduce their driving mileage as their lifestyles change. Many older drivers recognize and avoid driving in situations in which they feel uncomfortable, such as at night, on high-speed roads, or in unfamiliar situations (Staplin & Lococo, 2003).



Source: Traffic Safety Facts 2009 (NHTSA, 2011, Table 64)



Source: Insurance Institute for Highway Safety [IIHS] (2012)

These characteristics produce the following results.

- The older driver crash rate per licensed driver is *lower* than for younger drivers.
- However, the fatal crash rate for older drivers *per mile traveled* is *higher* than for all but the youngest drivers (IIHS, 2012). This is due to changes in driving habits and increased susceptibility to injury among older drivers:
    - Older drivers drive fewer miles annually than younger drivers but tend to drive more on local roads where there are more potential hazards, such as traffic congestion and confusing intersections (Wang, Kosonski, Schwartzberg, & Shanklin, 2003).
    - Because older drivers are more fragile, a crash is more likely to produce a serious injury or fatality than for younger drivers. Fragility, as measured by deaths per driver involved in a crash, begins to increase at 60 to 64 and increases steadily with advancing age. Fragility, rather than an increased tendency to get into crashes, accounts for about 60% to 95% (depending on age group and gender) of the increased death rates per miles traveled in older drivers (Li, Braver, & Chen, 2003).
    - More recent research has concluded that the fatal crash risk for drivers 70 and older declined during the 1997-2008 time period at a rate faster than that for the comparison group of 35- to 54-year-old drivers. The authors suggest that this reduction in fatality risk for the older drivers is due to their decreased likelihood of being involved in crashes combined with an increase in their chances of survival when they are involved in crashes (Cheung & McCartt, 2010).

Another informative study titled *Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers* reviewed published literature and analyzed the most recent national crash data to identify driving behaviors/performance errors, and combinations of driver, vehicle, and roadway/environmental characteristics associated with increased crash

involvement by older drivers (Stutts, Martell, & Staplin, 2009). The study found that drivers over 70 were overrepresented in a variety of types of crashes, but that drivers 60 and older were less likely than younger drivers to be involved in alcohol- or speed-related crashes. The older drivers were also underrepresented in nighttime-related crashes, probably due in part to this group's tendency to avoid driving at night. Another general trend is that as drivers get older, they tend to be overrepresented in crashes that require navigating more complex situations such as intersections, left turns, and reacting to an impending crash (Stutts, Martell, & Staplin, 2009).

Strategies to Reduce Crashes and Injuries Involving Older Drivers

The overall goal is to enable older drivers to retain as much mobility through driving as is consistent with safety on the road for themselves, their passengers, and other road users. "Safe mobility for life" is the phrase used in the U.S. Department of Transportation's *Safe Mobility for a Maturing Society: Challenges and Opportunities* plan published in 2003 (U.S. DOT, 2003). Four behavioral strategies to address this goal were established:

- Educate and train older drivers to assess their driving capabilities and limitations, improve their skills when possible, and voluntarily limit their driving to circumstances in which they can drive safely. This can be accomplished through formal courses or through communications and outreach provided directly to older drivers or to families, friends, and organizations that deal regularly with older drivers.
- Help drivers adapt to medical or functional conditions that may affect driving, through treatment (such as eyeglasses or cataract surgery to improve vision) or through vehicle adaptations (such as extra mirrors, extended gear shift levers, or hand controls).
- Identify older drivers who cannot drive safely, in certain situations or at all, and restrict or revoke their driver's licenses. This involves two steps:
    - Bring these drivers to the attention of the motor vehicle department through license renewal procedures or through referral from law enforcement, physicians, family, or friends.
    - At the motor vehicle department, assess their driving abilities and take appropriate action to re-issue an unrestricted license, issue a restricted license, or revoke the license.
- Increase seat belt use, because seat belts are even more effective for older than for younger occupants.

In 2005, NHTSA developed an "Older Driver Traffic Safety Plan" that synthesized research findings and expert opinions and guided research and programs involving NHTSA during the next few years (NHTSA, 2005).

Building on that work, NHTSA produced another "Older Driver Program Five-Year Strategic Plan" in 2010 focused on how NHTSA will address the safety needs of older drivers through the years 2012-2017 (NHTSA, 2010). Based on interviews and expert panel input and other research, NHTSA identified three main program initiatives to guide the implementation of its "Older Driver Traffic Safety Plan" for 2012-2017:

1. Build communications for older drivers and caregivers.
2. Establish and maintain partnerships to enhance older driver safety efforts.
3. Develop and promote driver licensing policies.

There are a number of vehicular, environmental, and societal strategies that are critical to provide safety and mobility for older people but are for the most part beyond the control of SHSOs. Vehicles can be designed with better crash protection for older and more easily injured occupants, with controls and displays that are easier to see, reach and understand, and with crash warning and crash avoidance technology. These measures will make vehicles safer for everyone, not just older people. Aftermarket vehicle devices such as one-hand joystick driving controls can make driving possible or easier for people with some physical limitations. Roadways with separate left turn lanes, protected left turn signal phases, larger and more-visible signage, more-visible lane markings, rumble strips, and a host of other measures will assist all drivers. These subjects are not discussed in this guide because they do not fall under direct SHSO jurisdiction. However, it is important that SHSOs become at least somewhat familiar with basic concepts of transportation planning and engineering – such as those mentioned above – since SHSOs can be expected to play increasingly important roles in partnerships to enhance older driver safety and mobility efforts.

Of all the subject areas in this guide, those related to older drivers are perhaps the most complex because they involve so many issues beyond traffic safety. Sooner or later, in the interest of safety, most older drivers must restrict or eliminate driving, either by choice or as the result of the State licensing authority restricting or revoking the license. Frequently, this has substantial effects on the older driver's mobility and on physical and mental health. State Highway Safety Offices and licensing agencies cannot act alone but must plan and implement their older driver policies and programs as part of integrated community activities to improve older people' safety, mobility, and health. As just one example, some communities have established referral centers where people can go for "one-stop" access to resources for addressing the full range of transportation safety and mobility issues, including driving skills assessment, educational courses, licensing regulations and practices, and public transportation. See Stutts (2005) for summaries of comprehensive programs for older drivers in 6 States.

Several studies and policy papers discuss these issues. See in particular the Department of Transportation's *Safe Mobility for a Maturing Society: Challenges and Opportunities* (U.S. DOT, 2003) and NCHRP's *Guide for Addressing Collisions Involving Older Drivers* (NCHRP, 2004) for excellent summaries and references to further information. The Organisation for Economic Co-Operation and Development's *Ageing and Transport: Mobility Needs and Safety Issues* (OECD, 2001) presents a discussion from an international perspective. The NCHRP synthesis *Improving the Safety of Older Road Users* (Stutts, 2005) summarizes State activities as of 2005. A report issued by the AAA Foundation for Traffic Safety (Stutts & Wilkins, 2009) documents current United States policies and practices for improving the safety of older drivers and identifies model programs. These policies and practices and model programs are made available through the AAAFTS "Driver Licensing Policies and Practices" and "Noteworthy Initiatives" databases that can be searched by State or by policy/topic area.

Resources

The agencies and organizations listed below can provide more information on older drivers and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Senior Drivers - www.nhtsa.gov/Senior-Drivers
  - Driver Safety Research Reports: Older Drivers – www.nhtsa.gov/Driving+Safety/Driver+Safety+Research+Reports:+Older+Drivers
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Centers for Disease Control and Prevention, Injury Prevention & Control: www.cdc.gov/Motorvehiclesafety/Older_Adult_Drivers/index.html
- Governors Highway Safety Association: www.ghsa.org/html/issues/olderdriver.html
- Insurance Institute for Highway Safety: www.iihs.org/research/topics/older_people.html
- National Safety Council: www.nsc.org/safety_road/DriverSafety/Pages/MatureDrivers.aspx
- AAA:
  - Senior Drivers: exchange.aaa.com/safety/senior-driver-safety/
  - AAASeniors: seniordriving.aaa.com/
- AAA Foundation for Traffic Safety:
  - www.aaafoundation.org
- AARP: aarp.org/driversafety
- The Hartford: hartfordauto.thehartford.com/Safe-Driving/Car-Safety/Older-Driver-Safety/
- National Center on Senior Transportation**:** seniortransportation.easterseals.com/

Countermeasures That Work

Countermeasures to improve older driver safety are listed below and discussed individually in this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The terms and symbols used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information.

1. Communications and Outreach

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Formal courses for older drivers	★★	$	Low	Short
1.2 General communications and education	★★	$	Unknown	Short

2. Licensing

Countermeasure	Effectiveness	Cost	Use	Time
2.1 License screening and testing	★★★★	$$	High	Medium
2.2 Referring older drivers to DMVs	★★★★	$$	Low	Medium
2.3 License restrictions	★★★★	$	Unknown	Short
2.4 Medical advisory boards	★★	Varies	High	Medium
2.5 License renewal policies	★★	$$$	Medium	Medium

3. Traffic Law Enforcement

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Law enforcement roles	★★★	Varies	Medium	Varies

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise.

See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment or facilities

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: fewer than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies

1. Communications and Outreach

1.1 Formal Courses for Older Drivers

Effectiveness: ★★	Cost: $	Use: Low	Time: Short

Formal courses specifically for older drivers are offered by organizations including AAA, AARP, and the National Safety Council, either independently or under accreditation by States (NCHRP, 2004, Strategy D2; Stutts, 2005, Table 12). AARP's Driver Safety Program, formerly called "55 Alive," is the oldest and largest. It has been conducted since 1979 and is offered both in the classroom and online (AARP, 2010). The courses typically involve 6 to 10 hours of classroom training in basic safe driving practices and in how to adjust driving to accommodate age-related cognitive and physical changes. As of 2010, 36 States and the District of Columbia mandated automobile insurance discounts for graduates of accredited courses (AARP, 2010).

Courses combining classroom and on-the-road instruction have been offered in a few locations (NCHRP, 2004, Strategy D2).

Use: Courses are taught in all States but reach only a small fraction of older drivers. For example, AARP reports that over 700,000 people each year complete the AARP Driver Safety Program nationwide, which represents approximately 1% of the eligible driving population age 50 and older (AARP, 2009).

Effectiveness: Graduates of both the AARP classroom and online courses report that they changed some driving behaviors as a result of the course (AARP, 2009; Skufca, 2008). However, none of the courses has been shown to reduce crashes (NCHRP, 2004, Strategy D2). NHTSA's Older Road User Research Plan includes the high-priority research problem statement, "Do assessment and retraining programs improve driving?" (Raymond, Knoblauch, & Nitzburg, 2001, Table 1). The most thorough evaluation studied approximately 200,000 course graduates and a 360,000-driver comparison group in California from 1988 to 1992. It found that course graduates had fewer citations but no fewer crashes than non-graduates (Janke, 1994; NCHRP, 2004, Strategy D2). AARP also concluded that its course reduces citations but has not been shown to reduce crashes (AARP, 2009).

A study conducted in 2004 evaluated the effects of a well-designed three-hour educational course promoting safe driving strategies for older drivers with some visual defects. Course graduates reported that they regulated their driving more following the course than a control group that did not attend the course. There was no significant difference in crash rates between course graduates and the control group (Owsley, McGwin, Phillips, McNeal, & Stalvey, 2004).

Another 2004 study involving a systematic review of studies evaluating the effectiveness of driver retraining programs (Kua, Korner-Bitensky, Desrosiers, Man-Song-Hing, & Marshall, 2007) reached a similar conclusion as did Owsley et al., (2004). These researchers reported that while there is moderate evidence that educational interventions improve driving awareness and behavior, these interventions do not reduce crashes in older drivers. Regardless, the authors felt

that the evidence regarding the effectiveness of retraining aimed at older drivers is encouraging enough warrant further research.

More recent evaluations of courses for older drivers have produced mixed results related to the crash rates of drivers attending these courses. Marottoli (2007) concluded that a training program that combined classroom education with on-road training improved the performance of older drivers on written and on-road tests and may allow these drivers to retain their licenses longer, but did not attempt to assess the program's impact on subsequent crash rates. Bedard et al. (2008) concluded that an in-class education program coupled with on-road education led to improvements in the participants' knowledge of safe driving practices and improvements on some aspects of safe driving performance, but that further research is required to determine if these changes will affect crash rates.

Nasvadi and Vavrik (2007) conducted research in British Columbia evaluating the crash risk of drivers after attending a safe driving class and found that, at least in some cases, these classes may produce a negative benefit - that these classes were associated with an increased number of crashes for men 75 and older. However, attendance in these classes had no effect on crashes of younger men and women of all ages. Though acknowledging several limitations of this study, the authors stress that "Recognizing and understanding characteristics and behaviors of older drivers who attend remedial driver education is essential to the design and delivery of successful driver safety programs."

Korner-Bitensky, Kua, von Zweck, and Van Benthem (2009) conducted a review of articles published between 2004 and 2008 on the effectiveness of older driver retraining programs for improving driving skills and reducing crash rates. Four studies met the inclusion criteria for the review and provided strong evidence that education combined with on-road training improves driving performance. They also found moderate evidence that education alone is not effective in reducing crashes and that physical retraining does improve driving performance. The value of physical training in addition to education is reinforced by the results of research by Romoser and Fisher (2009). They found that active training, such as practice with feedback, is a more effective strategy for increasing older drivers' likelihood of side-to-side scanning, looking for threats, during turns than is passive training (classroom lecture or video only) or no training.

Costs: Costs for making courses for older drivers available can be minimal since they have been developed and are offered by organizations such as AAA, AARP, and NSC. Courses typically charge a small fee, which may be offset by insurance discounts available to graduates.

Time to implement: Courses are offered regularly by AAA, AARP, NSC, and other organizations.

1.2 General Communications and Education

Effectiveness: ★★	Cost: $	Use: Unknown	Time: Short

Many organizations offer educational material for older drivers to inform them of driving risks, help them assess their driving knowledge and capabilities, suggest methods to adapt to and compensate for changing capabilities, and guide them in restricting their driving in more risky situations (NCHRP, 2004, Strategy D2).

Self-assessment tools include:

- AAA's *Roadwise Review*, a CD-ROM and instruction booklet;
- AARP's *Older Driver Skill Assessment and Resource Guide*;
- American Medical Association's *Am I a Safe Driver?* one-page checklist; and
- University of Michigan's *Driving Decisions Workbook*.

See Stutts (2005) for brief descriptions and Web links.

Other programs and material include:

- *Drive Well*, a joint program of American Society on Aging and NHTSA;
- *Getting Around*, from Emergency Nurses CARE, on safe driving decisions, pedestrian safety, and safe medication use; and
- Information from NHTSA and many State motor vehicle offices on general issues of older drivers or specific topics such as driving with glaucoma or arthritis.

See NCHRP (2004, Strategy D2) and Stutts (2005) for examples, brief descriptions, and Web links. See also AAAFTS (2009b) for examples of public information and awareness material included in their "Noteworthy Initiatives" database.

Other material is available to assist drivers and family members in understanding how aging affects driving, the effects of medications and health conditions, how to assess an older driver's skills, how to use specialized vehicle equipment to adapt to certain physical limitations, how to guide older drivers into voluntarily restricting their driving, and how to report older drivers to the department of motor vehicles if necessary (Stutts, 2005). Examples include:

- NHTSA's series of fact sheets and more detailed information for older drivers and their families and friends, available from NHTSA's older driver program Web site: www.nhtsa.gov/Senior-Drivers
- AAA's *How to Help an Older Driver*;
- AARP's *At the Crossroads: A Guide to Alzheimer's Disease, Dementia and Driving*;
- The Association for Driver Rehabilitation Specialists' series of fact sheets on issues such as driving after a stroke, driving with rheumatoid arthritis, and driving after a limb amputation;
- New York State Office for the Aging's *When You Are Concerned: A handbook for families, friends and caregivers worried about the safety of an aging driver*.

Use: Data are not available on how frequently these programs or material are used.

Effectiveness: The limited information available suggests that some material may increase driver's knowledge. There are no evaluations of the effects of this material on driving or on crashes (NCHRP, 2004, Strategy D2). As discussed in Chapter 7, Section 1.1, none of the more structured formal courses has been shown to reduce crashes. NHTSA's Older Road User Research Plan includes the high-priority research problem statement, "Do assessment and retraining programs improve driving?" (Raymond et al., 2001).

Costs: Funds are required for producing and distributing material.

Time to implement: Material and programs are available and ready for use.

Other issues:

- **Seat belt use:** Seat belts are even more effective in preventing injuries and fatalities to older than to younger occupants (NCHRP, 2004, Strategy E1). While belt use among older occupants is comparable to that of younger occupants -- 84% for occupants 70 and older and for occupants 25 to 69 in 2008 (NHTSA, 2009c) -- the fact remains that nearly 1 in 6 older occupants is unbelted. Communications and outreach on the benefits of seat belt use may be more effective with older occupants than with younger because they may be more attentive to health and safety issues. For example, signs urging seat belt use increased belt use substantially in 6 senior communities compared to controls, and use remained higher after 4 years (Cox, Cox, & Cox, 2005). No other State or local seat belt use efforts directed at older occupants have been identified (NCHRP, 2004, Strategy E1).

2. Licensing

2.1 License Screening and Testing

Effectiveness: ★★★★†	Cost: $$	Use: High	Time: Medium

† Proven for identifying drivers whose driving should be limited

State licensing agencies vary considerably in their procedures for screening and evaluating a driver's abilities and skills (NCHRP, 2004, Strategy C2). Many State guidelines are outdated, incomplete, or not based on actual functional impairment. Most do not include all the recommendations on medical conditions from the 1st and 2nd Editions of the *Physician's Guide to Assessing and Counseling Older Drivers* (Carr, Schwartzberg, Manning, & Sempek, 2010; Wang et al., 2003).

NHTSA and AAMVA have developed *Model Driver Screening and Evaluation Program Guidelines for Motor Vehicle Administrators* (Staplin & Lococo, 2003). This was the final stage in a research program that investigated the relationships between functional impairment and driving skills; methods to screen for functional impairment; and the cost, time, legal, ethical, and policy implications of the guidelines (Staplin, Lococo, Gish, & Decina, 2003a).

The *Model Driver Guidelines'* goal is to keep drivers on the road as long as they are safe, through early identification and assessment together with counseling, remediation, and license restriction when needed (Staplin & Lococo, 2003). The guidelines outline a complete process of driver referral, screening, assessment, counseling, and licensing action (Staplin & Lococo, 2003). They include 9 simple visual inspection tests that licensing agency personnel can administer to screen for functional ability (Staplin & Lococo, 2003). A survey of State motor vehicle departments outlines some of the legal, policy, cost, and other criteria that must be met before the guidelines could be implemented in some States (Staplin and Lococo, 2003, Appendix C). The guidelines were tested in Maryland (Staplin, Lococo, Gish, & Decina, 2003b).

The screening and testing of older drivers was a major issue discussed during the 2008 North American License Policies Workshop sponsored by the AAA Foundation for Traffic Safety. One of the general themes of this workshop was that "while certain declines are generally associated with aging, consensus is lacking on whether or at what age individuals should be required to be screened or tested. Regardless, it is generally accepted that final licensing decisions should be based on functional performance, not age, as there is wide variation in how individuals age" (Molnar & Eby, 2008, p.3).

Use: All States screen and test drivers referred to them, though their procedures and criteria vary considerably (NCHRP, 2004, Strategy C2). No State appears to have implemented the model guidelines. U.S. DOT recommends that further testing and evaluation of the guidelines are needed (U.S. DOT, 2003). See also the AAAFTS (2009a) "Driver Licensing Policies and Practices" database showing each State's driver licensing policies and practices regarding older and medically at-risk drivers.

Effectiveness: There is strong evidence that State screening and assessment programs identify some drivers who should not be driving at all or whose driving should be limited. The Maryland pilot test of the model guidelines concluded that "the analysis results ... have provided perhaps the best evidence to date that functional capacity screening, conducted quickly and efficiently, in diverse settings, can yield scientifically valid predictions about the risk of driving impairment experienced by older individuals" (Staplin et al., 2003b). In a study that evaluated the use of a screening tool on Alabama drivers age 18 to 87 (Edwards et al., 2008), older drivers performed significantly worse than younger drivers and older drivers with a crash history performed worse than older drivers without crashes.

A NHTSA-sponsored project conducted by Eby et al. (2008) had the goal of improving upon existing self-screening tools for older drivers by focusing on symptoms associated with medical conditions. A self-screening survey was created to provide feedback to older drivers to increase general awareness of issues associated with driving and the aging process, and to provide recommendations for behavioral changes and vehicle modifications to make to be able to maintain safe driving. Evaluation of the self-screening instrument found it to have positive value, but primarily as a "screening tool to determine gross impairment rather than fitness to drive" (Eby et al., 2008, p. 19).

Costs: The model guideline functional screening tests can be administered for less than $5 per driver, including administrative and support service costs (Staplin et al., 2003a).

Time to implement: States should be able to modify their driver license screening and assessment procedures in 4 to 6 months.

2.2 Referring Older Drivers to Licensing Agencies

Effectiveness: ★★★★†	Cost: $$	Use: Low	Time: Medium

† Proven for increasing physician referrals

Older drivers come to the attention of licensing agencies at regular license renewals, as discussed in Chapter 7, Section 2.1, or when they are referred to the licensing agency for reevaluation of their driving skills.

Licensing agencies in all States accept reevaluation referrals for drivers of any age. A survey of all State licensing agencies found that three sources accounted for 85% of referrals: law enforcement (37%), physicians and other medical professionals (35%), and family and friends (13%) (Stutts, 2005). The remaining 15% came from crash and violation record checks, courts, self-reports, and other sources.

Law enforcement officers have the opportunity to observe drivers directly at traffic stops or crashes. With appropriate training they can identify many drivers who should be referred to the licensing agency for assessment. NHTSA has developed and field-tested a set of cues that officers can use to identify potentially impaired drivers (NHTSA, 1998; see also NCHRP, 2004, Strategy C3, and Stutts, 2005, Chapter 7).

Physicians are in an excellent position to assess if changes in their patients' physical or cognitive abilities may increase their crash risk. In addition to assessment, physicians should provide counseling and assistance on driving as needed and refer patients to the licensing agency if appropriate. In 6 States, physicians are required to report patients who have specific medical conditions such as epilepsy or dementia (NCHRP, 2004, Strategy C3). Other States require physicians to report "unsafe" drivers, with varying guidelines for defining "unsafe." Physicians must balance their legal and ethical responsibilities to protect their patient's health and confidentiality with their duty to protect the general public from unsafe drivers. Physicians have been held liable for damages from crashes involving patients because they failed to report the patient to the licensing agency (Wang et al., 2003, Chapter 7).

NHTSA's *Physician's Guide to Assessing and Counseling Older Drivers* (Wang et al., 2003; Carr et al., 2010), prepared in cooperation with the AMA, provides detailed information for physicians and medical professionals. Chapter 8 has an extensive summary of State licensing and reporting laws. Chapter 9 contains a list of medical conditions and medications that may impair driving and consensus recommendations on what action to take for each. Other chapters include information on treatment and rehabilitation options that may allow patients to continue to drive and on how to counsel patients about retiring from driving. See also Lococo (2003, Appendix C) for State-level information and NCHRP (2004, Strategy C3) for overall discussion.

Chapter 3 of the second edition of the *Physician's Guide to Assessing and Counseling Older Drivers* (Carr et al., 2010) discusses the assessment of functional abilities and provides physicians with the instructions and basic forms needed for them to conduct a brief in-office "Assessment of Driving Related Skills" (ADReS). The ADReS screening tool assesses some aspects of the key functional areas of vision, cognition, and motor/sensory functions to help

physicians identify specific areas of concern as they relate to driving. An evaluation of ADReS (McCarthy, Mann, & Lanford, 2009) suggests that while this tool was able to identify all of the study participants who failed the behind-the-wheel test included as a part of the study, the ADReS may need to be revised to give physicians a more effective and efficient tool for in-office assessments.

In order to encourage more use of the *Physician's Guide to Assessing and Counseling Older Drivers*, a five-module curriculum that includes slides, video case segments, and handouts was developed by the AMA. The goal is to heighten knowledge and skills necessary for a clinician to evaluate driver fitness in a typical care encounter, and to develop a plan for further evaluation by other specialists or licensing authorities if needed. An evaluation of this curriculum found that continuing education training can enhance the confidence and clinical practices of health professionals as related to driver fitness evaluations and mobility planning (Meuser, Carr, Irmiter, Schwartzberg, & Ulfarsson, 2010).

Many States have established procedures for family members and friends to report drivers of any age whose abilities may be impaired. NCHRP (2004, Strategy C3) provides examples and Web links for programs in Florida, Missouri, Minnesota, and Oregon.

States can increase driver referrals by establishing and publicizing procedures for referring drivers, establishing referral policies and providing appropriate training and information to law enforcement officers, and informing physicians and health professionals of their responsibilities. NCUTLO's model law on reporting drivers with a physical or mental disability (NCUTLO, 2005) describes the responsibilities of health care providers and of State Medical Advisory Boards, driver licensing agencies, and license examiners. NHTSA, in collaboration with the American Association of Motor Vehicle Administrators has produced a guide titled "Driver Fitness Medical Guidelines" that is designed to provide guidance to licensing agencies that can be used in making decisions about an individual's fitness for driving (NHTSA, 2009d). Guidelines are provided for a variety of physical limitations and impairments as well as medical conditions. In addition, this guide provides information that can be used by State licensing agencies to educate medical professionals about the effects of functional impairments and medical conditions on safe driving in order to encourage them to refer drivers for additional evaluations related to driving.

