Tool

Costs and Effectiveness of Interventions to Reduce Motor Vehicle–Related Injuries and Deaths

Project Report and Online-Tool Documentation

Jeanne S. Ringel, Johanna Zmud, Kathryn Connor, David Powell,
Brian G. Chow, Liisa Ecola, Christina Panis, Gregory S. Jones

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Preface

The purpose of this project was to support states and local communities in making evidence-based resource allocation decisions relating to the implementation of effective evidence-based interventions for preventing motor vehicle–related injury. This report documents the data and assumptions that were used to develop the interactive online tool that states can use to assess state-specific costs and effectiveness of different interventions designed to prevent motor vehicle–related injuries. It also includes a user guide that describes how to use the tool. The tool should help states understand the trade-offs and prioritize the most cost-effective interventions to reduce motor vehicle–related injuries. The tool is available to the public at www.cdc.gov/motorvehiclesafety/calculator. The audience for this report is the users of the online tool, state and local health and safety officials seeking information on the effectiveness and costs of the various interventions.

This work was sponsored by the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention. Reference to any specific commercial products, programs, or services by trade name, trademark, manufacturer, or otherwise does not necessarily constitute or imply its endorsement, recommendation, or favoring by the U.S. government. The views and opinions of authors expressed herein do not necessarily state or reflect those of the U.S. government and shall not be used for advertising or product or program endorsement purposes.

RAND researchers have undertaken related work that extended the online tool by including two additional interventions. This additional work is sponsored by the Robert Wood Johnson Foundation and is incorporated into this report. In addition, an accompanying report uses the data in the tool to conduct policy analyses of traffic safety spending, and four research briefs highlight those analyses:

- Liisa Ecola, Benjamin Batorsky, and Jeanne S. Ringel, *Using Cost-Effectiveness Analysis to Prioritize Spending on Traffic Safety*, Santa Monica, Calif.: RAND Corporation, RR-1224-RWJ, forthcoming (a)
- Liisa Ecola and Jeanne S. Ringel, *Which Behavioral Interventions are Most Cost-Effective in Reducing Drunk Driving?* Santa Monica, Calif.: RAND Corporation, RB-9826-CDC, forthcoming
- Liisa Ecola, Benjamin Batorsky, and Jeanne S. Ringel, *A New Tool to Help Decisionmakers Select Interventions to Reduce Traffic Crash Deaths and Injuries*, Santa Monica, Calif.: RAND Corporation, RB-9827-CDC, forthcoming (b)
- Liisa Ecola, Benjamin Batorsky, and Jeanne S. Ringel, *How to Get the Biggest Impact from an Increase in Spending on Traffic Safety*, Santa Monica, Calif.: RAND Corporation, RB-9855, forthcoming (c)

- Liisa Ecola, Benjamin Batorsky, and Jeanne S. Ringel, *Should Traffic Crash Interventions Be Selected Nationally or State by State?* Santa Monica, Calif.: RAND Corporation, RB-9860, forthcoming (d).

The research reported here was conducted jointly in RAND Health and in the RAND Transportation, Space, and Technology Program. Questions or comments about this report should be sent to the project leader, Jeanne Ringel (Jeanne_Ringel@rand.org).

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Summary

Globally, motor vehicle crashes are the eighth-leading cause of death for all ages and the leading cause of death for people ages 15 to 29 (World Health Organization [WHO], 2013). In recognition of this fact, in 2010, WHO called for a Decade of Action for Road Safety 2011–2020. The problem is just as acute in the United States, where, in 2013, more than 32,700 people were killed and approximately 2.3 million were injured in motor vehicle crashes (National Highway Traffic Safety Administration [NHTSA], 2015). For 2010, the economic costs associated with motor vehicle crashes are substantial, estimated to be $242 billion in 2010 (Blincoe, Miller, et al., 2015). Fortunately, a wide range of evidence-based interventions, including both policies and programs, can help prevent motor vehicle–related injuries and deaths.