Use: A survey of all State licensing agencies found that fewer than 100,000 drivers 65 and older are referred each year from all sources, or fewer than 0.4% of the 28.6 million older licensed drivers (Stutts, 2005, Appendix E). The number of referrals varies substantially across the States, from a few hundred to 50,000.

Effectiveness: States that establish and publicize effective referral procedures will increase referrals. NCHRP (2004, Strategy C3) provides examples and Web links. As one example, Pennsylvania increased physician referrals substantially by sending letters to all physicians (NCHRP, 2004, Strategy C3).

A study of Missouri's voluntary reporting law and the resulting licensing outcomes found that the crash involvement of reported drivers decreased after implementation of the law and, to a

lesser degree, mortality declined as well. Though the Missouri law is not specific as to age, the mean age of reported drivers was 80 and only 3.5% of the 4,100 individuals (reported by a combination of law enforcement officers, driver license office staff, physicians, family members and others) retained their drivers' licenses after the process. (Meuser, Carr, & Ulfarsson, 2009).

The mandatory reporting law in Oregon was enacted in 2002 and requires primary physicians and other health care providers that function as a primary provider to report cognitively impaired drivers to the Department of Motor Vehicles. Reports by primary care providers result in automatic suspensions of driving privileges, but the suspended driver has the opportunity to request retesting and/or a hearing to appeal the suspension. A study of this Oregon law found that over 1,600 drivers reported as being cognitively impaired between 2003 and 2006, with the majority of the reported drivers being older than 80. The most common cognitive impairments were in judgment and problem solving, but impairments in memory and reaction time impairments were also reported about half the time. Of the 1,664 people reported who lost their licenses, less than 20% requested retesting or a hearing to contest their license suspensions and only about 10% of the total number reported and suspended (173) regained their driving privileges (Snyder & Ganzini, 2009).

Costs: Costs for establishing and publicizing effective referral procedures vary depending on the procedures adopted, but should not be extensive. Educational and training publications are available for use with law enforcement and medical professionals. Funds will be required to distribute this material and for general communications and outreach. If referrals increase substantially, then licensing agency administrative costs will increase.

Time to implement: States seeking to improve referrals will require at least 6 months to develop, implement, and publicize new policies and procedures.

2.3 License Restrictions

Effectiveness: ★★★★	Cost: $	Use: Unknown	Time: Short

If a State licensing agency determines through screening, assessment, medical referrals, road tests, or other means that a driver poses excessive risks only in certain situations, the driver can be issued a restricted license. This process of "graduated de-licensing" preserves the driver's mobility while protecting the driver, passengers, and others on the road. Drivers whose vision is adequate during daylight hours but not at night present an obvious example. Their licenses can be restricted to daylight driving only. Other common restrictions limit driving to a specific geographical area, such as the town or county where the driver lives, or limit driving only to low-speed roads.

The AAAFTS (2009b) "Noteworthy Initiatives" database lists Iowa, Kansas, and Minnesota as having noteworthy restricted licensing programs. Iowa offers tailored drive tests that allow drivers to be tested in their own community on roads they would typically drive and, if successful, these drivers are allowed to drive where they have demonstrated proficiency. Iowa license examiners conduct approximately 100 to 150 such examinations each year. Kansas offers a "Local Drive" road test program where, if a driver makes a written request, an examiner will meet the driver in his/her community and conduct the test on routes of the driver's own choosing. The driver must agree that the license will be restricted to areas close to home and possible specific routes. Kansas conducts about 200 to 250 local drive tests each year. In Minnesota, drivers who live in a rural area and only need driving privileges close to home may arrange for a road test examiner to go to the driver's home. Examiners perform only about 25 of these road tests per year, and they may result in very customized licenses such as being limited to a specific route, specific hours of the day, or any combination of restrictions as appropriate.

Use: Iowa and Utah are known to issue restricted licenses (Stutts, 2005; Vernon, Diller, Cook, Reading, & Dean, 2001). A survey of State licensing agencies found that two-thirds of the States said that restricted licenses would be feasible under current State policies, though two-thirds of these would require legislative changes before restricted licenses could be issued (Staplin & Lococo, 2003). The number of States that currently issue restricted licenses specifically for older drivers is not known, but the AAAFTS (2009a) "Driver Licensing Policies and Practices" database shows that 46 States and the District of Columbia place at least some types of conditions or restrictions on licenses of older and/or medically at-risk drivers. The most common restriction is the requirement of corrective lenses.

Effectiveness: Several studies show that driver license restrictions lower the crash risk for these drivers, though their crash risk is still higher than for similar-age drivers with unrestricted licenses (NCHRP, 2004, Strategy C2; Vernon et al., 2001). Research conducted by Braitman, Chaudhary, and McCartt (2010) found that license restrictions may be an effective alternative to complete driving cessation, and provide drivers with some degree of continued mobility and independence. However, they also concluded that while the overall safety benefits of license restrictions may be unknown, license restrictions tend to reduce driving exposure, especially in higher risk situations.

Langford and Koppel (2011) found that imposition of a license restriction was usually associated with a reduction in absolute crash rates, and identified three restrictions that produced lower crash rates and can be thought of as major components of a graduated driving reduction program. The three restrictions are driving within a specified distance of home, not driving at night, and driving only in specified areas.

An evaluation of the "local drive test" (LDT) option offered to older Iowa drivers who might not otherwise be able to renew their licenses found that the overall crash rate of the LDT drivers was higher than for the general population of licensed drivers 65 and older, but was lower than the overall driver crash rate for Iowa drivers (Stutts & Wilkins, 2012).

Costs: Once drivers have been screened and assessed, the costs of issuing a restricted license are minimal.

Time to implement: Restricted licenses can be implemented as soon as any needed policy or legislation changes are enacted.

2.4 Medical Advisory Boards

Effectiveness: ★★†	Cost: Varies	Use: High	Time: Medium

† Quality varies considerably

Thirty-four States and the District of Columbia have medical advisory boards (MABs) to assist the licensing agencies in evaluating people with medical conditions or functional limitations that may affect their ability to drive (AAAFTS, 2009a). MABs generally make policy recommendations on what licensing actions are appropriate for people with specific medical conditions or functional limitations. Most State MABs review individual cases, though this activity varies widely: 7 States reported that their MABs review 1,000 cases or more annually while another 7 review 10 or fewer cases (Lococo, 2003).

In 2003, NHTSA and AAMVA surveyed MAB practices in all States. Lococo (2003) contains the results: detailed documentation of how each State's medical review is organized; how drivers are identified, referred, screened, and assessed; and what licensing actions can be taken.

MABs should play a key role in each State as the link between health care professionals, licensing agencies, law enforcement, and the public. They should take the lead in defining how various medical conditions and functional impairments affect driving; defining medical assessment and oversight standards; improving awareness and training for healthcare providers, law enforcement, and the public; advising health care professionals how drivers can compensate for certain medical conditions or functional impairments; and reviewing individual cases. AAA has developed its list of best practices and recommendations for MABs based on the NHTSA-AAMVA study findings (AAA, 2004). The National Traffic Safety Board has made similar recommendations (NTSB, 2004). In June 2005, NHTSA released a summary of recommended strategies for MABs and national medical guidelines for driving, prepared in collaboration with AAMVA (Lococo & Staplin, 2005).

As noted above, NHTSA and AAMVA produced a guide in September 2009 titled "Driver Fitness Medical Guidelines" that is designed to provide guidance to licensing agencies in making decisions about an individual's fitness for driving (NHTSA, 2009d). These guidelines, as well as NHTSA's *Physician's Guide to Assessing and Counseling Older Drivers* (Wang et al., 2003; Carr et al., 2010), can be used to provide guidance to MABs as they define how various medical conditions and functional impairments affect driving and what steps can be taken to compensate for any limitations noted due to relevant conditions and limitations.

Use: The AAAFTS (2009a) Driver Licensing Policies and Practices database shows that 34 States have MABs or obtain input from the drivers' physicians or anonymous physicians.

Effectiveness: There are no studies evaluating the effects of MABs. Maryland's MAB reviewed over 500 individual cases in 2004 and recommended license suspension for about two-thirds of the cases (Soderstrom, 2005).

Costs: MABs are comprised of physicians and other health care professionals together with appropriate administrative staff. Costs will be minimal for an MAB whose activities are limited

to policy recommendations. Costs for an MAB that evaluates individual cases will depend on the caseload.

Time to implement: States probably will need at least a year to establish and staff an MAB, depending on what duties the MAB undertakes. States likely can expand the functions of an existing MAB in 6 months.

2.5 License Renewal Policies: In-Person Renewal, Vision Test

Effectiveness: ★★	Cost: $$$	Use: Medium	Time: Medium

Driver's licenses in most States are valid for 4 to 6 years, longer in a few States. To renew an expiring license, drivers in many States must appear in person, pay the license fee, and have new pictures taken for their licenses. A few States require a vision test for license renewal. Some States allow all drivers to renew by mail or electronically.

More than half the States change license renewal requirements for drivers older than a specified age, typically 65 or 70. These changes may include a shorter interval between renewals, in-person renewal (no renewal by mail or electronically), or a vision test at every renewal. A very few States require written or road tests for some older renewal applicants. AAA (2010), IIHS (2010), and Stutts (2005, Chapter 5) summarize these requirements. Wang et al. (2003, Chapter 8) and Staplin and Lococo (2003, Appendix B) provide more detail on the requirements in effect in 2001.

License examiners report that the driver's appearance at the motor vehicle office is the single most important criterion for identifying a person of any age whose driving skills may be impaired (NCHRP, 2004, Strategy C2). This observation is supported by Morrisey and Grabowski (2005), who found that in-person license renewal was associated with reduced traffic fatalities among the oldest drivers. Frequent in-person renewals and vision tests may be more useful for older drivers than for younger drivers because their abilities may change more quickly. AAMVA recommends that all drivers renew licenses in person and pass a vision test at least every 4 years (Staplin & Lococo, 2003; Stutts, 2005). Very few States meet these recommendations for all drivers. In-person renewals would be even more useful, for drivers of all ages, if they included functional ability tests as recommended in the NHTSA-AAMVA *Model Driver Screening and Evaluation Program Guidelines for Motor Vehicle Administrators* (Staplin & Lococo, 2003) (see Chapter 7, Section 2.1).

Use: At least 30 States and the District of Columbia have different license renewal requirements for older than for younger drivers. These include 18 States with a shorter interval between renewals, 9 that require in-person renewals, 10 plus the District of Columbia that require vision tests at renewal, and 2 States that require road tests for applicants 75 and older. On the other hand, Oklahoma and Tennessee reduce or waive licensing fees for older drivers and Tennessee driver's licenses issued to people 65 or older do not expire (AAA, 2010; IIHS, 2010). In 2001, about 12 States met the American Association of Motor Vehicle Administrators [AAMVA] recommendations of in-person renewal, with a vision test, at least every 4 years for all drivers over some specified age (Staplin & Lococo, 2003). See also the AAAFTS (2009a) "Driver Licensing Policies and Practices" database showing each State's driver licensing policies and practices including license renewal requirements for all drivers and, where applicable, older drivers as well.

Effectiveness: License examiners report that in-person renewals and vision tests are effective in identifying people whose driving skills may be impaired (NCHRP, 2004, Strategy C2). No data are available on the number of potentially impaired drivers identified through these practices or

on the effects of more frequent renewals and vision tests on crashes. Furthermore, studies regarding the effectiveness of vision screening for license renewal indicate that the value of the vision tests commonly used for licensing decisions as predictors of increased crash risk is inconclusive and that the aspects of vision currently assessed for licensing do not adequately explain unsafe driving (Bohensky, Charlton, Odell, & Keefe, 2008). Nonetheless, one study found that fatalities among drivers 80 years and older in Florida decreased by 17% after the State passed a law requiring these drivers to pass a vision test before renewing their driver licenses (McGwin, Sarrels, Griffin, Owsley & Rue, 2008).

Costs: More-frequent license renewals or additional testing at renewal impose direct costs on driver licensing agencies. For example, a State that reduces the renewal time from 6 years to 3 years for drivers 65 and older would approximately double the licensing agency workload associated with these drivers. If 15% of licensed drivers in the State are 65 and older, then the agency's overall workload would increase by about 15% to process the renewals. If more frequent renewals and vision tests identify more drivers who require additional screening and assessment, then additional costs are imposed. See Chapter 7, Section 2.1, for additional discussion.

Time to implement: A vision test requirement for renewal or a change in the renewal interval can be implemented within months. The new requirements will not apply to all drivers for several years, until all currently valid licenses have expired and drivers appear at the driver licensing agency for licensing renewal.

Other issues:

- **Age discrimination:** A few States explicitly provide that age alone is not a justification for reexamining a driver's qualifications (AAA, 2010; IIHS, 2010). These States have the same license renewal interval for all drivers.
- **Road tests and medical reports:** Several Australian States require a medical report, a road test, or both for drivers over a specified age to renew their licenses. Langford, Fitzharris, Koppell, and Newstead (2004) compared Australian States with and without these requirements. They found that Australian States with these requirements had higher older-driver crash rates than States without them. They conclude that there are "no demonstrable road safety benefits" to requiring medical reports or road tests for older drivers.

3. Traffic Law Enforcement

3.1 Law Enforcement Roles

Effectiveness: ★★★	Cost: Varies	Use: Medium	Time: Varies

Law enforcement plays three overall roles in improving the safety of older drivers:

- Enforce traffic laws. In particular, active publicized enforcement of seat belt use laws can help increase belt use for older drivers and occupants. See Chapter 2, Section 2.1, for discussion.

- Identify drivers with potential driving impairments and refer them to licensing agencies. Traffic stops and crash investigations provide officers excellent opportunities to observe and evaluate driving behavior. See Chapter 7, Section 2.2, for discussion.

- Provide information and education. Law enforcement officers have formed many partnerships with public and private organizations to give talks, teach safe driving courses, work with media on news stories and public service announcements, and other communications and outreach initiatives. Stutts (2005) summarizes several examples. NHTSA (2003) lists law enforcement programs that were active in 2003. They include training for officers, training for older drivers, and community relations programs that promote safety.

NHTSA's Older Driver Law Enforcement Course is available through the International Association of Directors of Law Enforcement Standards and Training. The 4-hour course provides background on older driver issues and discusses traffic stops, referring older drivers to licensing agencies, and community outreach.

Use: NHTSA (2003) describes older driver programs in 28 States.

Effectiveness: Law enforcement officers provide more than one-third of all referrals to licensing agencies for driver screening and assessment (Chapter 7, Section 2.2).

Costs: Costs vary depending on the nature and scope of activities.

Time to implement: Implementation time varies depending on the nature and scope of activities.

Older Driver References

AAA. (2004). *AAA Basic Best Practices for Medical Advisory/Review Boards.* Heathrow, FL: Author. Available at www.aaaexchange.com/Assets/Files/2006651520520.13MABbestpractices.pdf

AAA. (2010). *Senior Licensing Laws.* Heathrow, FL: Author. Available at www.aaaexchange.com/Main/Default.asp?CategoryID=3&SubCategoryID=73

AAA Foundation for Traffic Safety. (2009a). *Driver Licensing Policies and Practices: Driver Licensing Policies and Practices Database*. Washington, DC: Author. Available at http://lpp.seniordrivers.org/lpp/

AAAFTS. (2009b). *Driver Licensing Policies and Practices: Noteworthy Initiatives Database.* Washington, DC: Author. Available at http://lpp.seniordrivers.org/lpp/

AARP. (2009). *AARP Driver Safety Program History and Facts.* Washington, DC: Author. Available at www.aarp.org/families/driver_safety/driver_program/a2004-06-21-ds_history.html

AARP. (2010). *AARP Driver Safety Program History and Facts.* Washington, DC: Author. Available at www.aarp.org/home-garden/transportation/info-05-2010/dsp_article_program_history_and_facts/?cq_ck=1274207993910.html

Bedard, M., Porter, M. M., Marshall, S., Isherwood, I., Riendeau, J., Weaver, B., Tuokko, H. Molnar, F., & Miller-Polgar, J. (2008). The combination of two training approaches to improve older adults' driving safety. *Traffic Injury Prevention, 9*, 70-76.

Bohensky, M., Charlton, J., Odell, M., & Keefe, J. (2008). Implications of Vision Testing for Older Driver Licensing. *Traffic Injury Prevention, 9,* 304-313.

Braitman, K. A., Chaudhary, N.K., & McCartt, A. T. (2010). Restricted licensing among older drivers in Iowa. *Journal of Safety Research, 41,* 481–486.

Carr, D.B., Schwartzberg, J.G., Manning, L., & Sempek, J. (2010). *Physician's Guide to Assessing and Counseling Older Drivers*, 2nd edition. (Report No. DOT HS 811 298. Washington, DC: National Highway Traffic Safety Administration. Available at www.ama-assn.org/ama1/pub/upload/mm/433/older-drivers-guide.pdf

Cheung, I., & McCartt, A.T. (2010). *Declines in Fatal Crashes of Older Drivers: Changes in Crash Risk and Survivability*. Arlington, VA: Insurance Institute for Highway Safety. Available at www.iihs.org/research/topics/pdf/r1140.pdf

Cox, C. D., Cox, B. S., & Cox D. J. (2005). Long-term benefits of prompts to use safety belts among drivers exiting senior communities. *Journal of Applied Behavior Analysis, 38*, 533-536. Available at www.pubmedcentral.nih.gov/articlerender.fcgi?artid=1309715

Eby, D. W., Molnar, L. J., Kartje, P., St. Louis, R. M., Parow, J. E., Vivoda, J. M., & Neumeyer, A. L. (2008). *Older Driver Self-Screening Based on Health Concerns (Volume I: Technical Report).* (Report No. DOT HS 811 046A). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/30000/30500/30584/811046a.pdf

Edwards, J. D., Leonard, K. M., Lunsman, M., Dodson, J., Bradley, S., Myers, C. A., & Hubble, B. (2008). Acceptability and validity of older driver screening with the DrivingHealth Inventory. *Accident Analysis & Prevention, 40,* 1157-1163.

Federal Highway Administration. (1995). *Licensed Drivers by Sex and Age Group, 1963-1995.* Washington, DC: Author. Available at www.fhwa.dot.gov/ohim/summary95/dl220.pdf

FHWA. (2010). *Distribution of Licensed Drivers - 2008 by Sex and Percentage in Each Age Group and Relation to Population*, Table DL-20. Highway Statistics 2008. Washington, DC: Author. Available at www.fhwa.dot.gov/policyinformation/statistics/2008/dl20.cfm

FHWA. (2011). *Distribution of Licensed Drivers - 2008 by Sex and Percentage in Each Age Group and Relation to Population*, Table DL-20. Highway Statistics 2008). Washington, DC: Author. Available at www.fhwa.dot.gov/policyinformation/statistics/2008/dl20.cfm

Insurance Institute for Highway Safety. (2010). *U.S. Driver Licensing Renewal Procedures for Older Drivers, August 2010.* Arlington, VA: Author. Available at www.iihs.org/laws/state_laws/older_drivers.html

IIHS. (2012). *Fatality Facts 2010: Older People*. Arlington, VA: Author. Available at www.iihs.org/research/fatality.aspx?topicName=Olderpeople&year=2010

Janke, M. K. (1994). *The Mature Driver Improvement Program in California.* Sacramento, CA: California Department of Motor Vehicles.

Korner-Bitensky, N., Kua, A., von Zweck, C., Van Benthem, K. (2009). Older driver retraining: An updated systematic review of evidence of effectiveness. *Journal of Safety Research*, *40*, 105-111.

Kua, A., Korner-Bitensky, N., Desrosiers, J., Man-Son-Hing, M., & Marshall, S. (2007). Older driver retraining: A systematic review of evidence of effectiveness. *Journal of Safety Research*, *38*, 81-90.

Langford, J., Fitzharris, M., Koppell, S., & Newstead, S. (2004). Effectiveness of mandatory license testing for older drivers in reducing crash risk among urban older Australian drivers. *Traffic Injury Prevention, 5*, 326-335.

Langford, J., & Koppel, S. (2011). License restrictions as an under-used strategy in managing older driver safety. *Accident Analysis and Prevention*, *43*, 487-493.

Li, G., Braver, E. R., & Chen, L. H. (2003). Fragility versus excessive crash involvement as determinants of high death rates per vehicle-mile of travel among older drivers. *Accident Analysis and Prevention*, *35*, 227-235.

Lococo, K. H. (2003). *Summary of Medical Advisory Board Practices in the United States*). Washington, DC: U.S. Department of Transportation. Available at www.mdsupport.org/drivingsummary.pdf

Lococo, K. H., & Staplin, L. (2005). *Strategies for Medical Advisory Boards and Licensing Review*. (Report No. DOT HS 809 874). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/MedicalAdvisory/pages/Job%201602%20-%20final%20new.pdf

Marottoli, R. A. (2007). *Enhancement of Driving Performance Among Older Drivers.* Washington, DC: AAA Foundation for Traffic Safety. Available at www.aaafoundation.org/pdf/enhancingseniordrivingperfreport.pdf

McCarthy, D. P., Mann, W. C., & Lanford, D. (2009). Process and Outcomes Evaluation of Older Driver Screening Programs: The Assessment of Driving-Related Skills (ADReS) Older-Driver Screening Tool. (Report No. DOT HS 811 113). Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811113.pdf

McGwin, G., Sarrels, S. A., Griffin, R., Owsley, C., & Rue, L. W. (2008). The impact of a vision screening law on older driver fatality rates. *Archives of Opthamology*, *126*, 1544-1547.

Meuser, T. M., Carr, D. B., & Ulfarsson, G. F. (2009). Motor-vehicle crash history and licensing outcomes for older drivers reported as medically impaired in Missouri. *Accident Analysis & Prevention*, *41*, 246-252.

Meuser, T. M., Carr, D. B., Irmiter, C., Schwartzberg, J. G. & Ulfarsson, G. F. (2010). The American Medical Association older driver curriculum for health professionals: changes in trainee confidence, attitudes, and practice behavior. *Gerontology & Geriatrics Education*, *31*, 290-309.

Molnar, L. J. & Eby, D. W. (2008). *2008 North American License Policies Workshop Recommendations.* AAA Foundation for Traffic Safety, Washington, DC, June 2008. Available at www.aaafoundation.org/pdf/LPWorkshopRecommendations.pdf

Morrisey, M. A. & Grabowski, D. C. (2005). State motor vehicle laws and older drivers. *Health Economics, 14*, 407-419.

Nasvadi, G. E., & Vavrik, J. (2007). Crash risk of older drivers after attending a mature driver education program. *Accident Analysis & Prevention, Volume 39, 6,* 1073-1079.

NCHRP, Vol 9. (2004). *A Guide for Reducing Collisions Involving Older Drivers.* Washington, DC: Transportation Research Board. Available at onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v9.pdf

National Committee on Uniform Traffic Laws and Ordinances. (2005). *Reporting of Driver Impairment Model Law.* Alexandria VA: Author. Available at www.ncutlo.org/impairment.htm

National Highway Traffic Safety Administration. (1998). *Older Drivers: Cues for Law Enforcement.* (Report No. DOT HS 808 778). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/olddrive/cuesindex.html

NHTSA. (2003). *A Compendium of Law Enforcement Older Driver Programs.* Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/olddrive/LawEnforcementOlderDriver03/index.htm

NHTSA. (2005). *Older Driver Traffic Safety Plan*. Washington, DC: Author. Available at www.nhtsa.gov/people/injury/olddrive/OlderDriverPlan/images/OlderDriverSafetyPlan.pdf

NHTSA. (2009a). *Traffic Safety Facts, 2008 Data: Older Population*. (Report No. DOT HS 811 161). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/811161.pdf

NHTSA. (2009b) *Traffic Safety Facts 2008: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System.* (Report No. DOT HS 811 170). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811170.pdf

NHTSA. (2009c). *Traffic Safety Facts: Seat Belt Use in 2008 – Demographic Results*. (Report No. DOT HS 811 183). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811183.pdf

NHTSA. (2009d). *Driver Fitness Medical Guidelines*. (Report No. DOT HS 811 210). Washington, DC: Author. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811210.pdf

NHTSA. (2010). *Older Driver Program Five-Year Strategic Plan 2012-2017*. (Report No. DOT HS 811 432). Washington, DC: Author. Available at www.nhtsa.gov/staticfiles/nti/pdf/811432.pdf

NHTSA. (2011). *Traffic Safety Facts 2009: A Compilation of Motor Vehicle Crash Data from the Fatality Analysis Reporting System and the General Estimates System.* (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.pdf

NHTSA. (2012). *Traffic Safety Facts, 2010 Data: Overview*. (Report No. DOT HS 811 630). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/811630.pdf

National Transportation Safety Board. (2004). *Highway Special Investigation Report: Medical Oversight of Noncommercial Drivers.* Washington, DC: Author. NTSB/SIR-04/01 PB2004-917002. Available at www.ntsb.gov/publictn/2004/SIR0401.pdf

Organisation for Economic Cooperation and Development. (2001). *Ageing and Transport: Mobility Needs and Safety Issues.* Paris, France: Author. Available at www.oecd.org/dataoecd/40/63/2675189.pdf

Owsley, C., McGwin, G., Jr., Phillips, J. M., McNeal, S. F., & Stalvey, B. T. (2004). Impact of an education program on the safety of high-risk, visually impaired, older drivers. *American Journal of Preventive Medicine, 26*, 222-229.