This report contains the technical documentation for the development of an online tool for decisionmakers—primarily state health, transportation, and safety officials—to use in determining the costs and effectiveness of various interventions to reduce injuries and deaths from motor vehicle crashes and in determining what interventions together generate the largest reductions in injuries and deaths for a given implementation budget. In addition to helping with intervention selection, this report contains detailed cost categories and data, which can be useful to state planners in determining the types and amounts of costs involved in the implementation of selected interventions. RAND experts developed the online tool for the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention (CDC). The tool is available at www.cdc.gov/motorvehiclesafety/calculator.

The impetus for the project was that, although much information has been collected and developed over many years about the effectiveness and costs of various interventions at locations where interventions have been implemented, it has been difficult to develop information systematically about the comparative effectiveness and costs for an individual state. Although states are major actors in the realm of motor vehicle policy and safety, it has been difficult to assess which interventions are the most cost-effective for a given budget and how the effectiveness compares with the costs. The project addresses this concern by collecting a wide variety of information in one report and allowing users to look at costs and effectiveness scaled to their states.

The tool does not contain information on every possible intervention.[1] Rather, the tool contains interventions that have not yet been widely implemented across states, so as to focus on those interventions that can yield the largest benefit. Our selection was based on four criteria. Interventions had to be

[1] Reviews like the NHTSA-sponsored *Countermeasures That Work* (University of North Carolina [UNC] Highway Safety Research Center, 2011) are more comprehensive and contain information on more than 100 interventions.

- intended to change driver or passenger behavior (as opposed to changes to roadway or vehicle engineering)
- implementable at the state level (or affected by state policy)
- demonstrated to be highly effective
- not already in widespread use.

Thus, the goal was to focus on those interventions that would bring the greatest possible effectiveness from implementation and that other states could adopt. We ultimately analyzed 14 interventions that met these criteria.

For each of these 14 interventions, we developed a set of cost components. Our final cost-estimating structure has ten cost components, divided into subcomponents. The cost of each intervention consists of one or more components. We obtained information about costs from a variety of sources, including journal articles; federal, state, and other organization reports; commercial sources; and interviews with state officials and stakeholders. Some costs, such as the cost of staff time for state personnel (e.g., highway patrols and department of motor vehicles [DMV] staff), were scaled to each state based on wage rates provided by the Bureau of Labor Statistics. For other cost components, we developed a "most common cost" that was used across all states, based on the range of costs we documented.

Costs fall into one of four categories: costs borne by the state (such as the cost of police time), costs paid by individuals to the state (such as a seat belt fine), costs borne by offenders but not paid to the state (such as purchase of an alcohol interlock), and costs borne by individuals to comply with the law (such as purchase of a motorcycle helmet). Because the tool considers only costs that directly affect the cost or revenue to the state, costs borne by individuals are not included in the cost calculation to prioritize and select interventions for implementation. To ensure that these costs do not impose an undue burden on the public, before implementing a new intervention, state decisionmakers might want to know the total costs that people will bear but not pay to the state for that intervention. Thus, in addition to detailed assembly and estimation of costs in the first two categories, we have provided some data on costs in the third and fourth categories.

We also developed estimates of the effectiveness of interventions. *Effectiveness* is defined as the reduction in injuries and deaths that implementing a particular intervention can create. We developed two types of information: the actual number of anticipated lives saved and injuries prevented and a monetized value of those two things. Our estimates are based on published articles and reports that document empirical studies of the effectiveness of interventions. To create our estimates, we prioritized studies using four criteria: They provided information on the primary outcomes of interest (i.e., crashes, injuries, and deaths), they used rigorous study designs, they were relatively recent, and they assessed interventions in the United States. We relied on meta-analyses and systematic reviews when available to identify studies accepted and cited in the field. Most of the studies, systematic reviews, or meta-analyses that we used in developing these estimates looked at deaths only, so, with one exception, we assumed that injuries were reduced at the same rate.