Potts, I., Stutts, J., Pfefer, R., Neuman, T. R., Slack, K. L, & Hardy, K. K. (2004). *A Guide for Reducing Collisions Involving Older Drivers.* (NCHRP Report 500, Vol. 9).Washington, DC: Transportation Research Board. Available at http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v9.pdf

Raymond, P., Knoblauch, R., & Nitzburg, M. (2001). *Older Road User Research Plan.* (Report No. DOT HS 809 322). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/olddrive/OlderRoad/index.htm

Romoser, M.R E., & Fisher, D.L. (2009). The effect of active versus passive training strategies on improving older drivers' scanning in intersections. *Human Factors*, *51*, 652-668.

Skufca, L. (2008). *2007 AARP Driver Safety Program Course Evaluation*. Washington, DC: AARP Knowledge Management.

Snyder, K.M., & Ganzini, L.(2009). Outcomes of Oregon's law mandating physician reporting of impaired drivers. *Journal of Geriatric Psychiatry and Neurology*, *22*, 161-165.

Soderstrom, C. A. (2005). University of Maryland School of Medicine, personal communication, April, 2005.

Staplin, L., & Lococo, K. H. (2003). *Model Driver Screening and Evaluation Program. Vol. 3: Guidelines for Motor Vehicle Administrators.* (Report No. DOT HS 809 581). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/olddrive/modeldriver/

Staplin, L., Lococo, K. H., Gish, K. W., & Decina, L. E. (2003a). *Model Driver Screening and Evaluation Program. Vol. 1: Project Summary and Model Program Recommendations.* (Report

No. DOT HS 809 582). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/olddrive/modeldriver/

Staplin, L., Lococo, K. H., Gish, K. W., & Decina, L. E. (2003b). *Model Driver Screening and Evaluation Program. Vol. 2: Maryland Pilot Older Driver Study.* (Report No. DOT HS 809 583). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/olddrive/modeldriver/

Stutts, J. C. (2005). *Improving the Safety of Older Road Users.* Final report, NCHRP Synthesis Project 20-5, Synthesis Topic 35-10). Washington, DC: Transportation Research Board.

Stutts, J. C. & Wilkins, J. (2009). *Driver Licensing Policies and Practices: Gearing Up for an Aging Population.* Project Summary Report. AAA Foundation for Traffic Safety. Washington, DC. Available at http://lpp.seniordrivers.org/lpp/pdf/DriverLicensePoliciesReport.pdf

Stutts, J. C., Martell, C., & Staplin, L. (2009). *Identifying Behaviors and Situations Associated With Increased Crash Risk for Older Drivers.* (Report No. DOT HS 811 093). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811093.pdf

Stutts, J. C., & Wilkins, J. (2012). *Keeping Seniors Safe and Mobile: An Evaluation of a Local Drive Test Option.* AAA Foundation for Traffic Safety. Washington, DC. Available at www.aaafoundation.org/pdf/2012LocalDriveTest.pdf

U.S. Census Bureau. (2011). *The Older Population: 2010. 2010 Census Briefs*. C2010BR-09). Washington, DC: Author. Available at www.census.gov/prod/cen2010/briefs/c2010br-09.pdf

U.S. Census Bureau, Population Division (2008). *Table 2. Projections of the Population by Selected Age Groups and Sex for the United States: 2010 to 2050 (NP2008-T2).* Release Date: August 14, 2008. Washington, DC: Author.

U.S. Department of Transportation. (2003). *Safe Mobility for a Maturing Society: Challenges and Opportunities.* Washington, DC: Author. Available at ostpxweb.dot.gov/policy/Data/SafeMobility.pdf

Vernon, D. D., Diller, E., Cook, L., Reading, J., & Dean, J. M. (2001). *Further Analysis of Drivers Licensed with Medical Conditions in Utah.* (Report No. DOT HS 809 211). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/olddrive/utah/utah_index.htm

Wang, C.C., Kosinski, C. J., Schwartzberg, J. G., & Shanklin, A. V. (2003). *Physician's Guide to Assessing and Counseling Older Drivers.* (Report No. DOT HS 809 647). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/people/injury/olddrive/OlderDriversBook/index.html

8. Pedestrians

Overview

In 2010, 4,280 pedestrians died and about 70,000 were injured in traffic crashes in the United States. Pedestrians accounted for 13% of total traffic fatalities and 3% of total injuries (NHTSA, 2012). Of the pedestrian casualties:

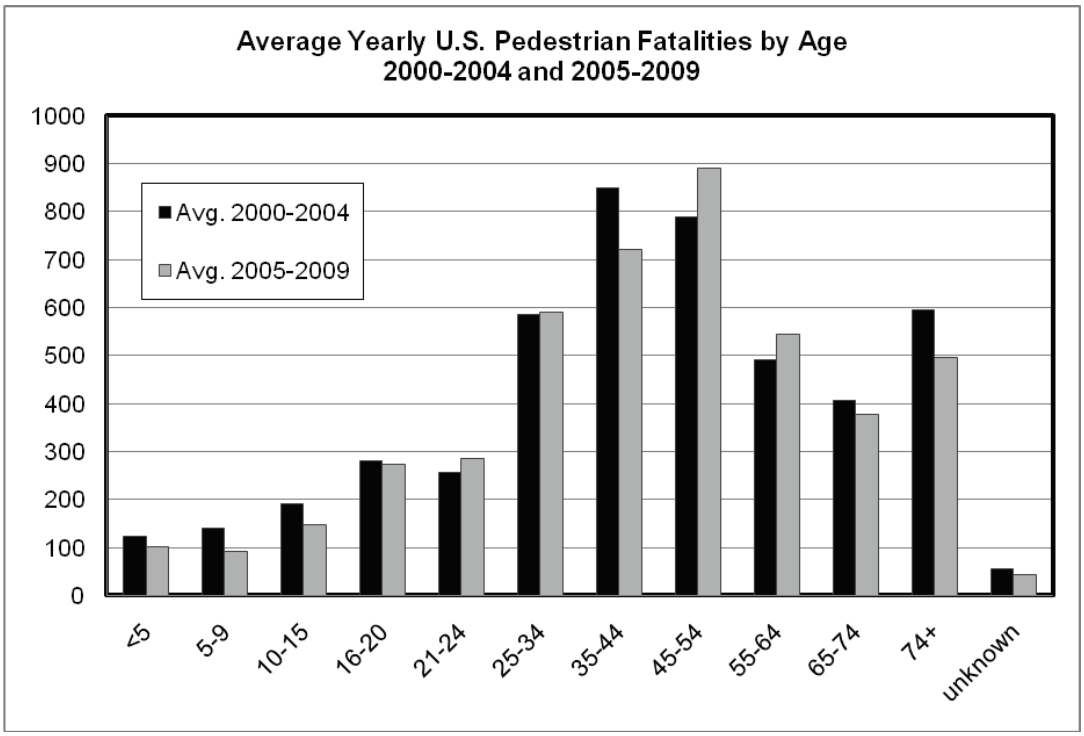
- Children 15 and younger accounted for 7% of the pedestrian fatalities in 2010 and 23% of all pedestrians injured in traffic crashes;
- 19% of those killed were adults 65 and older;
- 69% of those killed were males;
- 33% of pedestrians fatally injured had a BAC of .08 or greater (NHTSA, 2012).

Crash Trends. Pedestrian fatalities have dropped gradually over the past 20 years from about 7,000 to less than 5,000 annually. 2009 saw the fewest pedestrian crashes in decades, while there was a slight uptick in 2010. Fatality rate trends—or fatalities adjusted per number of walking trips or miles traveled by walking—are unavailable because there is no systematically collected consistent measure of walking (exposure) to estimate and compare fatality rates.

Source: Traffic Safety Facts 2009, Early Edition (NHTSA, 2010b, Table 4) and Traffic Safety Facts 2010 (NHTSA, 2012)

The age distribution of pedestrian fatalities has changed over the last decade. Comparing average fatalities for 2005 to 2009 to those from 2000 to 2004, pedestrian fatalities decreased for children 15 and younger and among adults 65 and older. Among other adults, crashes trended downward for those 35 to 44, but remained relatively the same or increased for other adult ages, particularly among those 45 to 54. These changes may reflect population and walking trends among different

ages as well as other exposure factors. To see the distribution of pedestrian crashes occurring in 2010 by age, go to: www-nrd.nhtsa.dot.gov/Pubs/811625.pdf.



Source data: FARS

Although pedestrian fatalities involving older adults have declined over the past 10 years, older pedestrians are still more likely to die from their injuries when struck. Pedestrians 75 and older have the highest fatality rate per population of any age group (2.2 per 100,000 population; NHTSA, 2010a). In comparison, pedestrians 25 to 64 years old have a fatality rate of 1.6 per 100,000 population (NHTSA, 2010a). Older adults are also more vulnerable when struck in intersection collisions. Although pedestrians of all ages are more frequently killed at non-intersection locations (75% overall), 35% of adults 65 and older died as a result of collisions at intersections in 2009 compared with 21% for other ages (NHTSA, 2010b, p. 131).

Several studies have noted the over-representation of minorities, immigrants, and low-income populations in pedestrian-vehicle crashes (Anderson, Vaca, & Chakravarthy, 2010; Chen, Lin, & Loo, 2011; Murtha, 2005). However, the causes and contributing factors of these elevated crash rates are not well-understood. Some studies attribute higher minority crashes to potential environmental justice issues in how pedestrian facilities are distributed (Kravetz & Noland, 2012). Other studies have found that lower income and minority populations have higher transit use and walking rates (or exposure) that may help partially explain elevated crash figures (Cottrill & Thakuriah, 2010). Still others have postulated that social-behavioral mechanisms and differing "safety cultures" play a role in pedestrian crashes, particularly for recent immigrants (Chen, Lin, & Loo, 2011). Despite the vulnerability of these groups to pedestrian crashes, no studies were identified that sought to tailor safety programs to the specific needs of low-income, minority, or immigrant populations, so the effectiveness of countermeasures in reaching these

special populations is not well-documented. NHTSA has recently introduced an English as a Second Language program tailored to include walking and bicycling safety (http://www.nhtsa.gov/ESL), but the program has not yet been evaluated.

Walking Trends. According to the Federal Highway Administration's National Household Travel Survey (NHTS), the number of walking trips increased from 18 billion in 1990 (FHWA, 1990) to 20.3 billion in 1995 (FHWA, 1995) and 35.3 billion in 2001 (FHWA, 2001), though the various surveys used somewhat different methodologies. It is likely, for example, that more trips were captured, beginning with the 2001 survey, partly as a result of the use of multiple prompts (Hu & Reuscher, 2004). The latest NHTS, conducted in April 2008 through May 2009, indicates that about 42.5 billion walking trips are made per year (FHWA, 2010). This number represents approximately 11% of all trips reported. In 2009, the most recently available survey year, about 6% of trips to work were made by walking (FHWA, 2010). Commuting, however, makes up only a small percentage of all walking trips. The next NHTS is planned for 2015.

Classifying Crash Types. Pedestrian crashes can be classified into types based on pedestrian and motor vehicle pre-crash actions and crash location. In the early 1990s this methodology was used to classify more than 5,000 pedestrian crashes in California, Florida, Maryland, Minnesota, North Carolina, and Utah (Hunter, Stutts, Pein, & Cox, 1996, summarized in www.walkinginfo.org/pc/types.cfm). Of these pedestrian crashes:

- The largest major grouping was crashes occurring at or within 50 feet of an intersection, accounting for 32% of all crashes. Of these intersection crashes, 30% involved a turning vehicle; another 22% involved a pedestrian dashing into the intersection, and 16% involved a driver violation (e.g., running a red light). Older pedestrians were over-represented in collisions with turning vehicles and motorist violations, while children were over-represented in intersection dashes.
- The second major grouping was crashes occurring in the middle of a block, accounting for 26%. In one-third of these, the pedestrian ran into the street and the driver's view was not obscured; one-sixth were "dart-outs" in which the pedestrian walked or ran into the street from a location where the pedestrian could not be seen. Children were also over-represented in dash-and-dart-out crashes at midblock locations.
- Only 7% of the crashes involved a pedestrian walking along a roadway not on a sidewalk. In three-quarters of these crashes the pedestrian was struck from behind while walking in the same direction as traffic. Darkness was a factor that was over-represented in these types of collisions, as were rural locations. These associations are not unexpected since rural areas are less likely to have sidewalks and supplemental street lighting.

While many states systematically ignore or discard off-road or private-road crash records, these crashes may constitute a significant portion of pedestrian-related crashes. In several studies, parking-lot and driveway-related crashes represented up to 15 to 25% of all reported pedestrian crashes (Stutts & Hunter, 1999). Research is needed to better understand the etiology of non-roadway pedestrian crashes and effective countermeasures.

In addition to under-reported off-road crashes, pedestrian crashes in general tend to be underreported. Past studies have estimated that police-reported crashes represent only about 56%

of pedestrian incidents that occur (Stutts & Hunter, 1998). Underreporting likely decreases as the crash severity increases; therefore, the FARS data presented earlier is thought to be a reliable source for estimating pedestrian fatal crash frequencies.

Different crash types at different locations involving different age groups can be targeted by different countermeasures. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) software is available to assist jurisdictions in typing pedestrian crashes and developing a database for analyzing their own pedestrian crash problems. States and communities can use PBCAT to analyze pedestrian crashes and to help select appropriate countermeasures. PBCAT may be downloaded from www.walkinginfo.org/facts/pbcat/index.cfm. Registration is requested for this free software so the user may receive any software updates or important technical information.

Crash Factors. A large body of research in the past several decades has established numerous factors associated with pedestrian crashes. Pedestrian and driver pre-crash actions and behaviors (such as distraction, driver speed, and alcohol use), vehicle type and design, pedestrian and vehicle volumes/exposure, and elements of the built environment (including roadway design, presence of pedestrian facilities, and street-crossing facilities) all contribute to pedestrian crashes. Several studies have provided evidence of the role of the transportation environment in pedestrian safety and summarized best practices in engineering and design for pedestrian safety (FHWA, 2011; Redmon, 2011; Retting, 2003). Enacting and implementing Complete Streets policies has been identified as one of the more low-cost and impactful countermeasures, as evidenced by numerous cities and states across the U.S. (for more on Complete Streets, visit www.completestreets.org/). For a factsheet synthesizing the evidence of Complete Streets on pedestrian safety, visit www.completestreets.org/webdocs/factsheets/cs-safety.pdf. More recent studies have focused on the role of vehicle type and design in the event of a crash (Searson & Anderson, 2011) and in the ability of pedestrians and even vehicle technology to detect and prevent a crash (Fredriksson, Shin, & Untaroiu, 2011; Greene et al., 2011). An emerging issue in the literature, as hybrid and electric vehicles begin to constitute a larger portion of the vehicle fleet, is the consequence of "quiet" vehicles on pedestrian safety, particularly among pedestrians with visual disabilities who rely more on auditory cues to detect traffic (Garay-Vega, Pollard, Guthy, & Hastings, 2011). While not dismissing the importance of vehicle design and the role of the built environment in preventing pedestrian crashes, the countermeasures described in this report relate primarily to educational and enforcement measures aimed at improving the knowledge and behaviors of road users to prevent a crash.

The study by Rosen and Sander (2009) is believed to be one of the most robust in terms of estimating the risk of pedestrian fatality based on driver impact speeds. The study estimated fatality risk curves based on driver impact speeds, ranging from 8% at 50 km/h and reaching 50% at 75 km/h. As pedestrians are particularly vulnerable to severe injury and fatality when struck by higher-speed vehicles, countermeasures aimed at reducing vehicle speeds present the potential to save lives for both pedestrians and drivers. Speed-related countermeasures are presented in Chapter 3.

The role of alcohol in pedestrian crashes has not been well-defined, based on the paucity of complete and high-quality data on alcohol use or blood alcohol contents of drivers and pedestrians involved in crashes. However, it has been estimated that alcohol use—by either the

driver or pedestrian—is a contributing factor in 48% of pedestrian fatalities (NHTSA, 2010a). Alcohol-related countermeasures that may also help address certain pedestrian crashes are presented in Chapter 1.

An emerging issue is cell phone and electronic device use as a source of distraction, not only for motorists, but for pedestrians. Talking on cell phones is associated with cognitive distraction that may undermine pedestrian safety, particularly among college-age pedestrians who may be more engaged with such devices (Hatfield & Murphy, 2007; Nasar, Hecht, & Wener, 2007; Stavrinos, Byington, & Schwebel, 2009 and 2001). In a simulation of pedestrian activity, college-age pedestrian study participants who were distracted by music or texting were more likely to look away from the street environment and were more likely to be hit by a vehicle in the virtual pedestrian environment than were undistracted participants (Schwebel et al., 2012). A study by Cooper et al. (2011) performed at several locations in the Bay Area reported that pedestrian cell phone or mobile device use was between 7 and 15%, giving a sense of the magnitude of the pedestrian distraction issue. At the moment, however, no studies of crash effects or evaluations of countermeasures to address this emerging issue have been identified. While numerous cities and states have passed driver cell phone/texting bans, no pedestrian-focused cell phone bans have been identified. Similarly, while a few communities have made efforts to educate pedestrians on the distraction issue (such as Philadelphia's "distracted pedestrian" lane: www.npr.org/2012/04/02/149829299/philadelphia-texting-while-walking-is-no-joke), no such efforts have been formally evaluated.

Strategies to Increase Pedestrian Safety

Countermeasures in this chapter are primarily aimed at improving safety behaviors of pedestrians and drivers through education and enforcement measures, and are organized by pedestrian sub-groups:

- Pre-school-age children;
- School-age children;
- Alcohol-impaired pedestrians; and
- All pedestrians.

The final section contains countermeasures that may affect all groups of pedestrians as well as drivers.

Basic countermeasure principles include reducing vehicle speed, which allows pedestrians and drivers more time to react and reduces impact forces if crashes do occur; reducing exposure to known risky situations through behavioral and environmental countermeasures (without necessarily discouraging walking); and increasing enforcement of pedestrian-friendly laws.

Countermeasures need to be tailored to diverse populations, including groups such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, or may not speak or read English. Countermeasures should also address particular problems identified within communities or common to a target group.

Resources

The agencies and organizations listed below can provide more information on comprehensive pedestrian safety issues and countermeasures, and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Pedestrians - www.nhtsa.gov/Pedestrians
  - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Federal Highway Administration: www.fhwa.dot.gov/
  - Office of Human and Natural Environment, Bicycle and Pedestrian Program - www.fhwa.dot.gov/environment/bikeped/index.htm
  - Safety Office, Pedestrian and Bicycle Safety - safety.fhwa.dot.gov/ped_bike/ped_focus/
  - Office of Research, Development, and Technology, (Turner-Fairbank Highway Research Center), Human Centered Systems Research, Pedestrian and Bicycle Program - www.tfhrc.gov/humanfac/ped-bike.htm
- Pedestrian and Bicycle Information Center: www.walkinginfo.org
- National Center for Safe Routes to School: www.saferoutesinfo.org
- Research and Administrative Technology Administration, National Transportation Library, Bicycle and Pedestrian Research: ntlsearch.bts.gov/repository/category.do?cat=5
- Complete Streets Coalition: www.completestreets.org
- SAFE KIDS Worldwide: www.safekids.org
- Safe Routes to School National Partnership: www.saferoutespartnership.org
- Safe States Alliance: http://safestates.org/
- United States Access Board: www.access-board.gov
- National Center for Bicycling and Walking: www.bikewalk.org
- America Walks: www.americawalks.org
- Association of Pedestrian and Bicycle Professionals: www.apbp.org

Several specific resources that provide further information on engineering, enforcement and educational strategies are:

- Pedestrian Countermeasure Policy Best Practice Report (Redmon, 2011): http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11017/

- Public Policies for Pedestrian and Bicycle Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan: http://katana.hsrc.unc.edu/cms/downloads/PBSPolicyReview.pdf

- Uniform Guidelines for State Highway Safety Programs: Highway Safety Program Guideline No. 14: Pedestrian and Bicycle Safety:

www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/PedBikeSafety.pdf

- AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities: https://bookstore.transportation.org/item_details.aspx?id=119

- *How to Develop a Pedestrian Safety Action Plan* (FHWA and NHTSA, 2006): http://drusilla.hsrc.unc.edu/cms/downloads/howtoguide2006.pdf

- *NCHRP Report 500 Guide for Reducing Collisions Involving Pedestrians* (National Cooperative Highway Research Program, 2004): onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v10.pdf

- *PEDSAFE*: Pedestrian Safety Guide and Countermeasure Selection System (FHWA, 2004): www.walkinginfo.org/pedsafe/index.cfm

- *A Resident's Guide for Creating Safe and Walkable Communities* (FHWA, 2008): http://drusilla.hsrc.unc.edu/cms/downloads/residentsguide.pdf

- *Child Pedestrian Safety Curriculum* (NHTSA, 2011): http://www.nhtsa.gov/ChildPedestrianSafetyCurriculum

- Pedestrian Safety Training for Law Enforcement (NHTSA, 2011): http://mcs.nhtsa.gov/index.cfm/product/786/nhtsa-pedestrian-safety-training-for-law-enforcement-cd-rom.cfm

- *The Pedestrian Safety Workshop: A Focus on Older Adults*, (NHTSA): www.nhtsa.gov/staticfiles/nti/older_drivers/pdf/PedSafetyWorkshop-02.pdf

Key Terms

- NHTS: National Household Travel Survey
- SRTS: Safe Routes to School

Countermeasures That Work

Countermeasures to improve pedestrian safety are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information on each item.

1. Pre-school-age Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Children's safety clubs	★★	Varies	Unknown	Unknown
1.2 Child supervision	★	$	Unknown	Short

2. School-age Children

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Elementary-age child pedestrian training	★★★	$	Unknown	Short
2.2 Safe Routes to School (SRTS)	★★	$	High	Short
2.3 Child school bus training	★★	$	High	Short

3. Impaired Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Communications and outreach	★★	Varies	Low	Medium
3.2 "Sweeper" patrols of impaired pedestrians	★	$$	Low	Medium

4. All Pedestrians

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Pedestrian safety zones	★★★★	$$$	Low	Medium
4.2 Reduce and enforce speed limits	★★★	$	High	Varies
4.3 Conspicuity enhancement	★★★	$	Low	Medium
4.4 Targeted enforcement	★★★	$$	Low	Short
4.5 Driver training	★	$	Low	Medium
4.6 Pedestrian gap acceptance training	★	$$	Unknown	Medium

Effectiveness:

★★★★★- Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★- Demonstrated to be effective in certain situations

★★★- Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★- Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★- Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Pre-School-Age Children

1.1 Children's Safety Clubs

Effectiveness: ★★	Cost: Varies	Use: Unknown	Time: Unknown

A primary purpose of children's safety clubs is to help parents and caregivers become more involved in educating young children about safe walking techniques through books and activities on road safety. Related goals are to help promote on-going, age-appropriate training and safe attitudes towards traffic (Gregersen and Nolen, 1994). An equally important outcome of safety clubs is for parents and other caregivers to recognize children's limits and capabilities, and to understand their obligation to provide adequate supervision and control (Gregersen and Nolen, 1994).

Young children have limited abilities to perceive, understand, and react appropriately to traffic hazards. Motor vehicle crashes involving preschool children often involve slow-moving vehicles, frequently backing up in driveways and parking lots (Agran, Winn, & Anderson, 1994; Olson, Sklar, Cobb, Sapien, & Zumwalt, 1993). A NHTSA report estimated that 106 children 14 and younger were killed by vehicles driving forward and 99 were killed by backing vehicles in non-traffic-related crashes such as in driveways and parking areas in 2007 (NHTSA, 2009). It is important to teach children age-appropriate lessons about traffic and motor vehicles. It is even more important that parents and caregivers take direct responsibility and supervise young children carefully near roadways or in any areas where vehicles may be in use (Rivara, Bergman, & Drake, 1989). See also the following section, Section 1.2 for more information on supervision.

Parents are primary role models and trainers for their children. Research in the United Kingdom has examined the interactions and messages between parents and children with regard to road safety (Green et al., 2008). The researchers found that parents, while feeling competent to the task, were inconsistent role models and lacking in knowledge of best approaches and messages to train their children. Moreover, parents did not take full advantage of opportunities to teach while walking, and attention was focused more on controlling their children's behavior than teaching, particularly under higher risk situations (Green et al, 2008).

The main development of safety clubs took place in Europe a number of years ago, but they have not been adopted broadly in the United States. In many of the European programs, children may be enrolled in a traffic safety club when they reach their third birthday. Books on traffic safety are then sent to the child every 6 months until they reach 5 years or older (Dragutinovic & Twisk, 2006), but other print or electronic media could be provided, bearing in mind that the intent is to engage both the parent and child. There do not appear to be any national or statewide standards, models, or curricula.

NHTSA has several brochures to educate parents and caregivers on child pedestrian safety, as does Safe Kids Worldwide. Most recently, NHTSA released *Teaching Children to Walk Safely as They Grow and Develop: A guide for parents and caregivers*, which can be found on the Safe Routes to School Web site. One online game for parents and young children (Otto the Auto, from

the California State Automobile Association) can be found at www.ottoclub.org. For a British traffic club source, see The Children's Traffic Club, www.trafficclub.co.uk.

Use: Pedestrian safety in general may be a topic at preschools, but programs are likely to be unique, without consensus objectives, material, or curriculum.

Effectiveness: Safety clubs are one way to promote understanding and to teach a specific set of appropriate behaviors for young pedestrians. However, the knowledge and skill benefits have not been found to translate into crash and injury reductions (Dragutinovic & Twisk, 2006; Gregersen & Nolen, 1994; West, Sammons, & West, 1993). The one study that evaluated effects on self-reported crashes found a negative result, but concluded that no impact on crashes could be inferred (Gregersen & Nolen, 1994).

Costs: The costs would depend on the cost of materials and delivery and whether the families are charged anything for participation. In most of the clubs, enrollment is free to the participants; some charge a fee for enrollment (Dragutinovic & Twisk, 2006). If integrated into preschool programs, training for teachers may be needed.

Time to implement: Before a safety club program could be implemented, program material must be located and adapted as necessary. Following that, a modest time period would be needed to arrange for material, identify target recipients, disseminate information, and train teachers as needed.

Other issues:

- A challenge would be to garner high enrollment among families with lower socio-economic status (SES) and low-car-ownership. Participation in child safety clubs has been found to be lower among low SES groups in European countries (Dragutinovic & Twisk, 2006).
- It is up to parents and caregivers of young children to use materials appropriately and a lack of control makes it difficult to monitor or assess results.

1.2 Child Supervision

Effectiveness: ★	Cost: $	Use: Unknown	Time: Short

The primary purpose of this countermeasure is to increase caregiver supervision of children when they are exposed to traffic, or when they are nearby with direct access to traffic. Because children do not have the impulse control to make safe walking decisions, these programs can be an asset to anyone responsible for the supervision of children. The State can require such training for teachers, day care workers, and others licensed to care for children. The programs can also be made available to parents, babysitters, or other caretakers through PTAs, churches, pediatricians, or even direct mail or Internet access.

One of the ways to "sell" these programs may be to point out that parents don't know how much their children need supervision (and effective training). Rivara et al. (1989) and Dunne, Asher, and Rivara (1992), for example, have shown that parents consistently overestimate the ability of children younger than 9 or 10 to negotiate in traffic. Adults should actively supervise children and not assume that their presence will be adequate to ensure safer behavior.

Use: The availability and use of programs to improve child supervision is unknown. One valuable resource is NHTSA, with publications such as *Walking Through the Years*, *Preventing Pedestrian Crashes: Preschool/Elementary School Children,* and *Teaching Children to Walk Safely as They Grow and Develop: A Guide for Parents and Caregivers*. Another key resource is Safe Kids Worldwide, with *Teach Your Child Street Smarts*.

Effectiveness: Programs or material can provide helpful training for caregivers if they point out specific risks as well as guidelines for the kind and degree of oversight that are necessary, but the caregivers need to put the training into practice. Widespread exposure of parents and caregivers to this material and resources should be a goal of such programs.

Costs: Material for individuals is already available and quite inexpensive. Training for licensed caregivers would be inexpensive to develop and distribute.

Time to implement: Short, for existing material; medium, to develop and disseminate a training curriculum with material.

Other issues:

- Cultural differences and social and perceived norms for pedestrian safety should be considered in the development of programs to improve child supervision. For example, in a study by Pfeffer, Fagbemi, and Stennet (2010), 59% of adults held the hands of female children compared with 36% who held the hands of male children when crossing a road. In another recent study, children 9 and younger in one cultural group believed that more of their peers crossed roadways alone than actually did (Rosenbloom, Sapir_Lavid, & Hadri-Carmi, 2009). Addressing discrepancies in perceived norms and actual norms may help to shift the actual norm toward safer trends.

2. School-Age Children

2.1 Elementary-Age Child Pedestrian Training

Effectiveness: ★★★	Cost: $	Use: Unknown	Time: Short

The purpose of elementary school pedestrian training is to equip school-age children with knowledge and practice to enable them to walk safely in environments with traffic and other safety hazards. A number of elementary school pedestrian training programs have been developed over the years. "Willy Whistle" was developed in the 1970s as a film to teach K-3 children to look left-right-left before crossing, and was updated in 2008. NHTSA-developed videos for grades 4-6 include "Keep on Looking" and "Walking with Your Eyes." Additional curricula have been developed for rural pedestrian concerns (Cleven & Blomberg, 1994). Furthermore, WalkSafe, a program adapted from many of these earlier resources, was implemented initially as a 5-day program in a high risk district in Miami-Dade County, Florida and later as a three-day program in all 220 Miami-Dade County elementary schools as part of a comprehensive effort to address pedestrian crashes in Miami-Dade County (Zegeer et al., 2008a).

In 2011, NHTSA produced a Child Pedestrian Safety Curriculum for elementary age students along with an instructor guide (www.nhtsa.gov/ChildPedestrianSafetyCurriculum/). Features of the curriculum include five lesson plans for each grade group K-1, 2-3, and 4-5 with developmentally appropriate lessons and messages, along with caregiver tip sheets, skills practice exercises, and student tests to evaluate knowledge change. While the curriculum was pilot tested in schools when it was developed, it has not yet been formally evaluated; an evaluation of the curriculum is planned for 2012-2014.

These school-based programs are useful to teach basic pedestrian concepts and safe behaviors at schools, churches, and other institutions with groups of elementary-aged children. Pedestrian safety programs are especially important for children who may be more likely to make risky pedestrian decisions, such as those from lower-income families or ethnic minority backgrounds, or those who are less able to control their behavior (Barton & Schwebel, 2007). A study from Australia identified younger ages, and attentional and developmental issues including hyperactivity and inattentiveness as factors in unsafe road-crossing decisions by children. Children who had some independent walking experience were less likely to make incorrect decisions (Congiu et al., 2008).

Use: Unknown. Materials have been available for years, and distributed widely, but not in a systematic program. In addition, materials and technology/formats may need to be updated or tailored for local use (e.g., VHS versus DVD). With schools being called on for a wider variety of services and narrower set of teaching requirements, finding time to add child traffic safety modules may be difficult.

Effectiveness: Child pedestrian training programs have been shown to increase knowledge. Long-lasting behavior improvements may be harder to achieve. Evaluations of 5-day and 3-day WalkSafe programs in the Miami school district that used videos, formal curricula, workbooks,

and outside simulation activities on an imaginary road on school grounds showed improvements in safety knowledge compared to before, although no control group was used in the evaluation. Improvements were more consistent for grades K-3 than for 4 and 5. Actual in-traffic behaviors were also reportedly improved in the short term, but did not hold up at 3 months after the program, and no comparison group was used (Hotz et al., 2004; Hotz et al., 2009). In a study of the longer-term impacts of the WalkSafe program, knowledge and behavior of more than 1,500 students receiving a one-time WalkSafe instructions were evaluated over 2 years (Livingston et al., 2011). While short- and intermediate-term knowledge retention was observed among all grades, long-term (i.e., more than a year) knowledge retention of pedestrian safety behaviors were observed only among children moving from 3rd to 4th grade. Knowledge change did not appear to result in improved pedestrian behaviors. The authors concluded that repetition and reinforcement may be needed for long-term knowledge and behavior change, as well as engagement by caregivers.

Another study by Gates, Savolainen, Datta, and Buck (2010) also indicates the importance of repetition in school-based trainings. In a study of 930 students in grades 2 to 7 in Detroit, pedestrian safety training was provided once and then again 7 to 12 months later (Gates et al., 2010). Measures of safety violations gathered by observing street-crossing behaviors before and after the trainings, as well as knowledge change based on pre/post tests were collected. After the initial training, both test scores and observed behaviors improved, but were only partially sustained. After retraining occurred, there was an increase in test scores and the cumulative difference (after initial training and retraining) was consistently larger than the impact of initial training alone for both test scores and observational behavioral measures.

Barton, Schwebel, and Morrongiello (2007) also reported that children crossed a road more safely immediately following a brief pedestrian safety training that included instruction followed by practice crossings on a pretend road. In the United Kingdom, a combination of adult-led training and peer discussions for children 5 to 8 led to improved roadside search skills (Tolmie et al., 2005). In a small study of mostly white and middle class pre-school children, Albert and Dolgin (2009) also reported that 4- and 5-year-olds trained by adults in groups of 3 or 4 using a play-mat model retained real-world behavioral (street crossing choices) improvement 6 months later compared to peers trained using two other less interactive methods or who received no training. According to the authors, the success of this treatment may lie in the opportunities for peer collaboration and corrective feedback from the adult trainers. Thus, although the evidence base is inconclusive, several studies suggest that knowledge and behaviors of young children may be improved through training programs and that behavior is more likely to be modified if the program incorporates interactive training with opportunities for feedback.

Effectiveness of school-based child pedestrian training would likely be enhanced if it combined child training with emphasis to teachers, parents, and other caregivers on the limits of children and the need for careful supervision, particularly for those younger than 10 (see Section 1.2), and on-going safety training and reinforcement of safe behaviors.

Costs: NHTSA publications can be distributed at low expense.

Time to implement: Short, once a decision is made by a school district to offer such a program. Time is needed to review the recommended material, work it into the curriculum, and train teachers. As indicated by the above research, the training needs to be repeatedly implemented in order to sustain effectiveness.

Other issues:

- A consensus is that practical training—that is, learning by doing with reinforcement of correct behaviors—is the most effective way for children to learn traffic safety skills (Bruce & McGrath, 2005; Dragutinovic & Twisk, 2006; Percer, 2009), The need for experiential learning is especially key for younger children who lack the capacity to generalize concepts and need to practice in environments with real objects that are as close as possible to those they will experience (Dragutinovic & Twisk, 2006). But real-world practice may be difficult to achieve with large groups of school children and without undue exposure to traffic risks.
- Classroom education may be enhanced by using outdoor simulation, 3-dimensional models, games, or other interactive learning methods such as with computer models, particularly in adult-led and small-group activities. These methods do not replace real-world practice but evidence from a few studies suggests that interactive training with opportunities for feedback, correction and practice (more than one session) may lead to more lasting behavior improvements (Tolmie et al., 2005; Albert & Dolgin, 2009).

2.2 Safe Routes to School

Effectiveness: ★★	Cost: $	Use: High	Time: Short

The goal of Safe Routes to School Programs (SRTS) is to increase the amount of walking and bicycling trips to and from school while simultaneously improving safety for children walking or bicycling to school. SRTS programs are community-based and are intended to be comprehensive in nature. Programs include education of children, school personnel, parents, community members, and law enforcement officers about safe bicycling and walking behavior and safe driving behavior around pedestrians and bicyclists. In addition, programs include enforcement and engineering activities to improve traffic safety and reduce or eliminate risky elements of the traffic environment around primary and secondary schools so children can safely bicycle or walk to school.

From 2005-2012, SAFETEA-LU legislation required each State to have its own SRTS program including a full-time coordinator to manage Federal funds. Each year, up to 70% (but not more than 90%) of available Federal funding was to be allocated on infrastructure (engineering) improvements, and up to 30% (but not less than 10%) of funding on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). Resources to support these efforts are available online from NHTSA on the pedestrian safety page and the National Center for Safe Routes to School (NCSRTS) Web site (www.saferoutesinfo.org). NCSRTS provides information, guidance, and support for community, State, and national SRTS efforts. A list of current State SRTS coordinators and funding levels may also be found at the NCSRTS Web site. In June 2012, Congress passed the Moving Ahead for Progress in the 21st Century (MAP-21) Act. The Act significantly alters how SRTS and other pedestrian and bicycle programs are structured and funded. To learn more, visit www.fhwa.dot.gov/MAP21/.

Use: With the establishment of the national SRTS program, all 50 States and the District of Columbia are now operating SRTS programs. Local SRTS programs exist, in different forms, in nearly all States. At the time of this report publication, the details of how MAP-21 will affect State SRTS programs were being determined. Visit the Web site above for details.

Effectiveness: SRTS material can be effective in teaching children and their parents how to evaluate and choose the safest routes for walking or bicycling to and from school. They are derived from analyses of types of crashes associated with to/from school trips, but it has not been possible to evaluate their effect on preventing crashes and injuries. Although the full program emphasizes broad education, some specific implementations have centered on site-appropriate engineering changes; results have shown behavioral improvements for pedestrians, bicyclists, and motorists (Britt, Bergman, & Moffat, 1995). Dumbaugh and Frank (2007) found that many of the safety benefits associated with SRTS countermeasures are assumed rather than known.

A variation on the SRTS theme, “walking school buses,” uses volunteer adults, usually parents, to walk a specific route to and from school, collecting or dropping off children on the way, so that a group of children walks to school under the supervision of adults. The program has been found popular and practical in New Zealand and Italy (Collins & Kearns, 2005; Roberts, 1995).

Roberts found in New Zealand that when parents walked with children to and from school, the risk of injury was 64% lower than the risk for unaccompanied children, though the sample sizes were small and the differences were not statistically significant. In a study of fourth grade students from eight low-income schools in Houston, TX, researchers examined the impact of walking school buses on several pedestrian behaviors (Mendoza et al., 2012). A walking school bus is a group of children walking to school on a specified route with one or more adult supervisors. Researchers found these students were five times more likely to cross at the intersection or crosswalk (rather than midblock locations) as opposed to children at schools without walking school buses.

Costs: Activities associated with SRTS may be low cost and may also be eligible for grant funding (non-infrastructure grants mentioned above). Grants are administered by each State's SRTS office. Material and resources can be accessed at no cost. NCSRTS provides downloadable material for State and local SRTS programs.

Time to implement: Once the school or district has decided to implement a SRTS program, a range of material, including an on-line step-by-step guide on getting started, is available from NCSRTS. Programs funded through State DOTs typically require applications on a funding cycle and can take significantly longer to implement.

2.3 Child School Bus Training

Effectiveness: ★★	Cost: $	Use: High	Time: Short

The purpose of school bus training for children is to teach school-age children how to safely approach, board, depart, and walk away from school buses. Approximately 800 school-aged children have died in traffic crashes in each recent year during normal school travel hours. On average, only 5 were school bus passengers and 15 were pedestrians near a school bus (TRB, 2002, p. 1). In 2009, there were 14 children killed in school-bus-related crashes. Of those, 2 were occupants of a school bus and 11 were pedestrians. It is also estimated that 6,000 people were injured while riding as a passenger in a school bus and 1,000 were injured as pedestrians in school-bus related crashes (NHTSA, 2010b). There are no data for pedestrian fatalities and injuries involving school buses during hours not associated with travel to and from school (i.e., for special school-related trips).

Basic training for children who ride school buses should be part of the normal school routine, if it is not already. Training should include behavior on the bus as well as getting on or off the bus at bus stops or school, obeying bus drivers and bus monitors, emergency evacuation procedures, and any topics unique to the school.

Jurisdictions should use a common curriculum for school bus safety training. Targeted behaviors include boarding and exiting from the bus and crossing the street to and from the bus. The NHTSA Child Pedestrian Safety Curriculum previously discussed includes a segment on safety around school buses.

Use: Most school districts have some form of school bus training in place, though the content and quality of those programs varies. Schools should be eager to provide this training, both for child safety and for legal liability.

Effectiveness: Burke, Lapidus, Zavoski, Wallace, and Banco (1996) found that stenciled pavement markings, together with in-school training, led to improved behavior in waiting for and boarding the school bus compared to training alone for students in grades 4-6. Reductions in crashes and injuries are difficult to demonstrate because minimal, basic training is very widespread and the choice to adopt a stronger curriculum would be confounded with any number of other factors.

Costs: The primary cost for the SHSOs would be in adapting material for their States and producing, stocking, and distributing the material.

Time to implement: Basic material is available from a variety of organizations, including NTHSA, and schools could adopt a curriculum of their choice quickly.

3. Impaired Pedestrians

3.1 Impaired Pedestrians: Communications and Outreach

Effectiveness: ★★	Cost: Varies	Use: Low	Time: Medium

In 2009, 39% of all fatally injured pedestrians had positive BACs, and 35% had a BAC of .08 g/dL or higher (NHTSA, 2010a). Nearly half of fatally injured pedestrians between 21 and 54 had BACs of .08 or higher (NHTSA, 2010a).

Communications and outreach to reduce impaired-pedestrian crashes can be directed at a wide variety of audiences, including law enforcement, drivers, alcohol servers and vendors, civic and neighborhood leaders, and friends and family of likely impaired pedestrians. Impaired pedestrians are also a target audience, of course. However, they are viewed as a very difficult audience for communications and outreach to have a meaningful effect on their behavior. Reaching others who are in a position to prevent these crashes, or to alter the circumstances that lead up to such crashes, may be most effective way to achieve success. Some of the countermeasures proposed for impaired drivers in Chapter 1, such as responsible beverage service training and alternative transportation, are also appropriate for impaired pedestrians.

Use: Low. NHTSA has successfully implemented one zone-based program in Baltimore, Maryland that included public service announcements, posters, flyers, and interventions aimed at alcohol-impaired pedestrians, but the program is not currently active (Blomberg & Cleven, 2000). Most impaired-roadway user programs focus on impaired drivers.

Effectiveness: Using 5.5 years of before data and 2 years of after data, Blomberg and Cleven (2000) found a 22% decrease in crashes among males 30-59 in the targeted zones where the intervention took place. Although encouraging, there have been no demonstrations of crash or injury reductions unless the communications and outreach is part of a comprehensive program that includes engineering measures and some form of law enforcement involvement, as in the case of Blomberg and Cleven (2000).

Costs: The costs for such a program can range from low to high, depending on the extent of the campaign that is designed and implemented.

Time to implement: The actual time to implement depends on the scope and ambition of the program.

3.2 "Sweeper" Patrols of Impaired Pedestrians

Effectiveness: ★	Cost: Varies	Use: Low	Time: Medium

The purpose of "sweeping" alcohol-impaired pedestrians from the streets until they no longer have high BACs is intended to reduce the exposure to traffic of these at-risk pedestrians, and can also address other social issues such as public intoxication and crime. Pedestrians with high BACs are at high risk of injury due to motor vehicle crashes. A program of removing alcohol-impaired pedestrians from the streets can be effective in reducing their exposure and thus the risk.

There are some important issues that need to be resolved when setting up sweeper programs, such as how to identify at-risk pedestrians (e.g., calls from bars or direct observers, observation by police or health professionals), who picks up the targets, where they are kept until they are sober, whether friends or family need to be notified at the time of the pickup, how the pedestrians are returned home after the intervention, and how the costs of the program are borne.

Huntley (1984) focused on police "sweeper" squads and "support on call" programs involving taxis and trained escorts to get intoxicated people home. Services of these types in the Boston area were surveyed. Both types of services appeared practical and effective, though the number of people who could be reached by these services was relatively small. There was a problem related to the number of available detoxification beds in the community. The sweeper squads wanted to deliver intoxicated pedestrians to the mental health community, not to police facilities, and they stopped the sweep when the beds were filled. There were also problems with the number of taxi drivers who wanted to deal with intoxicated people and the availability of volunteer escorts.

Use: Well-publicized sweep operations, which involve picking up intoxicated people from the street and letting them "sleep it off," have been conducted in Puerto Rico and in Gallup, New Mexico. Puerto Rico's program, which included a statute, communications and outreach, and law enforcement training, led to a 7% drop in alcohol-related pedestrian crashes (Stewart, 1994). There appear to be no well-publicized programs operating now.

Effectiveness: Such programs typically reach only a fraction of those people who need the services. The sweeps typically deal with people who are too drunk to walk or even know that they are being "swept." These same people are at risk while they are becoming intoxicated, and, in all likelihood, will be at risk again in the near future as they become sober and thus more mobile. As described by Huntley (1984), these individuals need intensive treatment for alcoholism; and sweeper programs may be useful in identifying potential treatment candidates.

Costs: The program incurs ongoing costs directly related to the effectiveness, i.e., the number of people swept up. Depending on how it is set up, the program may incur costs related to the sweeper patrol (or law enforcement overtime), the use of facilities, and any subsequent treatment requirements.

Time to implement: Once it is decided to offer the program, the logistics for starting it up could be handled within weeks or months, depending on the extent and coordination of services.

Other issues:

- The legal rights of those potentially being swept need to be preserved.
- Often if law enforcement or other formal agencies are involved, their regular procedures would require some formal charge or other processing to take place. Alternatively, a sweeper program could be without subsequent consequences to those being swept, with no formal records kept. This might eliminate certain organizations or agencies from participating.

4. All Pedestrians

4.1 Pedestrian Safety Zones

Effectiveness: ★★★★	Cost: $$$	Use: Low	Time: Medium

The pedestrian safety zone concept was developed in a joint effort study by NHTSA and FHWA (Blomberg & Cleven, 1998). The idea is to strive for large decreases in pedestrian crashes and injuries by more effectively targeting resources to problem areas. Specifically, the objective of pedestrian safety zones is to increase efficiency by targeting limited resources to geographic areas and audiences where significant portions of the pedestrian crash problem exist (NHTSA, 2008). Pedestrian zone programs, including education, enforcement, and engineering measures, can target at a full range of pedestrian crash problems within a limited geographic area or focused on particular types of problems that make up a large portion of the problem within a limited area.

Blomberg and Cleven (1998) implemented and analyzed an early pedestrian safety zone program in Phoenix, Arizona. Crash data were analyzed to identify areas where older pedestrian crashes occurred and "zones" were drawn around the high-incidence areas. Countermeasures were developed for the kinds of crashes that involved older pedestrians. The measures included signal retiming, providing communications and outreach for both drivers and pedestrians living near the crash zones, and enhanced enforcement. The result was a significant reduction in crashes and injuries to older pedestrians in the target areas.

In a recent Miami-Dade County, Florida, comprehensive application of the safety zone strategy, high crash zones were identified, and then the characteristics of those crashes were further analyzed within the zones (Zegeer et al., 2008a). The four zones, comprising less than 1% of the total land area of the County, accounted for about 20% of the total number of collisions (Zegeer et al., 2008b). Further analyses identified high child involvement in crashes in some areas, young adult involvement in others (particularly at night), and high senior involvement in certain corridors. Overall, there was an 8.5% to 13.3% reduction in pedestrian crash rates during and following the program implementation compared to control groups (Zegeer et al., 2008b).

Use: Pedestrian zone programs are known to have been implemented in only a handful of cities.

Effectiveness: Properly designed and implemented pedestrian zone programs have been shown effective in reducing crashes and injuries for older pedestrians (Blomberg & Cleven, 1998), for impaired pedestrians (Blomberg & Cleven, 2000), and for child and adult pedestrian crashes in Miami-Dade County (Zegeer et al., 2008a, 2008b).

Costs: Pedestrian zone programs require up-front analysis and planning, countermeasure development and tailoring, and implementation.

Time to implement: Medium. A pedestrian zone program can take several months of concentrated activity before countermeasures can be implemented. More comprehensive programs, such as in Miami-Dade, may be years-long programs involving data analysis and on-

site evaluations, lining up partners, and identifying, implementing and evaluating countermeasures. Programs to date have included local task forces, usually assembled for the program, to take critical leadership roles.

4.2 Reduce and Enforce Speed Limits

Effectiveness: ★★★	Cost: $	Use: High	Time: Varies

The goal of reducing speeds is to increase reaction time for both drivers and pedestrians to avoid crashes, as well as reduce the severity of injuries that result when pedestrian crashes occur. Higher vehicle speeds produce more frequent and more serious pedestrian crashes and casualties, as evidenced by several studies (Leaf & Preusser, 1999; Rosen & Sander, 2009). The most recent study, performed by the AAA Foundation (Tefft, 2011), found the average risk of severe injury for a pedestrian struck by a vehicle reaches 10% at an impact speed of 16 mph, 25% at 23 mph, 50% at 31 mph, 75% at 39 mph, and 90% at 46 mph.

Reducing speeds through lowering speed limits is a time-honored countermeasure. Evidence shows, though, that actual speeds are reduced by only a fraction of the reduction in speed limits – typically 1-2 mph speed reduction for every 5 mph speed limit reduction. For maximum effectiveness, speed limit reductions need to be accompanied by communications and outreach that inform the public and make the case for the reduction and by heightened, visible enforcement (Leaf & Preusser, 1999). Some reasons that travel speeds do not decrease by the same proportion as speed limit reductions include drivers not noticing the new speed limit, drivers not understanding the reason to reduce speed or speeding out of habit, or drivers continuing to keep up with the speeds maintained by other drivers. Speed limit reductions need to be made compelling through rational speed limit setting and enforcement (TRB, 1998). For more on speed-related issues and countermeasures, see Chapter 3.

Speed limit reductions can be most effective when introduced to a limited area as part of a visible area-wide change, for example, identifying a downtown area as a special pedestrian-friendly zone through signs, new landscaping or "streetscaping", lighting, etc. If done cleverly, this can been accomplished with relatively modest engineering changes and expense.

If speed limits are routinely ignored, then enforcing speed limits may be a more effective strategy than attempting to change them. Blomberg and Cleven (2006) reported on demonstration programs in two cities in which speed limit enforcement, combined with engineering changes and extensive publicity, reduced both average speeds and the number of excessive speeders in residential neighborhoods.

See Chapter 3, Section 1.1, for further discussion of speed limits.

Use: High, in the sense that all public roads have a speed limit and speed limit enforcement is widely employed.