These reductions were scaled to each state, based on the number of injuries and deaths associated with particular crash causes in 2010 (using the Fatality Analysis Reporting System [FARS] and General Estimates System [GES] for injuries) for that state. This scaling is needed because interventions address particular crash types (for example, we expect a motorcycle helmet law to reduce motorcyclist deaths), and the mix of crash types varies between states (for example, Florida, California, and Texas have higher numbers of motorcycle crashes than other states have).

We used an existing protocol to determine the economic benefits of a life saved or an injury prevented. This was developed by Blincoe, Miller, et al., 2015, specifically to monetize the benefits from reducing crashes.[2] The protocol includes nine cost categories; we scaled three of them at the state level and used national estimates (updated to 2012 dollars) for the other six. This provided us with a monetary value for each life saved or injury prevented specific to each state.

Using these costs and effectiveness or its monetized benefits, we then developed and programmed the online tool using SAS software for compatibility with CDC website requirements. The tool has two modes of analysis:

- Cost-effectiveness analysis assesses the costs and effectiveness of each intervention separately, without accounting for any interdependencies between interventions.
- Portfolio analysis takes interdependencies between interventions into account.

The cost-effectiveness analysis uses the information described above to provide the total annual monetized benefits and annual costs for each separate intervention selected. The attractiveness of an intervention is measured by the ratio of effectiveness to costs. The higher the ratio of effectiveness to costs, the more cost-effective the intervention. The portfolio analysis accounts for three sets of interdependencies, defined by the crash cause:

- alcohol interlock, license plate impoundment, limits on diversion and plea agreements, and vehicle impoundment
- saturation patrols and sobriety checkpoints
- primary enforcement of seat belt laws and seat belt enforcement campaign.

In each case, the new number of injuries and deaths averted is less than the sum of the individual interventions. This effect is easiest to see in an extreme hypothetical example in which two interventions could each reduce deaths by 100 percent. Implementing both interventions would still reduce deaths by a total of 100 percent, not the sum of the individual interventions or 200 percent. In a case in which interdependencies exist among three interventions (alcohol interlock, limits on diversion and plea agreements, and vehicle impoundment), we have provided

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[2] In May 2015, the report was reissued because of errors in its analysis. The tool and report have been updated to reflect these changes.

detailed calculations in this report (see Chapter Five) to show that the implementation of these three interventions would reduce the number of injuries and deaths by 53 percent. In contrast, if interdependencies are ignored, a larger reduction of 65 percent would result. The latter is larger than the former by 24 percent. If license plate impoundment were also implemented, the latter would be larger by 39 percent.

For both types of analysis, there are two ways to conduct model runs:

- *Fines included* means that the analysis takes into account the revenue that the state receives from those interventions for which offenders pay fines. This revenue is assumed to be available to fund the implementation of the interventions from which the revenue is generated, as well as other interventions.
- *Fines excluded* means that the analysis excludes any revenue received from fines. Without fines to defray some of the costs, the total cost to the state in implementing the selected interventions can be substantially higher.

In addition, users can conduct sensitivity analysis under the portfolio analysis option. For these analyses, the user can change any of the top-level cost and effectiveness assumptions and see the results.

The tool was developed, programmed, and tested by RAND experts. In accordance with CDC direction, we used .NET and SAS software. Once the tool was completed, we turned it over to be hosted by CDC.

There are many challenges associated with developing the cost and effectiveness estimates. In particular, numerous assumptions are needed to generate these estimates. We note a few examples here. First, the cost-effectiveness estimates reflect assumptions about the level and characteristics (e.g., how much enforcement is done, whether there was a publicity campaign) of implementation of the successful intervention. As a specific example, we estimated the number of cameras for each state's red-light and speed camera enforcement. Second, the effectiveness estimates from the literature are based on conditions in a specific jurisdiction, which might not reflect the conditions in others. Third, in many cases, there was no evidence for a specific parameter (e.g., the effect that an intervention could have on crash-related injuries), and we had to make assumptions. For example, effectiveness estimates for injuries were not available for most interventions, so, in the absence of more-specific information, we assumed that the reduction was the same as for fatality reductions. Finally, we used data for scaling by states from national databases, which we assumed accurately reflected conditions across states.