Effectiveness: Reduced speed limits and enforcement can reduce vehicle speeds and all types of crashes and crash severity. The association of pedestrian injury with speed trends strongly suggests that pedestrian injuries and crashes will be reduced if travel speeds are reduced, although direct evidence is lacking. Just changing speed limits is of limited, though positive, effectiveness as described above.

Costs: Simply changing speed limits is low-cost, only requiring updating speed limit signs or, where few signs exist, adding some new ones. Combining speed limit changes with communications and outreach, enforcement, and engineering changes can be significantly more expensive.

Time to implement: Depending on the scope of the program, the time can be very short, or it can take several months to a year to plan and implement a complex plan.

Other issues:

- Speed limit changes exist in the context of other, unchanged speed limits. The normal expectation is that there is an overall consistent approach to speed-limit setting. Where, for safety, some speed limits need to be reduced in a manner inconsistent with other speed limits, there must be clear and visible reminders that distinct conditions exist that justify the lower limits.

4.3 Conspicuity Enhancement

Effectiveness: ★★★	Cost: $	Use: Low	Time: Medium

The purpose of enhancing conspicuity for pedestrians is to increase the opportunity for drivers to see and avoid pedestrians, particularly at night. Pedestrians who are more visible are less likely to be struck. Retro-reflective materials are built into many shoes, including children's and athletic shoes. Other accessories, such as arm or leg bands, gloves, vests, and caps are available from sporting goods stores and other vendors. Light sources, including strobes and other flashing lights, are also available. Many have been designed for bicyclists but are equally applicable to pedestrians. The difficulty with most of these devices is that the user must decide in advance to take and use them. Because of this extra step, and because most of the conspicuity enhancements do not look like "normal" clothing, they are very much underused. Light-colored clothing, long a recommended solution, does little to improve conspicuity (NCHRP, 2004, Strategy B5).

There are a number of opportunities for improving pedestrian conspicuity. Devices designed to be semi-permanently fastened to children's clothing can be provided to parents through schools, group activities, or pediatricians. Light sticks and reflective bands can be supplied with new cars, or distributed by automobile clubs or insurance companies for use during vehicle breakdowns or emergencies.

Use: Retro-reflective materials are used regularly in athletic-type shoes, occasionally in backpacks and jackets, and minimally in other clothing.

Effectiveness: Widespread use of retro-reflective materials would increase the ability of drivers to detect pedestrians in time to avoid crashes. Pedestrians wearing good retro-reflective materials, particularly materials that highlight a person's shape and extremities, can be detected hundreds of feet farther than can pedestrians in normal clothing, even with low-beam illumination (NCHRP, 2004, Strategy B5). A study in a controlled (closed road) environment found that pedestrians were detected more readily when they wore reflective elements on their moving body parts (i.e., wrists and ankles). Although standing still did reduce recognition by drivers as compared to walking, adding clutter to the background did not significantly reduce detection (Tyrrell et al., 2009).

Costs: Cost to provide retro-reflective materials is low, if such supplementary materials are distributed in quantity and added to existing programs. Such items as reflective wrist and ankle bands are available commercially. To develop new programs promoting use of conspicuity materials would require somewhat more planning and start-up time and costs would also depend on communications strategies used.

Time to implement: Promoting increased conspicuity may require development of targeted messages and a publicity strategy.

Other Issues:

- **Social equity:** Aside from free retroreflective items that may be distributed at, for example, a school safety event, some people will not be able to afford these items.

4.4 Targeted Enforcement

Effectiveness: ★★★	Cost: $$	Use: Low	Time: Short

The purpose of targeted enforcement is to increase compliance with appropriate traffic laws by both pedestrians and motorists. Behavioral pedestrian safety initiatives require drivers or pedestrians to change their walking or driving actions and habits. Once pedestrians and drivers are informed of the changes needed and why they are important, enforcement often is necessary to encourage compliance. Although enforcement was implied or stated for many of the earlier countermeasures, it deserves to be discussed separately.

Enforcement is most effective when it is highly visible and publicized, to reinforce the message of the required behavior and to raise the expectation that failure to comply may result in legal consequences. Enforcement campaigns should be aimed at drivers and pedestrians, starting with the communications and outreach efforts that announce, describe and publicize the campaigns.

A coordinated program of targeted enforcement should involve a range of support activities, such as communications and outreach to notify the public of the campaign, training for the law enforcement officers on enforcement goals and procedures, and training for prosecutors and judges so that they understand the purposes of the campaign and are prepared for the increase in citations that the enforcement will produce. NHTSA has developed a training course aimed at teaching law enforcement personnel the basics of pedestrian safety and targeted enforcement techniques: http://mcs.nhtsa.gov/index.cfm/product/786/nhtsa-pedestrian-safety-training-for-law-enforcement-cd-rom.cfm.

Use: Low. Enforcement is largely a local option, and often is integrated into other police duties, so special enforcement efforts are difficult to isolate and track. However, the use of targeted pedestrian safety enforcement is on the rise. Several localities (including Chicago, IL; Detroit, MI; Miami, FL; Pinellas County, FL; and Raleigh/Durham, NC) and states such as New Jersey and New Mexico have, within the past few years, implemented training for law enforcement officers and conducted targeted enforcement efforts for pedestrian safety.

Effectiveness: Targeted enforcement can be employed for a wide range of purposes in a wide range of circumstances, so effectiveness is context-dependent. In Queens, New York, enforcement was a key part of a campaign that included minor engineering adjustments and communications and outreach and reduced pedestrian fatalities (CDC, 1989). In Seattle, a variety of communications and outreach and enforcement combinations were tested in conjunction with a change in the law for drivers to yield to pedestrians at crosswalks; the authors concluded that enforcement was not successful in increasing driver yielding (Britt et al., 1995). Van Houten and Malenfant (2004) found that driver yielding to pedestrians increased in response to targeted police enforcement at crosswalks on two corridors in Miami Beach, Florida. Warnings and educational flyers were handed out to most violators, while citations were issued for flagrant violations. Some publicity resulted from the enforcement efforts. Yielding also increased to some extent at other untreated crosswalks in the affected corridors. Increases in yielding were sustained for up to a year following the two-week intensive enforcement efforts with nominal additional enforcement, but effects on crashes and injuries have not been reported.

In a study by Savolainen, Gates, and Datta (2011), law enforcement officials in Detroit, MI implemented two pedestrian-oriented enforcement campaigns at Wayne State University aiming to educate campus pedestrians on proper use of crosswalks and the importance of obeying signals through the issuance of warnings. The study saw pedestrian violations (walking outside the crosswalk or against the signal) reduced 17 to 27% immediately after the campaign, with sustained reductions of 8 to 10% several weeks after active enforcement ceased. Study authors noted that pedestrian compliance was also heavily associated with the presence, quality, and location of pedestrian facilities (including pedestrian signals, bus stops, crosswalks, and convenient crossing opportunities).

Costs: The cost of the enforcement is a direct function of the size of the effort, the number of overtime officer hours and associated supplies, ranging from vehicle operating costs to equipment such as speed measurement devices or alcohol test machines.

Time to implement: Short. Law enforcement resources can be diverted to targeted enforcement very quickly. Support equipment can take longer to acquire and deploy, as can developing a plan that coordinates law changes, environmental changes, or support communications and outreach with enforcement activities. Communications and outreach are keys to maximal effectiveness.

4.5 Driver Training

Effectiveness: ★	Cost: $	Use: Low	Time: Medium

The purpose of pedestrian safety-related driver training is to increase the sensitivity of drivers to the presence and characteristics of pedestrians. Current training for new drivers typically includes relatively little information on other road users. Information on pedestrians can be significantly strengthened. Specifications for driver education curricula, typically a State requirement, can be adjusted to include more and more specific information on the status of the pedestrian in the traffic environment, right of way requirements for driver and pedestrian, other driver and pedestrian responsibilities, categories of pedestrian crash types, and key ways drivers can avoid being involved in such crashes. Standards for curriculum and training developed by the American Driver and Traffic Safety Education Association include some of these pedestrian-related learning objectives (Driver Education Working Group, 2009).

One way driver training can incorporate pedestrian and bicyclist concerns for new and existing drivers is through "Share the Road" concepts and programs, though many focus exclusively on bicycles. One such resource is the State of New York's highly readable *Sharing the Road Safely* (www.nysgtsc.state.ny.us/media/sharetheroad.pdf).

Use: As noted, all driver education curricula include some information on other road users, but the kind of expanded information recommended here is sparse.

Effectiveness: Driver education has not been shown to reduce overall crash rates. The objective for adding more pedestrian information would be to increase knowledge and desire to share the road safely with pedestrians, of how to avoid the most common types of crashes, and to improve drivers' anticipation of and interactions with pedestrians – as well as improve their behavior as pedestrians.

Costs: Low. The cost would be for the development of the new segments of the standard curriculum and for getting it into the material used by driver education instructors and schools.

Time to implement: Material would need to be developed and integrated into the standard driver education curriculum, and adjustments made elsewhere in the curriculum to reflect likely additional time required for the new pedestrian material.

The same timeframe would be appropriate for making changes to official State driving manuals, license exams, and related material and procedures.

4.6 Pedestrian Gap Acceptance Training

Effectiveness: ★	Cost: $$	Use: Unknown	Time: Medium

The purpose of pedestrian gap acceptance training is to help pedestrians learn to make better crossing decisions, which may reduce the incidence of crossing-related injuries and fatalities. Previous studies have indicated that human error, such as poor judgment in gauging the speed and/or distance of oncoming traffic, underlies a significant portion of roadway collisions (Hunt, Harper, & Lie, 2011).

Use: Unknown. Preliminary studies have taken place in New Zealand and France but no adult simulator trainings on gap acceptance have been found in the U.S.

Effectiveness: Hunt, Harper, and Lie (2011) used laboratory-based instruction (e.g., a video simulating the roadway environment) to test three different approaches for giving feedback to pedestrians in how to better incorporate vehicle speed information to their gap estimates and crossing decisions. While the study group was small—58 people age 18 to 80—preliminary results indicate that video-based training with a feedback mechanism can be successful in improving the accuracy of pedestrians' estimates of driver speeds. However, improved speed estimation did not consistently translate into improved gap-acceptance judgments, and participant age played a role in training effectiveness. Older pedestrians, in particular, had significantly more conservative gap judgments after the training, which were independent of improvements in vehicle speed estimations.

Another study by Dommes and Cavallo (2012) evaluated the effectiveness of an education-based intervention aimed at training older pedestrians (60+ years) to improve crossing safety by taking into account vehicle speeds. Results showed that after simulated crossing training, the treatment group participants crossed more quickly, had larger safety margins, and had fewer close encounters than the control group, although differences were no longer significant 6 months after training. Also, in contrast to the Hunt et al study, participants did not appear to improve in taking into account vehicle speed when making crossing decisions. The authors concluded that age-related perceptual and cognitive difficulties may exist in gauging speed and gap acceptance that cannot be remedied by educational training alone.

Costs: Medium. Costs would involve development of the training materials (or adaptation from existing study materials) and determining an applicable and appropriate venue to reach the adult and senior pedestrian population.

Time to implement: Medium. Training materials could be developed and integrated into existing educational channels for adult and senior pedestrians.

Pedestrian Safety References

Agran, P. F., Winn, D. G., & Anderson, C. L. (1994). Differences in child pedestrian injury events by location. *Pediatrics, 93*, 84-288.

Albert, R. R, & Dolgin, K. G. (2010). Lasting effects of short-term training on preschoolers' street-crossing behavior. *Accident Analysis & Prevention*, 42, 500-508.

Anderson, C. L., Vaca, F. E. & Chakravarthy, B. (2010). Socioeconomic Disparities in Pedestrian Injuries. *Injury Prevention*, *16*, A259.

Barton, B. K., Schwebel, D. C., & Morrongiello, B. A. (2007). Brief report: Increasing children's safe pedestrian behaviors through simple skills training. *Journal of Pediatric Psychology, 32*, 475-80.

Barton, B. K., & Schwebel, D. C. (2007). The influences of demographics and individual differences on children's selection of risky pedestrian routes. *Journal of Pediatric Psychology, 32*, 343-53.

Blomberg, R. D. (2001). *NHTSA Resource Guide on Laws Related to Pedestrian and Bicycle Safety.* (Report No. DOT HS 809 368). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/pedbimot/bike/resourceguide/

Blomberg, R. D., & Cleven, A. M. (1998). *Development, Implementation, and Evaluation of a Pedestrian Safety Zone for Elderly Pedestrians.* (Report No. DOT HS 808 692). Washington, DC: National Highway Traffic Safety Administration.
Available at www.nhtsa.dot.gov/people/injury/pedbimot/bike/resourceguide/

Blomberg, R. D., & Cleven, A. M. (2000). *Development, Implementation, and Evaluation of a Countermeasure Program for Alcohol-Involved Pedestrian Crashes*. (Report No. DOT HS 809 067). Washington, DC: National Highway Traffic Safety Administration. Available at http://ntl.bts.gov/lib/25000/25900/25960/DOT-HS-809-067.pdf

Blomberg, R. D., & Cleven, A. M. (2006). *Pilot Test of "Heed the Speed," A Program to Reduce Speeds in Residential Neighborhoods.* (Report No. DOT HS 810 648). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/HeedSpeedWeb/

Britt, J. W., Bergman, A. B., & Moffat, J. (1995). Law enforcement, pedestrian safety, and driver compliance with crosswalk laws: evaluation of a four-year campaign in Seattle. *Transportation Research Record*, *1485*, 160-167.

Bruce, B. & McGrath, P. (2005). Group interventions for the prevention of injuries in young children: a systematic review. *Injury Prevention*, *11*, 143-147

Burke, G. S., Lapidus, G. D., Zavoski, R. W., Wallace, L., & Banco, L. I. (1996). Evaluation of the effectiveness of a pavement stencil in promoting safe behavior among elementary school children boarding school buses**.** *Pediatrics, 97*, 520-523.

CDC. (1989). Queens Boulevard Pedestrian Safety Project--New York City. *Morbidity and Mortality Weekly Report, 38*, 61-64.

Cooper, J., Schneider, R., Ryan, S., & Co, S. (2012). *Documenting Targeted Behaviors Associated with Pedestrian Safety.* Presented at "Peds Count! 2012: Success, Challenges and Data" Conference. SafeTREC. Available at www.safetrec.berkeley.edu.

Cottrill, C. D., & Thakuriah, P. (2010). Evaluating pedestrian crashes in areas with high low-income or minority populations. *Accident Analysis and Prevention*, *42*, 1718-1728.

Cynthia, C., Lin, H., & Loo, B. P. Y. (2012). Exploring the impacts of safety culture on immigrants' vulnerability in non-motorized crashes: A cross-sectional study. *Journal of Urban Health*, *89*, 138-152.

Collins, D. C., & Kearns, R. A. (2005). Geographies of inequality: Child pedestrian injury and walking school buses in Auckland, New Zealand. *Social Science and Medicine, 60*, 61-69.

Congiu, M., Whelan, M., Oxley, J., Charlton, J., D'Elia, A., & Muir, C. (2008). *Child Pedestrians: Factors associated with ability to cross roads safely and development of a training package.* Monash University Accident Research Centre, Report 283.
Available at www.monash.edu.au/muarc/reports/muarc283.html

Driver Education Working Group. (2009). Novice Teen Driver Education and Training Administrative Standards. Report from *National Conference on Driver Education*. Washington, DC: National Highway Traffic Safety Administration.
Available at
www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Teen%20Driver/files/TeenDriverETAS-1.pdf

Dragutinovic, N. & Twisk, D. (2006). The effectiveness of road safety education: a literature review. Leidschendam, the Netherlands: SWOV Institute for Road Safety Research.

Dommes, A., Cavallo, V. (2012). Can simulator-based training improve street-crossing safety for elderly pedestrians? *Transportation Research Part F: Traffic Psychology and Behavior*, *15*, 206-218.

Dumbaugh, E., & Frank, L. D. (2007). *Traffic Safety and Safe Routes to Schools: Synthesizing the Empirical Evidence.* Transportation Research Board 86th Annual Meeting, Washington, DC.

Dunne, R. G., Asher, K. N., & Rivara, F. P. (1992). Behavior and parental expectations of child pedestrians. *Pediatrics, 89*, 486-490.

Federal Highway Administration. (1990). *1990 Nationwide Personal Transportation Survey*. Washington, DC: Author.

FHWA. (1995). *1995 Nationwide Personal Transportation Survey*. Washington, DC: Author.

FHWA. (2001). *2001 National Household Travel Survey*. Washington, DC: Author.

FHWA. (2010). *2009 National Household Travel Survey.* [Data file]. Retrieved from http://nhts.ornl.gov/tables09/FatCat.aspx

FHWA. (2011). International Technology Scanning Program; Public Policies for Pedestrian and Bicyclist Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan. Washington, DC: Author. http://katana.hsrc.unc.edu/cms/downloads/PBSPolicyReview.pdf

Fredriksson, R., Shin, J., & Untaroiu, C. D. (2011). Potential of pedestrian protection systems-A parameter study using finite element models of pedestrian dummy and generic passenger vehicles. *Traffic Injury Prevention*, *12*, 398-411.

Garay-Vega, L., Pollard, J. K., Guthy, C., & Hastings, A. (2011). Auditory detectability of hybrid electric vehicles by blind pedestrians. *Transportation Research Record: Journal of the Transportation Research Board*, *2248*, 68-73.

Gates, T. J., Savolainen, P. T., Datta, T. K,., & Buck, N. (2010). Effect of pedestrian safety retraining for elementary and middle school students. *Transportation Research Record: Journal of the Transportation Research Board*, *2198*, 145-151.

Greene, D., Liu, J., Reich, J., et al. An efficient computational architecture for a collision early-warning system for vehicles, pedestrians, and bicyclists 2011. *Intelligent Transportation Systems*, *12*, 942-953.

Green, J., Ayrton, R., Woodall, J., Woodward, J., Newell, C., Cattan, M., & Cross, R. (2008). *Child–Parent Interaction in Relation to Road Safety Education: Part 2 – Main Report.* London: Department for Transport.
Available at www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme1/

Gregersen, N. P., & Nolen S. (1994). Children's road safety and the strategy of voluntary traffic safety clubs. *Accident Analysis and Prevention, 26*, 463-470.

Hale, A., Blomberg, R. D., & Preusser, D. F. (1978). *Experimental field test of the model ice cream ordinance in Detroit.* (Report No. DOT HS 803 410). Washington, DC: National Highway Traffic Safety Administration.

Hatfield, J., & Murphy, S. (2007) The effects of mobile phone use on pedestrian crossing behaviour at signalised and unsignalised intersections. *Accident Analysis & Prevention, 39*, 197-205.

Hotz, G., Cohn, S., Castelblanco, A., Colston, S., Thomas, M., Weiss, A., Nelson, J., Duncan, R., & The Pediatric Pedestrian Injury Task Force. (2004). WalkSafe: a school-based pedestrian safety intervention program. Traffic Injury Prev*ention, 5*, 382-389.

Hotz, G., Garces de Marcilla, A., Lutfi, K., Kennedy, A., Castellon, P., and Duncan, R. (2009). The WalkSafe program: Developing and evaluating the educational component. *Journal of Trauma, Injury, Infection, and Critical Care* 66, S3 – S9.

Hu, P. S., & Reuscher, T.R., (2004). *Summary of Travel Trends: 2001 National Household Travel Survey.* (Report No. FHWA-PL-92-027). Washington, DC: U.S. Department of Transportation, Federal Highway Administration. http://nhts.ornl.gov/2001/pub/STT.pdf

Hunt, M., Harper, D. N., & Lie, C. (2011). Mind the gap: Training road users to use speed and distance when making gap-acceptance decisions. *Accident Analysis and Prevention*, *43*, 2015-2023.

Hunter, W. H., Stutts, J. C., Pein, W. E., & Cox, C. L. (1996). *Pedestrian and Bicycle Crash Types of the Early 1990's.* (Report No. FHWA-RD-95-163). Washington, DC: Federal Highway Administration.

Huntley, M. S., Jr. (1984). *Pedestrian/alcohol problems: Countermeasures to consider*. Cambridge, MA: Transportation Systems Center.

Kravetz, D. & Noland, R. B. (2012). *A Spatial Analysis of Income Disparities in Pedestrian Safety in Northern New Jersey: Is There an Environmental Justice Issue?* TRB 91st Annual Meeting Compendium of Papers DVD. Washington, DC: Transportation Research Board.

Leaf, W.A., & Preusser, D.F. (1999). *Literature Review on Vehicle Travel Speeds and Pedestrian Injuries*. (Report No. DOT HS 809 021). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.dot.gov/people/injury/research/pub/HS809012.html

Livingston, D. H., Suber, I., Snyder, D., Clancy, S. F., Passannante, M. R. & Lavery, R. F. (2011). Annual pediatric pedestrian education does not improve pedestrian behavior. *Journal of Trauma-Injury Infection & Critical Care*, *71*, 1120-1125.

Mendoza, J. A., Watson, K., Chen, T-A., et al. (2012). Impact of a pilot walking school bus intervention on children's pedestrian safety behaviors: A pilot study. *Health & Place*, *18*, 24-30.

Murtha, T. (2005). Pedestrian and bicycle safety data in Northeastern Illinois. Presentation to Association of Pedestrian and Bicycle Professionals,October 2005. Available at www.walkinginfo.org/training/pbic/archive.cfm#part7.

Nasar, J., Hecht, P., & Wener, R. (2007). Mobile telephones, distracted attention, and pedestrian safety. *Accident Analysis and Prevention*, *40*, 69–75.

NCHRP, Vol. 10. (2004). *A Guide for Reducing Collisions Involving Pedestrians*. Washington, DC: Transportation Research Board. onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v10.pdf

National Highway Traffic Safety Administration. (2008). *Zone Guide for Pedestrian Safety*. (Report No. DOT HS 808 742). Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/ped/ZoneGuideWeb/pages/index.htm

NHTSA (2009). *Traffic Safety Facts: Not-in-Traffic Surveillance – Children 2007: A Brief Statistical Summary.* (Report No. DOT HS 811 116). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811116.pdf

NHTSA (2010a). *Traffic Safety Facts 2009 Data: Pedestrians*. (Report No. DOT HS 811 394). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/811394.PDF

NHTSA (2010b). *Traffic Safety Facts 2009 (Early Edition).* (Report No. DOT HS 811 402). Washington, DC: Author.
Available at www-nrd.nhtsa.dot.gov/Pubs/811402.PDF

NHTSA (2012). *Traffic Safety Facts 2010 Data*. (Report No. DOT HS 811 630). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811630.pdf

Organization for Economic Co-operation and Development. (2004). *Keeping Children Safe in Traffic.* Paris, France: Author. Available at www.oecd.org/document/9/0,2340,en_2649_34351_31416393_1_1_1_1,00.html

Olson, L. M., Sklar, D. P., Cobb, L., Sapien, R., & Zumwalt, R. (1993). Analysis of childhood pedestrian deaths in New Mexico, 1986-1990. Annals of Emergency Med*icine, 22*, 512-516.

Percer, J. (2009). *Child Pedestrian Safety Education: Applying Learning and Developmental Theories to Develop Safe Street Crossing Behaviors*. (Report No. DOT HS 811 190). Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/811190.pdf

Pfeffer, K., Fagbemi, H. P., & Stennet, S. (2010). Adult pedestrian behavior when accompanying children on the route to school. *Traffic Injury Prevention*, *11*, 188-193.

Pucher, J., & Renne, J. L. (2003). Socioeconomics of urban travel: evidence from the 2001 NHTS. *Transportation Quarterly*, *57*, 49-77.

Redmon, T. (2011). *Pedestrian Countermeasure Policy Best Practice Report: FHWA Safety Program*. Washington, DC: Federal Highway Administration. Available at http://safety.fhwa.dot.gov/ped_bike/tools_solve/fhwasa11017/fhwasa11017.pdf

Retting, R. A., Ferguson, S. A, & McCartt, A T. (2003). A review of evidence-based traffic engineering measures designed to reduce pedestrian–motor vehicle crashes. *American Journal of Public Health*. *93*, 1456–1463.

Reschovsky, C. (2004). Journey to Work: 2000. Census 2000 Brief. U.S. Census Bureau. Available at www.census.gov/prod/2004pubs/c2kbr-33.pdf

Rivara, F. P., Bergman, A. B., & Drake, C. (1989). Parental attitudes and practices toward children as pedestrians. Pediatrics*, 84*, 1017-1021.

Roberts, I. (1995). Adult accompaniment and the risk of pedestrian injury on the school-home journey. Injury Prev*ention, 1*, 242-244.

Rosén, E., & Sander, U. (2009). Pedestrian fatality risk as a function of car impact speed. *Accident Analysis and Prevention*, *41*, 536–542.

Rosenbloom, T., Sapir_Lavid, Y., & Hadari-Carmi, O. (2009). Social norms of accompanied young children and observed crossing behaviors. *Journal of Safety Research*, *40*, 33-39.

Savolainen, P. T., Gates, T. J., & Datta, T. K. (2011). Implementation of targeted pedestrian traffic enforcement programs in an urban environment. *Transportation Research Record: Journal of the Transportation Research Board*, *2265*, 137-145.

Sayer, J. R., & Buonarosa, M. L. (2008). The roles of garment design and scene complexity in the daytime conspicuity of high-visibility safety apparel. *Journal of Safety Research, 39*, 281-286.

Schwebel, D. C., Stavrinos, D., Byington, K. W., Davis, T., O'Neal, E. E., & de Jong, D. (2012). Distraction and pedestrian safety: How talking on the phone, texting, and listening to music impact crossing the street. *Accident Analysis and Prevention*, *45*, 266-271.

Searson, D. J., & Anderson, R. W. (2011). *The Global Technical Regulation on Pedestrian Safety: Likely Effects on Vehicle Design*. Presentation at the Australasian Road Safety Research, Policing and Education Conference, Perth, Western Australia, Australia.

Stavrinos, D., Byington, K. W., & Schwebel, C. D. (2009). Effect of cell phone distraction on pediatric pedestrian injury risk. *Pediatrics* 123;e179-e185.

Stavrinos, D., Byington, K. W., Schwebel, D. C. (2011). Distracted walking: cell phones increase injury risk for college pedestrians. *Journal of Safety Research*, *42*, 101–107.

Stevens, C. R., Jr., & Lord, D. (2006). Evaluating Safety Effects of Daylight Savings Time on Fatal and Nonfatal Injury Crashes in Texas. *Transportation Research Record: Journal of the Transportation Research Board*, *1953*, 147-155.

Stewart, K. (1994). *Report of the ICADTS Working Group on Alcohol-Involved Pedestrians.* Available at www.druglibrary.org/schaffer/misc/driving/s25p1.htm

Stutts, J, C., & Hunter, W. H. (1998). *Police-reporting of Pedestrians and Bicyclists Treated in Hospital Emergency Rooms*. Chapel Hill, NC: UNC,Highway Safety Research Center. Available at http://katana.hsrc.unc.edu/cms/downloads/PoliceReporting_PedBikeHospital1998.pdf.

Stutts, J, C., & Hunter, W. H. (1999). *Injuries to Pedestrians and Bicyclists: An Analysis Based on Hospital Emergency Department Data*. Washington, DC: Federal Highway Administration.

Tefft, B.C. (2011). Impact Speed and a Pedestrian's Risk of Severe Injury or Death.AAA Foundation for Traffic Safety. Washington, DC. Available at www.aaafoundation.org/pdf/2011PedestrianRiskVsSpeed.pdf.

Tolmie, A., Thomson, J. A., Foot, H. C., Whelan, K., Morrison, S., & McLaren, B. (2005). The effects of adult guidance and peer discussion on the development of children's representations: evidence from the training of pedestrian skills. British Journal of Psycholo*gy, 96*, 181-204.

Transportation Research Board. (1998). *Managing Speed: Review of Current Practices for Setting and Enforcing Speed Limits*. Special Report 254). Washington, DC: Author. Available at www.nap.edu/catalog.php?record_id=11387

Tyrrell, R. A., Wood, J. M., Chaparro, A., Carberry, T. P., Chub, B-S., & Marszalek, R. P. (2009). Seeing pedestrians at night: Visual clutter does not mask biological motion. *Accident Analysis & Prevention*, *41*, 506-512.

U.S. Census Bureau. (n/a). American Community Survey. Commuting Characteristics by Sex. Data Set: 2006-2008 American Community Survey 3-Year Estimates. U.S. Census Bureau. Retrieved from http://factfinder.census.gov/servlet/STTable?_bm=y&-geo_id=01000US&-qr_name=ACS_2008_3YR_G00_S0801&-ds_name=ACS_2008_3YR_G00_&-redoLog=false&-format=&-CONTEXT=st

Van Houten, R., & Malenfant, J.E.L. (2004). Effects of a driver enforcement program on yielding to pedestrians. *Journal of Applied Behavior Analysis, 37,* 351-363.

West, R., Sammons, P., & West, A. (1993). Effects of a traffic club on road safety knowledge and self-reported behaviour of young children and their parents. *Accident Analysis and Prevention, 25*, 609-618.

Zegeer, C., Henderson, D., Blomberg, R., Marchetti, L., Masten, S., Fan, Y., Sandt, L., Brown, A., Stutts, J., & Thomas, L. (2008a). *Evaluation of the Miami-Dade Pedestrian Safety Demonstration Project*. (Report No. DOT HS 810 964). Washington, DC: National Highway Traffic Safety Administration. Available at http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810964.pdf

Zegeer, C. V., Blomberg, R. D., Henderson, D., Masten, S. V., Marchetti, L., Levy, M. M., Fan, Y., Sandt, L. S., Brown, A., Stutts, J., & Thomas, L. J. (2008b). Evaluation of Miami–Dade pedestrian safety demonstration project. *Transportation Research Record* 2073, 1-10.

9. Bicycles

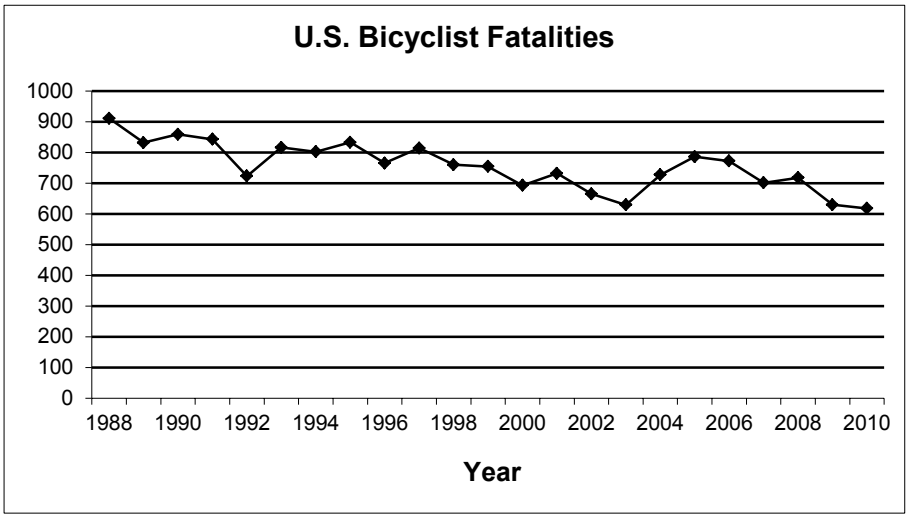
Overview

In 2010, 618 bicyclists died and 52,000 were injured in traffic crashes in the United States. Bicyclists accounted for 2% of total traffic fatalities and 2% of total injuries (NHTSA, 2012). Of the 2010 bicyclist crashes:

- Children 15 and younger represented about 11% of bicycle fatalities and 21% of injuries, a drop since 2001;
- Cyclists age 25-64 represented 65% of all bicycle fatalities, a 16% increase since 2001;
- 86% of the bicyclists killed and 75% of those injured were male;
- About 21% of bicyclists killed had a BAC of .08 g/dL or higher and alcohol use by either bicyclist or driver was reported in more than 34% of fatal crashes (NHTSA, 2012).

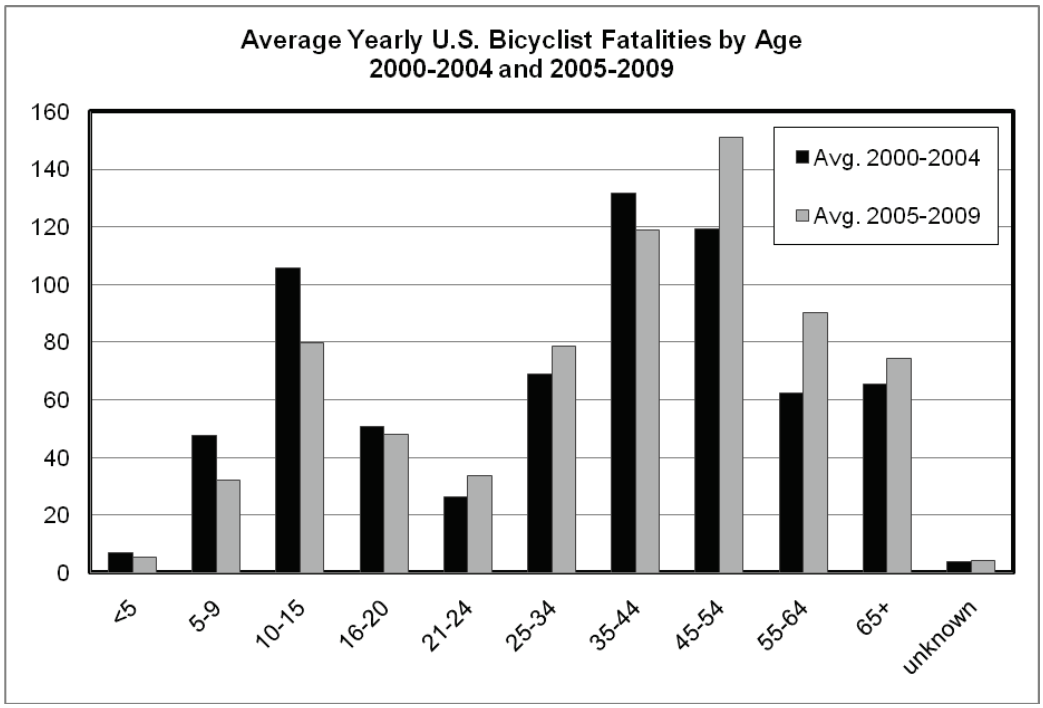
The majority of bicyclist fatalities occurred in urban areas (72%) and at non-intersections (67%).

Crash Trends. Bicyclist fatalities dropped from an average of 815 per year for the years 1989 – 1993 to an average of 740 for the years 2004-2008, an approximate 9% decrease between these two time periods. There are substantial fluctuations in fatalities year-to-year.



Source: Traffic Safety Facts 2009, Early Edition (NHTSA, 2010b, Table 4; NHTSA, 2012)

Over the past decade, fatalities have decreased for bicyclists under 16 years old and increased for most adult ages. Comparing average yearly fatalities for 2004 to 2008 to those from 1999 to 2003, fatalities have risen substantially for adults 45 and older (see Figure). In 2010, the average age of bicyclists killed was 42, up from 32 in 1998. In 2010, the average age of bicyclists injured was 31, up from 24 in 1998 (NHTSA, 2009a; NHTSA, 2012).



Source data: FARS

It is also worth noting, especially as trends indicate increasing fatalities involving riders ages 45 and above, that older adult bicyclists are more vulnerable when involved in a crash. Recent data from Sweden found that older adult bicyclists were twice as likely to be hospitalized when injured, and spent three times as long in the hospital as cyclists under age 65 (Scheiman et al., 2010).

Fatality rate trends, or fatalities adjusted per number of bicycling trips or miles traveled by bicycle, are unavailable because there is no consistent measure of bicycling (exposure) to estimate and compare fatality rates. According to the Federal Highway Administration's National Household Travel Survey, the annual number of bicycling trips has, however, increased from 1.7 billion in 1990 (FHWA, 1990) to 3.3 billion in 1995 (FHWA, 1995) and 2001 (FHWA, 2001), though the various surveys used somewhat different methodologies. For example, the use of multiple prompts beginning with the 2001 survey has resulted in capturing more bicycle trips in the 2001 and later surveys (Hu & Reuscher, 2004). Results from the latest NHTS, conducted in April 2008 through May 2009, indicate that trips made by bicycle have again increased up to 4.1 billion per year (Pucher, Buehler, Merom, & Bauman, 2011a). The next NHTS is planned for 2015. In addition to the number of trips increasing, the proportion of all trips made by bicycle has generally trended upwards since 1990, from 0.7% to 0.9% in 1995 and 1% in 2009. (The exception to this upward trend was the 0.8% of trips made by bicycle in 2001.) While the increase might seem small, a change from 0.8% to 1% between 2001 and 2009 represents a 25% increase in the proportion of trips made by bicycle. An analysis by Pucher et al. (2011a) found the average number of cycle trips and the average miles of cycling per capita per year each rose a few percentage points from 2001 to 2009, and more cycling trips were taken by males, adults 24-64, people without cars, and people with university degrees. An important note is that while the number of trips has risen, there has not been a significant increase in cycling trip rates (e.g., trips per capita) on a national basis. In select cities, however, there has been a substantial increase in

cycling in recent years. In a study of 9 large cities in the U.S. and Canada (Chicago, Minneapolis, Montréal, New York, Portland, San Francisco, Toronto, Vancouver, and Washington, DC), the authors found bike commuting rates more than doubled since 1990, while bicycle fatality rates subsequently dropped (Pucher et al, 2011b). The authors attribute these trends to the substantial investment in infrastructure and bicycle-supporting programs implemented in these cities.

In addition to number of trips, exposure to traffic and crashes is affected by where, when, and for how long a cyclist rides, as well as the skill, knowledge and application of safe behaviors by the cyclist and the drivers around him or her. The risk of a crash may also be increased due to inattention, distraction, or impairment by either the bicyclist or driver. Emerging problems include the use of media players or other electronic devices while riding or driving.

Classifying Crash Types. Bicycle crashes can be classified into types based on bicyclist and motor vehicle pre-crash actions and the location of the crash. In the early 1990s this methodology was used to classify more than 3,000 bicycle-motor vehicle crashes in California, Florida, Maryland, Minnesota, North Carolina, and Utah (Hunter, Stutts, Pein, & Cox, 1996). The sample was approximately evenly divided among small/rural communities, medium-sized cities, and large cities (as opposed to representing the proportion of crashes that occurred in each of those area types). Of these bicycle-motor vehicle crashes:

- Half (51%) occurred at intersections or were related to intersections. The most common type of crash involved bicyclists riding out or through intersections and into the path of a motorist. The second most common type of crash involved motorists failing to yield at intersections. Another common type included motorists turning or merging into the path of a parallel moving bicyclist (same or opposite direction). Child bicyclists were over-represented when the bicyclist failed to yield at an intersection and adult bicyclists were over-represented in crashes at intersections where motorists turned across their path.
- Twenty-two percent of bicycle-motor vehicle crashes occurred at junctions with commercial and private driveways or alleys. Children were highly over-represented in these crashes.
- Twenty-seven percent of bicycle-motor vehicle crashes occurred at roadway sections with no special features (meaning no intersections or driveways at the segment near the crash); fatal and serious injuries occurred at a higher rate at such non-junction locations. Adult cyclists were over-involved in crashes with overtaking motor vehicles at midblock locations.

In the Hunter et al. (1996) study, bicyclist factors contributing to crashes, especially at intersections or other junctions, included bicyclists riding wrong-way. Thirty-two percent of all bicyclists in the study were riding against traffic; for intersection collisions, the proportion was 42%. In 15% of crashes, bicyclist riding wrong-way was coded as a contributing factor to the crash (Hunter et al., 1996). Bicyclist failure to yield was coded in 21% of the study crashes and stop sign violations were coded in 8%. Children were over-represented in stop-sign and yield violations and crashes on local and two-lane streets, whereas adult bicyclists were more likely to contribute to their crashes through alcohol or drug use and lane position and lane change errors. The most common driver contributing factor was a yield violation at either an intersection or

midblock location; however, as mentioned the bicyclist riding wrong-way may have been a contributing factor in such crashes.

Different crash types can be targeted by different countermeasures. The Pedestrian and Bicycle Crash Analysis Tool (PBCAT) software is available to assist jurisdictions in typing bicycle-motor vehicle crashes and developing a database that contains information on pre-crash maneuvers as well as other crash factors. States and communities can then analyze their own bicycle crashes and can also use PBCAT and PedSafe (www.walkinginfo.org/pedsafe/) to help select appropriate countermeasures. PBCAT may be downloaded from www.walkinginfo.org/facts/pbcat/index.cfm. Registration is requested for this free software so the user may receive any software updates or important technical information.

Bicyclist attributes: Bicyclists come in all ages with many levels of knowledge, skill, perception and judgment. Thus, educational and enforcement programs must take these factors into account and be designed to target age-specific concerns and the knowledge, skills and behavioral attributes of these different groups of riders.

Bicycles have an even smaller profile than motorcycles, are usually purchased without head lights and rear active lights attached, and are more difficult for many motorists to notice than four-wheeled vehicles, especially at night. Because they are human powered, there may be substantial speed differentials between bicycles and motorized traffic. Bicyclists also lack the protective body of a motorized vehicle in the event of a crash and some riders feel uncomfortable mingling with traffic, especially in high speed, high volume situations.

Crash Factors. As with all crashes, bicycle crashes often result from multiple contributing factors. Bicyclist and driver pre-crash actions and behaviors (such as distraction, driver speed, and alcohol use), vehicle type and design, cyclist and vehicle volumes/exposure, and elements of the built environment (including roadway design, presence of bicycle facilities) all contribute to cycle crashes. Several resources have provided evidence of the role of the transportation environment in bicycle safety and summarized best practices in planning, engineering, and design for bicycle safety (FHWA, 2011; NACTO, n.d.; AASHTO, 2012). Enacting and implementing Complete Streets policies has been identified as one of the more low-cost and impactful countermeasures, as evidenced by numerous cities and states across the U.S. (for more on Complete Streets, visit www.completestreets.org/). More recent studies have focused on the role of vehicle type and design in the event of a crash. Ackery, McLellan, and Redelmeier, (2012) found that larger motor vehicles—especially freight trucks and SUVs—were overrepresented in bicycle crashes compared to other crash types. While not dismissing the importance of vehicle design and the role of the built environment in preventing bicycle crashes, the countermeasures described in this report relate primarily to educational and enforcement measures aimed at improving the knowledge and behaviors of road users to prevent or mitigate the severity of a crash.

Strategies to Reduce Bicycle Crashes and Injuries

Several strategies may be used to decrease bicycle crashes and injuries.

- Increase the use of properly fitted bicycle helmets by all bicyclists, including children and adults, and the enforcement of helmet laws to increase compliance.
- Increase the conspicuity of bicyclists.
- Reduce distracted riding or driving behaviors (cell phones, headphones, etc.). See the chapter on distracted and drowsy driving for countermeasures targeting drivers.
- Decrease riding or driving while impaired. See the chapter on strategies to reduce alcohol-impaired driving. Some of the countermeasures would be applicable to target any type of impaired roadway use.
- Enact laws to facilitate safe, predictable, and efficient bicycling in traffic, to update and fill gaps in existing laws. Educate the public on any new laws.
- Increase traffic law compliance by both motorists and bicyclists. Train law enforcement officers in appropriate enforcement strategies. In particular, decrease wrong-way riding, sidewalk riding, and traffic control violations by bicyclists; and decrease speeding, cutting off bicyclists, passing too closely, or blocking or driving in a designated bicycle lane by motorists.
- Educate motorists and bicyclists on how they should interact safely with each other and what the relevant laws require.
- Improve bicycle handling skills for bicyclists of all ages.
- Tailor countermeasures to diverse populations, including groups such as recent immigrants who may not be familiar with U.S. traffic laws, the U.S. traffic environment, or may not speak or read English.

Finally, the idea that vulnerable road users' safety may be improved by increasing the numbers of bicyclists (and pedestrians) is gaining traction and some empirical support. If there are more bicyclists on the road, it may enhance the likelihood that motorists will expect to see a bicyclist and be better prepared to respond appropriately. A 2009 scanning tour by U.S. transportation officials and researchers of Denmark, Sweden, Germany, Switzerland, and the United Kingdom reported that the concept of "safety in numbers" has motivated promotion of more bicycling and walking in these countries as a safety countermeasure (Fischer et al., 2010). Research from abroad as well as the United States finds that, although actual numbers of crashes may go up, individual risk of crashes with motor vehicles declines as numbers of bicyclists and pedestrians increase (Geyer, Raford, Ragland, & Pham, 2006; Jacobsen, 2003; Leden, Garder, & Pulkkinen, 2000).

Resources

The agencies and organizations listed below can provide more information on bicycle safety issues and countermeasures and links to numerous other resources.

- National Highway Traffic Safety Administration:
  - Bicycles - www.nhtsa.gov/Bicycles
  - Research and Evaluation - www.nhtsa.gov/Driving+Safety/Research+&+Evaluation
  - Behavioral Safety Research Reports - ntlsearch.bts.gov/repository/ntlc/nhtsa/index.shtm
- Federal Highway Administration:
  - Office of Human and Natural Environment (Bicycle and Pedestrian Program) - www.fhwa.dot.gov/environment/bikeped/index.htm
  - Office of Safety - http://safety.fhwa.dot.gov/ped_bike/
  - Office of Research, Development, and Technology (Turner-Fairbank Highway Research Center), Human Centered Systems Research, Pedestrian and Bicycle Program - www.tfhrc.gov/humanfac/ped-bike.htm
- Pedestrian and Bicycle Information Center: www.bicyclinginfo.org
- National Center for Safe Routes to School: www.saferoutesinfo.org
- SAFE KIDS Worldwide: www.safekids.org
- National Bicycle Safety Network: www.bicyclinginfo.org/network/
- Consumer Product Safety Commission: www.cpsc.gov
- Bicycle Helmet Safety Institute: www.helmets.org
- Association of Pedestrian and Bicycle Professionals: www.apbp.org
- Complete Streets Coalition: www.completestreets.org
- National Center for Bicycling and Walking: www.bikewalk.org
- Safe Routes to School National Partnership: www.saferoutespartnership.org
- League of American Bicyclists: www.bikeleague.org

Specific resources that provide further information on engineering, enforcement, and educational strategies are:

- AASHTO Guide for the Development of Bicycle Facilities, 4th Edition: https://bookstore.transportation.org/collection_detail.aspx?ID=116

- NACTO Urban Bikeway Design Guide: http://nacto.org/cities-for-cycling/design-guide/

- Public Policies for Pedestrian and Bicycle Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan: http://katana.hsrc.unc.edu/cms/downloads/PBSPolicyReview.pdf

- Uniform Guidelines for State Highway Safety Programs: Highway Safety Program Guideline No. 14: Pedestrian and Bicycle Safety: www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/PedBikeSafety.pdf

- *BIKESAFE: Bicycle Countermeasure Selection System* www.bicyclinginfo.org/bikesafe/

- *National Cooperative Highway Safety Research (NCHRP) Report 500, Volume 18, A Guide for Reducing Collisions Involving Bicycles,* (NCHRP, 2008),

For more information on education, engineering, vehicular, and legislative practices and recommended strategies from Europe, refer to *Keeping Children Safe in Traffic* by the Organization for Economic Co-operation and Development (OECD) (2004).

Key Terms

- NHTS: National Household Travel Survey
- SRTS: Safe Routes to School

Countermeasures That Work

Countermeasures to improve bicycle safety are listed below and discussed individually in the remainder of this chapter. The table is intended to give a rough estimate of each countermeasure's effectiveness, use, cost, and time required for implementation. The symbols and terms used are described below. Effectiveness, cost, and time to implement can vary substantially from State to State and community to community. Costs for many countermeasures are difficult to measure, so the summary terms are very approximate. See each countermeasure discussion for more information on each item.

All States are required by Congress and FHWA to have a Pedestrian and Bicyclist Coordinator in their Department of Transportation. The coordinator will be aware of active programs within the State and will have access to resources for implementing many of the countermeasures listed below.

1. Children

Countermeasure	Effectiveness	Cost	Use	Time
1.1 Bicycle helmet laws for children	★★★★★	$$	Medium	Short
1.2 Safe Routes to School (SRTS)	★★	$	High	Short
1.3 Bicycle education for children	★★	$	Unknown	Short
1.4 Cycling skills clinics, bike fairs, bike rodeos	★	$	Unknown	Short

2. Adult Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
2.1 Bicycle helmet laws for adults	★★★	$	Low	Short
2.2 Bicycle safety education for bike commuters	★	$$	Low	Medium

3. All Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
3.1 Active lighting and rider conspicuity	★★★	$	High*	Varies
3.2 Promote bicycle helmet use with education	★★	$$$	Medium	Medium
3.3 Enforcement strategies	★	$$	Unknown	Varies
3.4 Bicyclist passing laws	★	$	Low	Short

*High for active lighting laws; unknown for promoting other conspicuity measures

4. Drivers and Bicyclists

Countermeasure	Effectiveness	Cost	Use	Time
4.1 Driver training	★	$	Low	Medium
4.2 *Share the Road* awareness programs	★	$$	Unknown	Medium

Effectiveness:

★★★★★ Demonstrated to be effective by several high-quality evaluations with consistent results

★★★★ Demonstrated to be effective in certain situations

★★★ Likely to be effective based on balance of evidence from high-quality evaluations or other sources

★★ Effectiveness still undetermined; different methods of implementing this countermeasure produce different results

★ Limited or no high-quality evaluation evidence

Effectiveness is measured by reductions in crashes or injuries unless noted otherwise. See individual countermeasure descriptions for information on effectiveness size and how effectiveness is measured.

Cost to implement:

$$$: requires extensive new facilities, staff, equipment, or publicity, or makes heavy demands on current resources
$$: requires some additional staff time, equipment, facilities, and/or publicity
$: can be implemented with current staff, perhaps with training; limited costs for equipment, facilities, and publicity

These estimates do not include the costs of enacting legislation or establishing policies.

Use:

High: more than two-thirds of the States, or a substantial majority of communities
Medium: between one-third and two-thirds of States or communities
Low: less than one-third of the States or communities
Unknown: data not available

Time to implement:

Long: more than one year
Medium: more than three months but less than one year
Short: three months or less

These estimates do not include the time required to enact legislation or establish policies.