We have tried to mitigate this problem in several ways. We have worked to find the best available evidence on which to build the assumptions. We have also described our assumptions and calculations in detail in this report, so the reader can assess the assumptions for him- or herself. Finally, those who disagree with the assumptions can conduct sensitivity analyses with the tool by adjusting model parameters and use that analysis to inform their selection of the most cost-effective interventions.

The estimates provided by the tool are approximations. They are meant to give decisionmakers a sense of the relative costs and effects of different interventions under consideration. There may be other costs and benefits not captured by the tool that should be considered (e.g., the improved employment or quality of life among people who are deterred from driving while drunk, effects on civil liberties) or political issues that make some interventions more feasible than others. In essence, the estimates are designed to be one category of information in the larger policy debate.

Despite the necessary reliance on assumptions to build the model, we believe that the tool will be of great use to state decisionmakers. Although information about which interventions are effective has been generally available, this is the first effort to estimate the implementation costs across a broad array of interventions and to translate these costs to the state level according to a specific state's demographics and traffic crash profile. States need information on both the potential costs and effects of interventions to make informed resource allocation decisions.

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We thank Andrés Villaveces, formerly of RAND, who developed some of the cost models, and Adrian Montero, also formerly of RAND, who helped build the online web tool. Christina Y. Huang conducted background research on costs and effectiveness, and Chaoling Feng helped compile the lists of interventions by state. Andria Tyner, Joanna Mahoney, and Stephanie Lonsinger assisted with preparing the reference section and fact sheets.

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Abbreviations

AAA	American Automobile Association
AAMVA	American Association of Motor Vehicle Administrators
ALR	administrative license revocation
ARIMA	autoregressive integrated moving average
BAC	blood alcohol concentration
BHSI	Bicycle Helmet Safety Institute
BLS	Bureau of Labor Statistics
BrAC	breath alcohol concentration
BRFSS	Behavioral Risk Factor Surveillance System
CDC	Centers for Disease Control and Prevention
CIOT	Click It or Ticket
CODES	Crash Outcome Data Evaluation System
DMV	department of motor vehicles
DOT	U.S. Department of Transportation
DWI	driving while intoxicated
DWS	driving while suspended
DWU	driving while unlicensed
FARS	Fatality Analysis Reporting System
FBI	Federal Bureau of Investigation
FHWA	Federal Highway Administration
FMVSS	Federal Motor Vehicle Safety Standards
FTE	full-time equivalent
FY	fiscal year
GAO	U.S. General Accounting Office, before July 7, 2004
GES	General Estimates System
GHSA	Governors Highway Safety Association

ICC	Illinois Commerce Commission
ICU	intensive care unit
IDOT	Illinois Department of Transportation
IIHS	Insurance Institute for Highway Safety
ITE	Institute of Transportation Engineers
MAIS	maximum abbreviated injury score
NASS	National Automotive Sampling System
NCHRP	National Cooperative Highway Research Program
NCSL	National Conference of State Legislatures
NCUTLO	National Committee on Uniform Traffic Laws and Ordinances
NEISS-AIP	National Electronic Injury Surveillance System—All Injury Program
NHTSA	National Highway Traffic Safety Administration
NightCAP	Nighttime Concentrated Alcohol Patrol
NOPUS	National Occupant Protection Use Survey
NSC	National Safety Council
NTSB	National Transportation Safety Board
OLS	ordinary least squares
OUI	operating under the influence
PAS	passive alcohol sensor
PennDOT	Pennsylvania Department of Transportation
PIRG	Public Interest Research Group
RDP	Rural Demonstration Program
SBT	selective breath testing
SFST	Standardized Field Sobriety Test
S/R	driver with a suspended or revoked license
STEP	Selective Traffic Enforcement Program
TBI	traumatic brain injury
TIRF	Traffic Injury Research Foundation