1. Children

1.1 Bicycle Helmet Laws for Children

Effectiveness: ★★★★★	Cost: $$	Use: Medium	Time: Short

The purpose of bicycle helmet laws for children is to increase bicycle helmet use, thereby reducing the number of severe and fatal head injuries to children involved in bicycle crashes. Several meta-analyses discuss the effectiveness of bicycle helmets in reducing head injuries and fatalities (Attewell, Glase, & McFadden, 2001; Elvik, 2011; Thompson, Rivara, & Thompson, 2006). While Elvik's (2011) research focused on all riders, not just children, he estimated that bicycle helmet use results in about a 42%, 95% CI [25, 55], reduction in the risk of a non-fatal head injury.

A helmet use law is a significant tool in increasing helmet use, but as with all laws effectiveness is related to implementation.

Legislation effectiveness is enhanced when combined with supportive publicity and education campaigns. See, for example, Rivara, Thompson, Patterson, and Thompson (1998), Kanny, Schieber, Pryor, and Kresnow (2001), and Rodgers (2002). The practical effect of bicycle helmet laws is to encourage parents to require their children to use helmets (and educate parents to serve as role models and wear a helmet despite the lack of a law).

Law enforcement and other safety officials can reinforce the need to wear a helmet through positive interactions such as free or discounted helmet distribution programs and incentives for helmet use. Publicizing helmet laws, and child/parent education on helmet fitting and the importance of wearing a helmet every ride may enhance effectiveness. Schools may also implement policies requiring helmet use by children riding to school.

Use: As of July 2012, 22 States, the District of Columbia, and at least 201 municipalities or counties have child helmet laws (BHSI, 2012). Most laws cover all bicyclists under age 16. Only 13 States have no State or local bicycle helmet laws.

Effectiveness: Two systematic reviews, of 12 studies and three studies respectively, using different study inclusion criteria found that legislation may be effective at increasing helmet use (Karkhaneh, Kalenga, Hagel, & Rowe, 2006; Macpherson & Spinks, 2007). The degree of improvement varied but there was a lack of evidence to determine whether enforcement, supporting publicity, and helmet distribution efforts explain some of the variation (Karkhaneh et al., 2006; Macpherson & Spinks, 2007). There was a non-significant trend toward a greater overall increase in helmet use in communities with laws covering all cyclists compared to those covering only children, and effects were larger among children (Karkhaneh et al., 2006). Study methods also explained some of the variation, with before-after studies resulting in a smaller effect sizes than cross-sectional control studies.

A Cochrane review examined the effectiveness of helmet use laws in reducing head injuries. Again, only three hospital-based studies met the strict inclusion criteria with respect to injury

reductions. Two of the three controlled studies reported reductions in head or traumatic brain injury following legislation (Macpherson & Spinks, 2007).

Earlier crash-trend analyses using FARS data suggested that State helmet-use laws for children reduce child bicycle fatalities by about 15% in the long run (Grant & Rutner, 2004). Wesson et al. (2008) examined before and after trends in child and adult fatalities in Ontario, Canada following implementation of a law requiring helmets for riders under 18 years old. A reduction was found in child fatalities but not in adult bicycle-related deaths. Supporting data from one community suggested that the declines were not due to decreases in child bicycling. The authors attributed the lower child mortality rates to multiple factors including education, promotion, and general trends.

Costs: A helmet law should be supported with appropriate communications and outreach to parents, children, schools, pediatric health care providers, and law enforcement. NHTSA has a wide range of material that can be used to educate and promote the use of a helmet every ride, demonstrate helmet effectiveness, and educate and demonstrate how to properly fit a helmet. While helmets that meet safety requirements can be purchased for under $20, States may wish to provide free or discounted helmets to some children. When considering the costs of providing helmets, agencies should consider the benefits. A NHTSA summary of helmet laws reported that "every dollar spent on bicycle helmets saves society $30 in indirect medical and other costs" (NHTSA, 2008).

Time to implement: A bicycle helmet law can be implemented as soon as the appropriate legislation is enacted. Enacting local ordinances may take less time than enacting statewide legislation. To develop custom communications and outreach, train law enforcement officers on implementing the law, or start a helmet distribution or subsidy program in support of the law may require a medium-to longer-term effort.

1.2 Safe Routes to School

Effectiveness: ★★	Cost: $	Use: High	Time: Short

The goal of Safe Routes to School (SRTS) Programs is to increase the amount of bicycling and walking trips to and from school while simultaneously improving safety for children walking or bicycling to school. SRTS programs are community-based and are intended to be comprehensive in nature. Programs include education of children, school personnel, parents, community members, and law enforcement officers about safe bicycling and walking behavior and safe driving behavior around pedestrians and bicyclists. In addition, programs include enforcement and engineering activities to improve traffic safety and risky elements of the traffic environment around primary and secondary schools so children can safely bicycle or walk to school.

From 2005 to mid-2012, the SAFETEA-LU legislation required each State to have its own SRTS program including a full-time coordinator to manage Federal funds. Each year, up to 70% (but not more than 90%) of available Federal funding was to be allocated on infrastructure (engineering) improvements, and up to 30% (but not less than 10%) of funding on non-infrastructure projects to encourage walking and bicycling to school (public awareness and outreach, enforcement near schools, education, and training for volunteers). Resources to support these efforts are available online from NHTSA on the pedestrian safety and bicycle safety pages and the National Center for Safe Routes to School (NCSRTS) Web site (www.saferoutesinfo.org). NCSRTS provides information, guidance, and support for community, State, and national SRTS efforts. A list of current State SRTS Coordinators may also be found at the NCSRTS Web site. In June 2012, Congress passed the Moving Ahead for Progress in the 21st Century (MAP-21) Act. The Act significantly alters how SRTS and other pedestrian and bicycle programs are structured and funded. To learn more, visit www.fhwa.dot.gov/MAP21/.

Use: With the establishment of the national SRTS program, all 50 States and the District of Columbia are now operating SRTS programs. Local SRTS programs exist in different forms in nearly all States. At the time of this report publication, the details of how MAP-21 will affect state SRTS programs were being determined. Visit the Web site above for details.

Effectiveness: SRTS materials can be effective in teaching children and their parents how to evaluate and choose the safest routes for walking or bicycling to and from school. The material is derived from analyses of types of crashes associated with trips to and from school, but it has not been possible to directly evaluate effects of these programs on crashes and injuries. Although the full program emphasizes broad education, some specific implementations have centered on site-appropriate engineering changes; results have shown behavioral improvements for pedestrians, bicyclists, and motorists (NHTSA, 2004). Dumbaugh and Frank (2007) found that many of the safety benefits associated with SRTS countermeasures are assumed rather than known.

Costs: Activities associated with SRTS may be low cost and may also be eligible for grant funding (non-infrastructure grants mentioned above). Grants are administered by each State's SRTS coordinator. Significant materials and resources can be accessed at no cost. NCSRTS provides downloadable material for State and local SRTS programs.

Time to implement: Short. Once a school or district has decided to implement an SRTS program, a range of material, including an on-line step-by-step guide on getting started, is available from the NCSRTS. Programs funded through State DOTs typically require applications on a funding cycle and can take significantly longer to implement.

1.3 Bicycle Education for Children

Effectiveness: ★★	Cost: $	Use: Unknown	Time: Short

The purpose of bicycle education is to teach children traffic laws, how to ride on streets with traffic present, proper helmet use, and bicycle safety checks and maintenance. As part of a regular school curriculum, education can reach every student, but providing training outside of school settings such as through parks and recreation departments, community centers or churches may be more feasible in some circumstances. Community-based programs could also provide greater flexibility in tailoring to meet the needs of specific target groups.

Readers should note that safe bicycling principles can be counterintuitive, and safety skills taught to pedestrians (such as walking facing traffic) do not necessarily hold true for bicyclists. Further, bicycle safety skills for children may differ from safety skills needed by adults riding in different environments and at different speeds. For example, many bicycle education programs teach children to ride their bikes slowly on the sidewalk, and as far away from the roadway as possible. However, adult cyclists may need to be trained on when it is safer to position themselves in the travel lane, going with traffic, and further from the curb depending on the facility. For more on adult cycle education, see section 2.2. One common theme in bicycle education for adults and children is the need to ride predictably, including using correct hand signals to indicate changes in speed or direction.

Whether school or community-based, bicycle education should include, at a minimum, a demonstration and handout on how to properly fit a bicycle helmet, a helmet effectiveness demonstration, and an emphasis on wearing a helmet every ride. As noted above, the curriculum should also include information on how parents and children should decide what locations are safe places to ride, and how children can be predictable and visible to drivers. In addition, bicycle safety training should be reinforced (potentially by caregivers), making it part of a comprehensive traffic safety program, with components assembled from NHTSA or comparable programs. Many bicycle safety education materials target children in grades K-8, though some are aimed at younger children.

For a careful review of training programs, many aimed at school children, see Rivara and Metrik (1998). A listing of many training programs and their characteristics can be found in the FHWA Bicycle Safety Education Resource Center, available on the bicyclinginfo.org Web site. See also the *Good Practices Guide for Bicycle Safety Education* (FHWA, 2005).

NHTSA has also produced publications on how to properly fit a bicycle helmet, rules of the road and games to educate children and parents on bicycle safety. The material is available in English and Spanish on NHTSA's Bicycles page.

Use: The use of school-based programs, which is at the discretion of local school districts, is unknown. In-school education and training, however, is a frequent part of local Safe Routes to School programs. In addition to programs offered by teachers and school personnel, local bicycling coalitions sometimes offer age-appropriate bicycle training within a school setting.

Examples are the Bicycle Transportation Alliance in Portland, OR, and the Hawaii Bicycling League. The prevalence of community-based programs is also unknown.

Effectiveness: Programs such as these can increase knowledge of laws and proper behaviors. A recent review of evaluations of 13 educational programs (without legislation enactment) among children and youth found that these programs were effective at increasing observed helmet use. Most of the programs also offered discounted or free helmet distribution. Meta-analyses found the odds of observed helmet wearing to be more than 2 times higher than at baseline or among the non-intervention group, but results were quite varied across the different studies (Royal, Kendrick, and Coleman, 2007). The authors were unable to tease apart differences in programs that might contribute to different outcomes other than whether they were community-based or school-based, and whether or not they offered free or reduced-priced helmets. Community educational programs that provided free helmets were reported to be more effective than programs set in schools or that provided only an opportunity to purchase a discounted helmet, although the latter types also increased use. School-based programs also tended to obtain best results among the younger participants (Royal et al.). Three of the studies found helmet use benefits persisting at 9 to 12 months follow-up, although evidence is still lacking regarding longer-term (1 year or more). Based on the evidence of effectiveness of helmets at preventing head-injuries when worn, injury-reduction benefits would be expected from programs that increase proper use of helmets. Crash reduction benefits of educational programs have not been demonstrated. Evidence is also lacking as to whether programs might have any unintended effects such as reducing amounts of riding or conferring overconfidence in one's riding skills.

Costs: Coalitions may be paid by the State, or otherwise use SRTS funds. Teachers can provide education using NHTSA's free materials, but training, administration, and supervision of a comprehensive program could increase costs somewhat.

Time to implement: Short, for existing material; medium, to develop and disseminate a training curriculum with material.

1.4 Cycling Skills Clinics, Bike Fairs, Bike Rodeos

Effectiveness: ★	Cost: $	Use: Unknown	Time: Short

The purpose of cycling skills clinics, bike fairs, or bike rodeos is to teach children about traffic laws that apply to them and how to ride defensively in a number of traffic conditions. The intent of a rodeo is to introduce or reinforce bicycle safety concepts as part of a more comprehensive program of traffic safety education and training, parent education, and other efforts. Young children are just learning about traffic. They have little experience with which to anticipate and interpret potential traffic hazards, and limited abilities to reason and react. Their brains are still developing and they lack the maturity and judgment needed to negotiate traffic safely and limit risk-taking behaviors. They are also less skilled at riding than older children or adults. Young children should not ride without supervision until they are at least 10 years old and are able to ride in a straight line, swerve to avoid hazards in the roadway, comfortably start and stop their bicycles, and maintain balance at slow speeds.

A cycling skills clinic, bike fair, or rodeo is an event that provides children an opportunity to learn and practice bicycling skills. A clinic typically has several stations for specific skills and also includes bicycle and helmet inspections. Parental involvement can also be a valuable component of bicycle fairs, providing reinforcement of desired safe riding behaviors and modeling appropriate bicycling behaviors. Events should also include discussions and examples of proper bicycle helmet fitting.

There are a number of bicycle safety courses and models for fairs, rodeos, and clinics. Examples include Washington Area Bicyclist Association (undated), Chaplin (2005), Minnesota Safety Council (undated), and Williams and Burden (1994). In addition, the League of American Bicyclists has numerous League Certified Instructors across the country that can teach a variety of classroom-based and on-bicycle courses and new youth instructor training for those wishing to be certified to provide cycling skills clinics.

Use: Bicycle safety fairs and rodeos are local events. They are often run by law enforcement, school personnel, or other civic and volunteer organizations. There may be permanent "neighborhood" layouts where the rodeos are conducted, and the events may be scheduled as part of the elementary and middle school curriculum. Although the extent of use is unknown, they are increasingly implemented as part of Safe Routes to School projects.

Effectiveness: While rodeos can result in increases in knowledge and skills, a review of the research literature does not reveal any studies that document crash and injury reduction, at least not in isolation. One program of comprehensive education for preschool children and their parents, that included a skills and safety rodeo, led to a doubling of helmet use (Britt, Silver, & Rivara, 1998; Rivara & Metrik, 1998). Some studies have found that single event bike rodeos did not lead to increases in knowledge or improvements in behaviors or attitudes (Macarthur, Parkin, Sidky, & Wallace, 1998); thus, bike rodeos need to be part of a larger, more comprehensive program. Again, see Rivara and Metrik (1998) for a more in-depth discussion.

Costs: A one-time rodeo can be operated with volunteers at minimal cost. A permanent rodeo facility could cost thousands of dollars.

Time to implement: A one-time rodeo can be organized in a few months. Implementing a permanent rodeo program with a facility may take up to a year or longer.

2. Adults

2.1 Bicycle Helmet Laws for Adults

Effectiveness: ★★★	Cost: $	Use: Low	Time: Short

The purpose of bicycle helmet laws is to reduce the number of severe and fatal injuries resulting from bicycle crashes. Bicycle helmets, when worn properly, are the single most effective piece of equipment to reduce head injuries in the event of a crash. A recent meta-analysis of bicycle helmet effectiveness (Elvik, 2011) estimated that bicycle helmet use results in about a 42%, 95% CI [25, 55], reduction in the risk of a non-fatal head injury.

Use: No States have yet enacted laws requiring adults to wear bicycle helmets. About 60 localities require people of all ages to wear helmets when bicycling (BHSI, 2012).

Effectiveness: Likely to be effective. Ginsberg and Silverberg (1994) analyzed a prospective helmet law in Israel, finding a 3:1 benefit-to-cost ratio. Puder, Visintainer, Spitzer, and Casal (1999) found a helmet law for all ages produced higher helmet wearing than laws for children only; consistently, teens were least likely to wear helmets. Studies have also found that when children are accompanied by adults using helmets, the children are also more likely to be using helmets (Wesson et al., 2008). Universal (all ages) helmet requirements for motorcyclists result in the greatest reductions in fatalities and injuries (see Chapter 5, Section 1.1).

Costs: Minimal costs could be incurred for informing and educating the public and providing training for enforcement personnel.

Time to implement: A universal helmet use law can be implemented as soon as the law is enacted.

2.2 Bicycle Safety Education for Bike Commuters

Effectiveness: ★	Cost: $$	Use: Low	Time: Medium

The goal of bicycle safety education for adult bicycle commuters is to improve knowledge of laws, risks, and cycling best practices, and to lead to safer cycling behaviors, including riding predictably and use of safety materials such as reflective clothing and helmets.

A handful of communities have developed bicycle education programs, with large variation in program elements. Common elements include safety ads (radio, TV, outdoor, etc.), dissemination of safety materials, bike "ambassadors" and social supports, individual skills training or workshops, and coordination with enforcement officers to reinforce safe behaviors. Case study summaries are available of programs in Tucson, AZ, Portland, OR, Augusta, ME, Chicago, IL, and many other cities (PBIC, 2010).

NHTSA has recently developed a campaign, *Be a Roll Model*, aimed at encouraging all road users, including bicyclists, to model safe travel behaviors for their children and others. The campaign includes educational materials, tip sheets, and a pledge program for local agencies to adopt and disseminate (www.nhtsa.gov/Driving+Safety/Bicycles/Be+a+Roll+Model).

Use: Low. Adult-oriented safety education programs in the U.S. are not well documented and are rarely formally evaluated.

Effectiveness: Unlikely to be effective in reducing crashes without comprehensive and sustained efforts to improve the cycling environment. A high-quality evaluation conducted in Brazil by Bacchieri, Barros, dos Santos, Goncalves, and Gigante (2010) found that "an intervention based on an educational component and the promotion of the active use of safety equipment is not capable of reducing accidents among cycling workers." The study concluded that "isolated educational programs, attempting to only change individual behavior, are not effective in reducing accidents" and that "the number of accidents will not considerably decrease without actions that also include improved road infrastructure and the effective application of legislation (with comprehensive and systematic law enforcement)" (Bacchieri et al., 2010).

Costs: Medium. Costs may vary depending on the intensity of the educational program. Costs for radio/TV ads, print materials, safety equipment, workshop and training events, and personnel time could be incurred.

Time to implement: A comprehensive education program could require several months of start-up time to plan and develop program materials.

3. All Bicyclists

3.1 Active Lighting and Rider Conspicuity

Effectiveness: ★★★	Cost: $	Use: High*	Time: Varies

*High for active lighting laws; unknown for promoting other conspicuity measures

Improving bicyclist conspicuity is intended to make bicyclists more visible to motorists and to allow motorists more opportunity to see and avoid collisions with bicyclists. A common contributing factor for crashes involving bicyclists in the roadway is the failure of the driver to notice the bicyclist, particularly at night.

New bicycles must be sold with reflectors meeting the Consumer Product Safety Commission requirements. The reflectors may improve a bicycle's night-time visibility when they are illuminated by motor vehicle lights approaching from behind. Active bicycle lighting can be critical for the detection of bicyclists coming toward the path of a motor vehicle, because the bicyclist is outside the vehicle's headlight beam until the last moment (NCHRP, 2008). In most States and jurisdictions, bicycles ridden after dark are required by law to have active white front lights and most States also require red rear reflectors or lights. However, most bicycles do not come equipped with such lighting (Osberg, Stiles, & Asare, 1998). Efforts to increase enforcement of laws requiring use of lights is needed to maximize use of lights at night (NCHRP, vol. 18, 2008). However, a recent study from Australia found the presence of a bicycle light alone, whether static or flashing, did not enhance the conspicuity of the bicyclist among study drivers, so additional measures to improve conspicuity (such as clothing or reflective leg straps) may be needed (Wood et al., 2011).

Though standard headlights and taillights are continuously lit, bicycle lights that flash are readily available; the user may even switch modes from continuously lit to flashing. Lights also may be applied to helmets or backpacks to make the rider more conspicuous to other vehicles. More extreme lighting is also available. For example, bright neon tubes are designed to be mounted on the bicycle frame, where they cast a bright, broad pattern of light onto the roadway, creating the illusion of a vehicle much wider than a bicycle.

Most active lights are not permanently mounted on bicycles, so they may not be available when needed. Newer mounting devices may, however, make it easy to attach or remove the lights as needed. Batteries also last much longer with LED lighting, increasing convenience and safety. Communications and outreach to the general public and law enforcement officers about State and local laws regarding the use of active bicycle lighting should be provided.

Additional materials attached to bicyclists or bikes can increase their conspicuity day or night. For daytime, bright-colored or fluorescent clothing, including shirts, vests, caps, etc., make the bicyclist more noticeable. In low light conditions (rain, fog, etc.) and at night, the same items can have retro-reflective materials incorporated in them, to make the bicyclist visible and identifiable from much greater distances. Retro-reflective bicycle tires are also available, but may be costly. Lower cost stickers to put on rims and other parts of the bike are also available. Pedal reflectors are another option and may help drivers identify cyclists and estimate their speeds based on

pedal rotations, though further research is needed. White or light-colored clothing, long a recommended solution, does little to improve conspicuity (NCHRP, 2008, Strategy F2).

Use: Most States have laws requiring use of active lights and reflectors on bikes ridden at night. There is no data on how frequently active lighting is used among those who bicycle after dark, but bicyclists involved in collisions at night appear to use lights infrequently. Use of bicycle reflectors is thought to be higher since they come pre-attached to bicycles at purchase, but these may be removed after purchase for aesthetic or other reasons so are not guaranteed.

Use of retro-reflective clothing is unknown. Most, if not all, athletic shoes contain some retro-reflective material. Some athletic clothing also has retro-reflective material. Bicycle helmets may have retro-reflective elements. Some bicyclists may be seen wearing additional retro-reflective materials, such as vests, jackets, arm bands, or rear-mounted reflective triangles located under their bicycle seats.

Effectiveness: A Cochrane review of studies of pedestrian and bicycle conspicuity aids concluded that "fluorescent materials in yellow, red and orange improved driver detection during the day..." (Kwan & Mapstone, 2004). Even low beam headlights can illuminate figures wearing florescent materials hundreds of feet away, much farther than figures wearing normal clothing (NCHRP, 2004, Strategy B5; NCHRP, 2008, Strategy F2). One study among a cohort of riders participating in a large mass bicycle event found results suggesting that consistent use of fluorescent colors provides a protective effect against crashes and injuries (Thornley, Woodward, Langley, Ameratunga, & Rodgers, 2008).

A small Australian study found that bicyclist clothing (such as vests and ankle and knee reflectors) significantly affected conspicuity, enabling drivers to react to bicyclists from further away than when the bicyclist wore only a vest or no reflective material at all (Wood et al., 2011). Younger drivers detected and responded to bicyclists more often and from a further distance than older drivers.

The challenge is getting bicyclists to wear retro-reflective materials and use proper lighting routinely. It is possible to obtain widespread use of lighting. Osberg et al. (1998) found nearly half of nighttime bicyclists in Paris used active lighting, compared to just 14% of Boston bicyclists, reflecting differences in laws, public health priorities, and perceived risk.

Evidence is unavailable about the effectiveness of various conspicuity promotional measures, or of laws requiring use of active lighting at increasing use. NCHRP (2008) suggests that increased enforcement of laws enhanced by coordinated communications and outreach efforts could heighten awareness among cyclists of the need for using proper lighting and the benefits of retro-reflective materials at enhancing conspicuity. Logic suggests that if bicyclists are more noticeable, the frequency and severity of crashes would likely be reduced.

Costs: Moderate costs are involved for communications and outreach and for law enforcement training to enforce active lighting laws. Conspicuity-enhancing gear such as retroreflective wrist and ankle straps, are sometimes distributed for free in such promotional programs. Additional costs for such materials are modest.

Time to implement: Brochures and flyers for a bicycle safety education campaign highlighting conspicuity can be created quickly. Several months can be taken up by designing, producing, and implementing the communications and outreach and law enforcement training for enforcing active lighting laws. See section 3.3 for more on enforcement and available resources.

3.2 Promote Bicycle Helmet Use with Education

Effectiveness: ★★	Cost: $$$	Use: Medium	Time: Medium

The purpose of bicycle helmet promotions is to increase use of helmets and thereby decrease the number of severe and fatal injuries to bicyclists involved in crashes. Bicycle helmet promotions are frequent, but are usually aimed only at child bicyclists, often through youth health organizations and schools. Promotions can target various barriers to helmet use, including lack of a helmet, lack of understanding of the importance of helmet use, and negative attitudes or beliefs about helmet use. Programs that provide helmets can include sponsoring organizations and often involve law enforcement and schools to deliver helmets and teach their proper use. Promotions can be conducted through single events or extended campaigns to promote helmet distribution and use. Expanding helmet promotions to include adults requires an expansion in focus, and perhaps different sponsors. However, adding adult-oriented riding tips may increase the appeal of the program. Other adult-oriented strategies should also be included, such as peer-based interventions on a college campus (Buckley, Sheehan, & Chapman, 2009).

Regardless of the target audience, bicycle helmet promotions must include instruction on how to properly fit the helmet and the importance of wearing helmets on every trip. Programs might also need to target differences in tendency to adopt helmet use for different riding purposes (e.g. recreational versus commuting), or riders who identify as only one type of rider (Kakefuda, Stallone, & Gibbs, 2009). All bicyclists could benefit from utilizing resources that demonstrate how helmets work to reduce injury. Moreover, further efforts are needed to encourage parents and authority figures (e.g., law enforcement officers, school officials) to reinforce and model desired behaviors including the use of a properly fitted bicycle helmet every ride. Trained and skilled cyclists may also be more likely to adopt helmet use (Kakefuda et al., 2009), so adult bicycle training programs that incorporate the importance of helmet use may help increase wearing by adult riders.

Use: Most States have conducted bicycle helmet promotions for children within the last few years, although only a few have ongoing or regular programs. Some States have conducted bicycle helmet promotions for a general audience.

Effectiveness: Bicycle helmets are proven to reduce injuries and fatalities (see Chapter 9, Sections 1.1 and 2.1). Helmet promotions are successful in getting more helmets into the hands of bicyclists. Rouzier and Alto (1995) describe a comprehensive program of presentations, media coverage, messages from doctors to patients, as well as low-cost helmet availability, which significantly increased helmet purchases and use for all ages. A peer-led, social marketing program on a medium-sized college campus also raised observed helmet use, at least for the short term (Ludwig, Buchholz, & Clarke, 2005). A school-based injury-reduction program targeting 13- and 14-year-olds incorporating opportunities for instruction, demonstration, rehearsal, feedback, social reinforcement and practice was associated with a 20% increase in observed rate of helmet use among this challenging target age group at 6 months follow-up (Buckley et al., 2009).