UNC	University of North Carolina
U.S. PIRG	U.S. Public Interest Research Group
WHO	World Health Organization
WISQARS	Web-based Injury Statistics Query and Reporting System

Chapter One. Introduction

Project Objectives

Globally, motor vehicle crashes are the eighth-leading cause of death for all ages and the leading cause of death for people ages 15 to 29 (World Health Organization [WHO], 2013). In recognition of this fact, the United Nations General Assembly mandated a Decade of Action for Road Safety 2011–2020, which aims to reduce road injuries and deaths across the world. The problem is just as acute in the United States, where, in 2013, more than 32,700 people were killed and approximately 2.3 million were injured in motor vehicle crashes (National Highway Traffic Safety Administration [NHTSA], 2015). In 2010, the economic costs associated with motor vehicle crashes were substantial, estimated to be $242 billion (Blincoe, Miller, et al., 2015). Fortunately, a wide range of evidence-based interventions, including both policies and programs, can help prevent motor vehicle–related injuries. As such, prevention of motor vehicle–related injuries has been designated as one of ten "Winnable Battles" by the Centers for Disease Control and Prevention (CDC).[3]

In the United States, many of the available evidence-based interventions to prevent motor vehicle–related injuries can be implemented at the state level. Given limited resources for implementing interventions, states must prioritize interventions and choose those that will give them the greatest reduction in injuries and deaths for their implementation dollars. To do this prioritization, states require state-specific information on the costs and effects of the interventions. Although considerable evaluation work has identified evidence-based interventions to prevent motor vehicle–related injuries and estimated the costs of motor vehicle–related injuries and deaths in the United States, little has been done to identify the levels of economic resources needed to implement these interventions. Consequently, decisionmakers—a term we use broadly throughout this report to include state health, transportation, and safety officials, as well as other officials who might use the tool—are not able to fully assess the costs and effects of different interventions and select the most cost-effective ones.

The purpose of this project was to support states and local communities across the United States in making evidence-based resource allocation decisions relating to the implementation of effective interventions to prevent motor vehicle–related injuries. This is achieved by building an interactive online tool (www.cdc.gov/motorvehiclesafety/calculator) that states can use to assess state-specific costs and effects of different interventions designed to prevent motor vehicle–related injuries and deaths and to select interventions that are most effective for a given implementation budget. The tool should help states understand the trade-offs and prioritize the

[3] CDC's Winnable Battles are defined as public health priorities with large-scale impact on health and with known, effective strategies to address them. For more information on CDC's Winnable Battles, please see CDC, 2014a.

most cost-effective interventions to reduce motor vehicle–related injuries and deaths. This report also contains detailed implementation cost information, which can be useful to state planners in determining the types and amounts of costs involved in implementing selected interventions.

We conducted this project in five steps:

1. We selected a set of evidence-based interventions based on systematic reviews and evaluated against a set of predetermined criteria.
2. We examined existing literature to estimate the interventions' effectiveness in reducing injuries and deaths and followed the National Cooperative Highway Research Program (NCHRP) Report 622 (Preusser, Williams, et al., 2008) methodology in estimating the effect for each individual state.
3. We extended a methodology used to estimate the costs of motor vehicle–related injuries at the national level to account for state-level variation in these costs and calculated these costs for each state to account for state-level variation.
4. We developed a methodology to estimate the cost components and subcomponents for implementing each intervention through a review of the literature to identify existing implementation cost estimates and scaled the costs to the state level.
5. We built an online tool that state decisionmakers can use to generate a variety of state-specific cost-effectiveness analyses, whose outcomes include estimates for costs and effectiveness, automatic prioritization according to effectiveness–cost ratio, and selection of the most beneficial package of interventions to implement for a given budget according to portfolio analysis.