Recently, a Cochrane systematic review and meta-analysis of twenty-two studies evaluating non-legislative helmet promotion programs aimed at children under 18 years found the odds of observed helmet wearing were significantly greater among those receiving the interventions (Owen, Kendrick, Mulvaney, Coleman, & Royal, 2011). The study found the more effective programs were community-based (rather than aimed at individuals), provided free rather than subsidized helmets, and were set in schools. A Canadian program, *Operation Headway*, involving enforcement of bike helmet legislation, education, rewards for wearing and economic penalties for non-wearing, and provision of helmets to low-income groups was evaluated by Lockhart, Fenerty, and Walling (2010). The researchers found the program increased wearing rates (based on observations pre- and post-intervention), increased knowledge and commitment to wearing a helmet, saw greater public awareness of the law through media tracking, and improved relationships between police and the public (based on anecdotal evidence). Another helmet-use promotion program, involving distributing helmets and information, was evaluated in France (Constant, Messiah, Felonneau, & Lagarde, 2012). This study found that the helmet promotion program was of value in increasing helmet use but not sufficient to achieve high rates of helmet use among adult cyclists. A related theme of these studies is that population-wide, multifaceted, integrated, and repeated prevention programs are needed, which should include distribution of free helmets and safety information and strategies to increase peer and parental pressure.

Programs that increase proper use of helmets would be expected to reduce injuries (see section 1.3).

Costs: The cost for underwriting large numbers of helmets can be quite high, including supporting communications and outreach material. Adequate helmets can be purchased for as little as $8 each, within reach of most adult bicyclists. Making those helmets or more expensive ones available at no cost or reduced cost, through subsidies or merchant-manufacturer participation, could greatly increase the possible impact of the program by making helmets available to all at-risk segments of the population.

Time to implement: A good campaign, including market research, material development, and message placement, will require at least 6 months to plan and implement.

3.3 Enforcement Strategies

Effectiveness: ★	Cost: $$	Use: Unknown	Time: Varies

The purpose of targeted enforcement is to increase compliance with appropriate traffic laws by both bicyclists and motorists. Enforcement of traffic laws for all operators, including speed enforcement, may help to reduce the severity and frequency of collisions as well as promote bicycle safety. (See Chapter 3 for more information on strategies to reduce aggressive driving and speeding.)

The SHSO can help ensure correct riding through a communications and outreach campaign and through training law enforcement officers about the laws, the safety benefits of obeying the laws, and how to enforce bicycle safety-related laws. Some types of violations may be especially pertinent to bicyclist safety. For example, motorists may violate bicyclist' right-of-way following an overtaking maneuver by immediately turning across the bicyclist's path, or passing a bicyclist too closely. Similarly, bicyclists riding the wrong-way put themselves at greater risk of head-on collisions or angle collisions with motorists pulling out at side streets who are looking to the left for oncoming traffic. By enforcing relevant laws, the motoring and bicycling public may become better-informed about the risk of these types of violations and importance of obeying all traffic laws. Law enforcement can also reinforce active lighting and helmet use laws in effect by stopping and educating offending bicyclists as well as writing citations if appropriate. (Also see Chapter 9, Section 1,1, and BIKESAFE Law Enforcement countermeasure, www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=40 for more information.)

Specific training for law enforcement to enhance the safety of bicyclists can be found from several sources including:

- Pedestrian and Bicycle Information Center: www.bicyclinginfo.org/enforcement/training.cfm
- NHTSA's *Enhancing Bicycle Safety: Law Enforcement's Role*: www.nhtsa.gov/Driving+Safety/Bicycles/Enhancing+Bicycle+Safety:+Law+Enforcement's+Role
- Safe Routes to School's *Enforcement: Role for Law Enforcement in SRTS*: www.saferoutesinfo.org/resources/enforcement_role-for-law-enforcement.cfm

These products can satisfy the needs of departments regardless of how they choose to emphasize bicycle safety. Additional training for prosecutors and judges is important as well so that there is appropriate follow-up for citations throughout the judicial system. Educational diversion programs are an alternative to other penalties, for adjudication of citations involving bicyclists. Diversion programs may be easier to implement in settings such as universities and college campuses. For example, UC Berkeley teamed with the East Bay Bicycle Coalition to provide free bicycle safety classes as an option to reduce the fine for a bicycle ticket from the UC police department. For more, visit: www.ebbc.org/safety.

Use: Unknown. Targeted enforcement of bicycle-related violations is likely a rarely used intervention.

Effectiveness: Gilchrist, Schieber, Leadbetter, and Davidson (2000) describe an enforcement program in Georgia that impounded the bicycles of unhelmeted children and produced long-term increases in helmet wearing. This specific example seems unlikely to be broadly popular. Increasing community awareness and law enforcement efforts through the training courses and approaches noted above could, however, yield benefits that go beyond bicycle safety, to include improved community relations and more positive interactions between law enforcement and members of the community. A Japanese study by Okinaka and Shimazaki (2011) evaluated the effects of vocal and written prompts delivered by security guards on a university campus to reinforce safe behaviors (such as dismounting and walking bicycles on a sidewalk). The intervention involved posting campus security guards at sidewalk locations. The guards wore sashes that read, "Let's not drive on campus" and provided vocal prompts, "Please get off and push [bicycles] to [bike racks] for safety on campus," and then thanked compliant riders for their cooperation. Results indicated the intervention was effective at increasing safe behaviors exhibited by bicycle riders in this context. Riders walked their bicycles on the sidewalk 22% of the time at baseline, compared to 88% of the time during the intervention phases.

Costs: Training currently exists for law enforcement officers. Roll-call videos can be implemented at essentially no cost to the departments. The CD-ROM training can be taken by officers on their work or personal computer. It has been designed and incentivized to allow them eligibility for in-service training hours. The longer courses take officers away from their regular duties or require overtime commitment and may incur a financial cost as well. SHSOs may be able to provide funding for departments to participate in such training. Training for prosecutors and judges would likely need to be developed, as would a supporting communications and outreach program for the public, motorists and bicyclists.

Time to implement: For existing law enforcement training, with ongoing presentation schedules, implementation time can be quite short. For the full effort described above, a longer time frame would be needed.

3.4 Bicyclist Passing Laws

Effectiveness: ★	Cost: $	Use: Low	Time: Short

The purpose of bicyclist passing laws are to require drivers to leave at least three feet of clearance space between the vehicle and the cyclist when overtaking the cyclist, to minimize the likelihood of a sideswipe, and to reduce the chance of a close encounter that could potentially destabilize or divert the course of a cyclist and cause a crash.

Use: Low. To date, roughly 14 states are known to have enacted bicyclist passing laws requiring drivers to leave a space of more than three feet (Love et al., 2012).

Effectiveness: Love et al. (2012) evaluated the effectiveness of a passing law enacted in Baltimore, Maryland. The study saw low compliance with the passing law and little to no enforcement of the law by area police. Other factors that influenced passing distance included lane width, bicycle infrastructure, cyclist identity, and street type. The authors concluded that in addition to the passage of a law, interventions such as driver education, signage, enforcement, and bicycle infrastructure changes (such as bike lanes and Complete Streets designs) are needed to influence driving behavior and to increase motorist compliance with the three-foot law.

Costs: Minimal costs could be incurred for informing and educating the public and providing training for enforcement personnel.

Time to implement: A bicyclist passing law can be implemented as soon as the law is enacted.

4. Drivers and Bicyclists

4.1 Driver Training

Effectiveness: ★	Cost: $	Use: Low	Time: Medium

The purpose of addressing bicycle safety as part of driver education is to increase the sensitivity of drivers to the presence and characteristics of bicyclists and how to safely share the road with them. Although driver education and most State driver manuals address sharing the road with bicyclists, many spend relatively little time on the topic. Model driver handbook materials that may be adapted by States to enhance their driver handbook information on sharing the road with bicyclists were released by NCHRP (Thomas, Stutts, & Gillenwater, n.d.). These materials could also be used in driver education courses. Other existing print and electronic publications could also be used to increase the emphasis on driving around bicyclists. For example, the Utah Department of Health developed a 12-minute video to be shown in driver education classes to reinforce how drivers can safely share the road with bicyclists.

One standard approach would be to implement a *Share the Road* module (see section 4.2), covering interactions with bicyclists into driver education curriculums. For complete coverage, the same messages would need to be included in State-provided material for new drivers and covered by new questions added to the license knowledge exam. Standards for driver education curriculum and training developed by the American Driver and Traffic Safety Education Association mentions sharing the road with cyclists and pedestrians as a learning objective (Driver Education Working Group, 2009).

For links to more resources and discussion of considerations in educating motorists about bicycle safety, see the Pedestrian and Bicycle Information Center, under Educating Motorists (www.bicyclinginfo.org/education/motorists.cfm).

Use: As noted, all driver education curricula have some coverage of bicycles on the road. However, enhanced modules in the spirit of this countermeasure are quite likely rare. New Mexico has recently added an expanded section on bicycle safety to its driver's handbook (see page 25 of www.nmcycling.org/advocacy/NM_Driver_Manual_Jun11.pdf).

Effectiveness: Driver education has not been shown to reduce overall crash rates. The objective for adding more bicycle information would be to increase knowledge and desire to share the road safely with bicyclists, of the most common crash types and hazards and to improve new drivers' anticipation of and interactions with bicyclists – as well as improve their behavior as bicyclists.

Costs: Materials such as those listed above are available from TRB, AAMVA and the League of American Bicyclists. The cost would be for the adaptation or development of the new segments of the standard curriculum and for getting it into the material used by driver education instructors and schools. Changes to State driver manuals and other publications could be done within the normal material update budget.

Time to implement: Material would need to be adapted and integrated into the standard driver education curriculum, and adjustments made elsewhere in the curriculum to reflect likely additional time required for the new bicycle material.

The same timeframe would be expected for making changes to official State driving manuals, license exams, and related material and procedures.

4.2 *Share the Road* Awareness Programs

Effectiveness: ★	Cost: $$	Use: Unknown	Time: Medium

The purpose of Share the Road programs is to increase drivers' awareness of bicyclists, as well as improve both bicyclist and driver compliance with relevant traffic laws. *The National Strategies for Advancing Bicycle Safety* was developed from a July 2000 conference of bicycle advocates, injury prevention specialists, and government representatives (NHTSA, 2001). The result was five goals, each with a series of strategies and action steps. The first goal, Motorists Will Share the Road, called for the creation of a "coordinated 'Share the Road' public education campaign that can be adapted at the State and local levels."

For an example of communication and outreach material,
see www.bicyclinginfo.org/ee/ed_motorist.htm.

Use: Unknown.

Effectiveness: Share the Road awareness materials can be effective in increasing knowledge and appropriate attitudes, but as with other awareness programs, there is no evidence of behavior change or reductions in crashes.

Costs: Medium, including the costs to develop new publications or tailor current ones. The material can be delivered as training for specific target audiences, such as new drivers or all high school students, or drivers as they renew their licenses, or general communications and outreach intended for mass media delivery.

Time to implement: A good campaign, including market research, message development and testing, and implementation, will require at least 6 months to plan and implement.

Bicycle Safety References

American Association of State Highway and Transportation Officials. (2012) *Guide for the Development of Bicycle Facilities, 4*th *Edition*. Washington, DC: Author. Available at https://bookstore.transportation.org/collection_detail.aspx?ID=116.

Ackery, A. D., McLellan, B. A., & Redelmeier, D. A. (2012). Bicyclist deaths and striking vehicles in the USA. *Injury Prevention*, *18*, 22-26.

Attewell, R. G., Glase, K., & McFadden, M. (2001). Bicycle helmet efficacy: a meta-analysis. *Accident Analysis and Prevention, 33*, 345-352.

Bacchieri, G., Barros, A. J. D., dos Santos, J. V., Goncalves, H., & Gigante, D. P. (2010). A community intervention to prevent traffic accidents among bicycle commuters. *Revista De Saude Publica*, *44*, 867-875.

Bicycle Helmet Safety Institute. (2012). *Helmet Laws for Bicycle Riders.* Arlington, VA: Author. Available at www.helmets.org/mandator.htm

Britt, J., Silver, I., & Rivara, F. P. (1998). Bicycle helmet promotion among low income preschool children. *Injury Prevention, 4*, 280-283.

Buckley, L., Sheehan, M., & Chapman, R. (2009). Bicycle helmet wearing among adolescents: Effectiveness of school-bsedbased injury prevention countermeasure. *Transportation Research Record, 2140*, 173-181.

Chaplin, L. (2005). *An Organizer's Guide to Bicycle Rodeos*. Ithaca, NY: Cornell University Cooperative Extension.

Constant, A., Messiah, A., Felonneau, M., & Lagarde, E. (2012). Investigating helmet promotion for cyclists: Results from a randomised study with observation of behaviour, using a semi-automatic video system. *Plos One*, *7*, e31651.

Driver Education Working Group. (2009). Novice Teen Driver Education and Training Administrative Standards. Report from *National Conference on Driver Education*. Washington, DC: National Highway Traffic Safety Administration. Available at www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Teen%20Driver/files/TeenDriverETAS-1.pdf

Dumbaugh, E., & Frank, L. D. (2007). Traffic safety and Safe Routes to Schools: Synthesizing the empirical evidence. *Transportation Research record: Journal of the Transportation Research Board, 2009,* 89-97.

Elvik, R. (2011). Publication bias and time-trend bias in meta-analysis of bicycle helmet efficacy: A re-analysis of Attewell, Glase and McFadden, 2001. *Accident Analysis & Prevention*, *43*, 1245-1251.

Federal Highway Administration. (1990). *1990 Nationwide Personal Transportation Survey*. Washington, DC: Author.

FHWA. (1995). *1995 Nationwide Personal Transportation Survey*. Washington, DC: Author.

FHWA. (2001). *2001 National Household Travel Survey*. Washington, DC: Author.

FHWA. (2005). *Good Practices Guide for Bicycle Safety Education*. (Report No. FHWA-SA-02-001, HAS-4/30-02 (5M)QE). Washington, DC: Author. Available at www.bicyclinginfo.org/education/resource/bestguidedoc.pdf

FHWA. (2011). *International Technology Scanning Program; Public Policies for Pedestrian and Bicyclist Safety and Mobility: An Implementation Project of the Pedestrian and Bicyclist Safety and Mobility International Scan*. Washington, DC: Author. Available at http://katana.hsrc.unc.edu/cms/downloads/PBSPolicyReview.pdf

Fischer, E.L., Rousseau, G. K., Turner, S. M., Blais, E. J., Engelhart, C. L., Henderson, D. R., … & Zegeer, C. V. (2010). *Pedestrian and Bicyclist Safety and Mobility in Europe.* (Report No. FHWA-PL-10_010). Washington, DC: Federal Highway Administration. Available at www.international.fhwa.dot.gov/pubs/pl10010/pl10010.pdf

Geyer, J., Raford, N., Ragland, D., and Pham, T. (2006). The continuing debate about Safety in Numbers—Data from Oakland, CA. Oakland, CA: Safe Transportation Research & Education Center, Institute of Transportation Studies, UC Berkeley.

Gilchrist, J., Schieber, R. A., Leadbetter, S., & Davidson, S. C. (2000). Police enforcement as part of a comprehensive bicycle helmet program. *Pediatrics, 106*, 6-9.

Ginsberg, G. M., & Silverberg, D. S. (1994). A cost-benefit analysis of legislation for bicycle safety helmets in Israel. *American Journal of Public Health, 84*, 653-656.

Grant, D., & Rutner, S. M. (2004). The effect of bicycle helmet legislation on bicycling fatalities. *Journal of Policy Analysis and Management, 23*, 595-611.

Hu, P. S., & Reuscher, T. R., (2004). *Summary of Travel Trends: 2001 National Household Travel Survey.* (Report No. FHWA-PL-92-027). Washington, DC: Federal Highway Administration. Available at http://nhts.ornl.gov/2001/pub/STT.pdf

Hunter, W. W., Stutts, J. C., Pein, W. E., & Cox, C. L. (1996). *Pedestrian and Bicycle Crash types of the Early 1990s*. (Report No. FHWA-RD-95-163). Washington, DC: Federal Highway Administration. Available at http://katana.hsrc.unc.edu/cms/downloads/PedBikeCrashTypes.pdf

Hunter, W. W., Thomas, L., & Stutts, J. C. (2006). BIKESAFE: Bicycle Countermeasure Selection System. (Report No. FHWA-SA-05-006). Washington, DC: Federal Highway Administration, 384 pp. Available at www.bicyclinginfo.org/bikesafe/downloads.cfm

Jacobsen, P. L. (2003) Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention 9,* 205-209 and 2004, Correction *Injury Prevention 10,* 127.

Kakefuda, I., Stallone, L., & Gibbs, J. (2009). Discrepancy in bicycle helmet use among college students between two bicycle use purposes: Commuting and recreation. *Accident Analysis & Prevention* 41, 513-521.

Kanny, D., Schieber, R. A., Pryor, V., & Kresnow, M. J. (2001). Effectiveness of a State law mandating use of bicycle helmets among children: an observational evaluation. *American Journal of Epidemiology, 154*, 1072-1076.

Karkhaneh, M., Kalenga, J-C., Hagel, B. E., & Rowe, B. H. (2006). Effectiveness of bicycle helmet legislation to increase helmet use: a systematic review. *Injury Prevention*, *12*, 67-82.

Kwan, I. & Mapstone, J. (2004). Visibility aids for pedestrians and cyclists: a systematic review of randomised controlled trials. *Accident Analysis & Prevention* 36, 305–312

Leden, L., Garder, P., and Pulkkinen, U., (2000). An expert judgment model applied to estimating the safety effect of a bicycle facility. *Accident Analysis and Prevention 32,* 589-599.

Lockhart, S., Fenerty, L., & Walling, S. (2010). Operation headway: A multifaceted bike helmet promotion program. *Injury Prevention*. *16*, A161.

Love, D. C., Breaud, A., Burns, S., Margulies, J., Romano, M., & Lawrence, R. (2012). Is the three-foot bicycle passing law working in Baltimore, Maryland? *Accident Analysis and Prevention*. *48*, 451-456.

Ludwig, T. D., Buchholz, C., & Clarke, S. W. (2005). Using Social Marketing to Increase the Use of Helmets Among Bicyclists. *Journal of American College Health*, 54, 51-58.

Macarthur, C., Parkin, P. C., Sidky, M. & Wallace, W. (1998). Evaluation of a bicycle skills training program for young children: a randomized controlled trial. *Injury Prevention* 4, 116-121.

Macpherson, A., & Spinks, A. (2007). Bicycle helmet legislation for the uptake of helmet use and prevention of head injuries. *The Cochrane Database of Systematic Reviews*, Issue 8.

Minnesota Safety Council. (n.d.). *Bike Rodeo Planning Guide.* St. Paul, MN: Minnesota Safety Council. Available at www.minnesotasafetycouncil.org/bicycle/programs/rodeo/intro.cfm

National Association of City Transportation Officials. (n.d.). *Urban Bikeway Design Guide. National Association of City Transportation Officials*. New York, NY: Author. Available at http://nacto.org/cities-for-cycling/design-guide/.

NCHRP, Vol. 10. (2004). *A Guide for Reducing Collisions Involving Pedestrians*. Washington, DC: Transportation Research Board. onlinepubs.trb.org/Onlinepubs/nchrp/nchrp_rpt_500v10.pdf

NCHRP, Vol. 18. (2008). *A Guide for Reducing Collisions Involving Bicycles*. Washington, DC: Transportation Research Board. onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v18.pdf

National Highway Traffic Safety Administration. (2001). *National Strategies for Advancing Bicycle Safety.* (Report No. DOT HS 809 347). Washington, DC:Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/bike/bicycle_safety/

NHTSA. (2004). *Safe Routes to School: Practice and Promise*. Washington, DC: Author. Available at www.nhtsa.dot.gov/people/injury/pedbimot/bike/Safe-Routes-2004/

NHTSA. (2008). *Bicycle Helmet Use Laws*. (Report No. DOT HS 810 886W). Washington, DC: Author. Available at www.nhtsa.gov/people/injury/TSFLaws/PDFs/810886.pdf

NHTSA. (2010a). *Traffic Safety Facts: Bicyclists and Other Cyclists*. (Report No. DOT HS 811 386). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811386.PDF

NHTSA. (2010b). *Traffic Safety Facts 2009: Early Edition.* (Report No. DOT HS 811 402). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811402.PDF

NHTSA. (2012). *Traffic Safety Facts 2010 Data: Bicyclists and Other Cyclists*. (Report No. DOT HS 811 624). Washington, DC: Author. Available at www-nrd.nhtsa.dot.gov/Pubs/811624.pdf

Organization for Economic Co-operation and Development. (2004). *Keeping Children Safe in Traffic.* Paris, France: Author. Available at www.oecd.org/document/9/0,2340,en_2649_34351_31416393_1_1_1_1,00.html

Okinaka, T., & Shimazaki, T. (2011). The effects of prompting and reinforcement on safe behavior of bicycle and motorcycle riders. *Journal of Applied Behavior Analysis*, *44*, 671-674.

Osberg, J. S., Stiles, S. C., & Asare, O. K. (1998). Bicycle safety behavior in Paris and Boston. *Accident Analysis and Prevention, 30*, 679-687.

Owen, R., Kendrick, D., Mulvaney, C., Coleman, T., & Royal, S. (2011). *Non-legislative interventions for the promotion of cycle helmet wearing by children*. Cochrane Database of Systematic Reviews (Online), (11)(11), CD003985.

Pedestrian and Bicycle Information Center. (2010). *Pedestrian and Bicycle Information Center Case Study Compendium*. Chapel Hill, NC: Author. Available at http://katana.hsrc.unc.edu/cms/downloads/pbic_case_study_compendium.pdf

Pucher, J., Buehler, R., Merom, D., & Bauman, A. (2011a). Walking and cycling in the United States, 2001-2009: Evidence from the NHTS. *American Journal of Public Health*, *101*, S310-S317.

Pucher, J., Buehler, R., & Seinen, M. (2011b). Bicycling renaissance in North America? An update and re-appraisal of cycling trends and policies. *Transportation Research Part A-Policy and Practice*, *45*, 451-475.

Puder, D. R., Visintainer, P., Spitzer, D., & Casal, D. (1999). A comparison of the effect of different bicycle helmet laws in 3 New York City suburbs. *American Journal of Public Health, 89*, 1736-1738.

Rivara, F. P., & Metrik, J. (1998). *Training Programs for Bicycle Safety*. Olympia, WA: Washington Traffic Safety Commission.

Rivara, F. P., Thompson, D. C., Patterson, M. Q., & Thompson, R. S. (1998). Prevention of bicycle-related injuries: helmets, education, and legislation. *Annual Review of Public Health, 19*, 293-318.

Rodgers, G. B. (2002). Effects of state helmet laws on bicycle helmet use by children and adolescents. *Injury Prevention, 8*, 42-46.

Royal, S., Kendrick, D., & Coleman, T. (2007). Promoting bicycle helmet wearing by children using non-legislative interventions: Systematic review and meta-analysis. *Injury Prevention*, *13*, 162-167.

Rouzier, P., & Alto, W. A. (1995). Evolution of a successful community bicycle helmet campaign. *Journal of the American Board of Family Practitioners, 8*, 283-287.

Scheiman, S., Moghaddas, H. S., Bjornstig, U., Bylundb, P.-O.,Saveman, B.-I. (2010). Bicycle injury events among older adults in Northern Sweden: A 10-year population based study. *Accident Analysis & Prevention, 42,* 758-763.

Thomas, L, Stutts, J., & Gillenwater, Z. (n.d.). Development of a Model Drivers License Handbook: Final Products Description and Summary Report. NCHRP 20-07/Task 212. Research for AASHTO Standing Committee on Highways. 144.171.11.40/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=1227

Thornley, S. J., Woodward, A., Langley, J. D., Ameratunga, S. N. & Rodgers, A. (2008). Conspicuity and bicycle crashes: Preliminary findings of the Taupo bicycle study. *Injury Prevention, 14,* 11-18.

Thompson, D. C., Rivara, F. P., & Thompson R. (2006). Helmets for preventing head and facial injuries in bicyclists. *The Cochrane Database of Systematic Reviews*, Issue 2. Available at www.cochrane.org/reviews/en/ab001855.html

Washington Area Bicyclist Association. (n.d.). Bike/Ped Safety Education Program. Washington, DC: Author. Available at www.waba.org/bikingforkids/leaders.php

Wesson, D. E., Stephens, D., Lam, K., Parsons, D., Spence, L., & Parkin, P. C. (2008). Trends in pediatric and adult bicycling deaths before and after passage of a bicycle helmet law. *Pediatrics, 122*, 605-610.

Williams, J., & Burden, D. (1994). *The Guide to Bicycle Rodeos*. Woodinville, WA: Outdoor Empire Publishing.

Wood, J. M., Tyrrell, R. A., Marszalek, R., Lacherez, P., Carberry, T., & Chu, B. S. (2012). Using reflective clothing to enhance the conspicuity of bicyclists at night. *Accident Analysis and Preventio*n, *45*, 726-730.

DOT HS 811 727
April 2013

U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA
www.nhtsa.gov

9435-080513-v4b