Organization of This Report

This report serves as the documentation of this effort. Following this introduction, Chapter Two describes our process for selecting the 14 interventions that are included in the tool and provides a brief description of each. Chapter Three explains the cost-estimating structure, as well as the data and supporting assumptions used to develop the costs for implementing each intervention. Chapter Four describes the parallel process for identifying the effectiveness of each intervention. Chapter Five describes how these data and assumptions were used to build the tool. Finally, Chapter Six serves as a user manual, providing a detailed example of how to use the tool, including a series of screenshots. Appendix A details the process of selecting interventions, and Appendix B provides fact sheets about each intervention.

Chapter Two. Selecting Interventions

This chapter explains our approach to selecting interventions to be included in the tool. Our first task consisted of identifying evidence-based interventions to be studied in the course of the project. The project evaluates interventions that seek to change driver and passenger behavior, such as wearing seat belts and helmets, avoiding drunk driving, and obeying speed limits and traffic signals. We did not consider any interventions that make vehicles safer in crashes without any action by the driver (such as air bags) or those that change the design of roadways.

Given the nature of the project (i.e., assisting states in determining the most cost-effective interventions), we proposed the following criteria to select these interventions:

- the likely magnitude of the effect (i.e., potential for high impact). This study focused on interventions with sufficient empirical evidence to suggest a significant reduction in the number of motor vehicle–related injuries or deaths. We first identified interventions that seemed to have a solid evidence base and later reviewed specific studies to determine the reduction in injuries and crashes (see Chapter Four for more details).
- the number of states that have implemented the intervention (i.e., potential for broader implementation). If an intervention is already in widespread use, the potential for additional impact is limited. The study included interventions that have been implemented in no more than two-thirds of the states; most have been implemented in fewer than half the states.
- states' ability to implement an intervention. Because the goal of this project was to assist state decisionmaking, interventions that would be implemented exclusively at the federal or local level would be ranked low.

Following our initial review of the NHTSA-sponsored *Countermeasures That Work* report (University of North Carolina [UNC] Highway Safety Research Center, 2011),[4] which describes and assesses 131 interventions, we identified a preliminary list of interventions that meet the three criteria.[5] The *Countermeasures* report ranked all interventions on a scale of 1 to 5, with 5 considered the most effective. We retained only the 38 interventions that rated 4 or 5. Of these, we eliminated 13 whose use was deemed "high" (that is, all or almost all states already use these interventions), five that would be implemented by actors other than states, and another five that would be difficult to study either because they are seldom implemented as stand-alone measures or for which data appear to be limited. We made iterative changes to the initial list in conjunction with CDC staff, bringing the number of interventions to 12; details of those changes are provided in Appendix A.

[4] This was the most recent version of the report when we conducted our search.

[5] Although we also reviewed interventions cataloged in Governors Highway Safety Association, undated, and Child Injury Prevention Tool, undated, none of these additional interventions was selected.

As part of a follow-on project, we added two other interventions. We again began with the *Countermeasures That Work* report (which had, by that point, been updated; see Goodwin, Kirley, et al., 2013) but looked for promising policies that addressed four areas that had not been part of the original 12 interventions: older drivers, increased fines, bicyclists and pedestrians, and cell phone and texting bans. According to research not cited in Goodwin, Kirley, et al., 2013, we determined that in-person license renewal appeared to be an effective policy and that higher seat belt fines met our original criteria.

The final list is shown in Table 2.1. Brief definitions are provided below, and fact sheets with more detail on each intervention (including evidence of effectiveness) are provided in Appendix B. In addition, in Chapter Three, we describe how we operationalized the interventions for the purposes of estimating the implementation costs.

Table 2.1. Interventions for Analysis

Name of Intervention (Short Name)	Description	Effectiveness	Use	Comments
Automated red-light camera enforcement (red-light camera)	Automated red-light camera enforcement, more commonly called *red-light cameras*, is used to capture an image of a vehicle whose driver fails to stop for a red light. Tickets are generally sent to offenders by mail.	5	Medium	Retained despite some conflicting evidence about effectiveness
Automated speed-camera enforcement (speed camera)	Automated speed-camera enforcement, often called *speed cameras*, captures an image of a vehicle whose driver is driving in excess of the posted speed limit. Unlike red-light cameras, which are deployed only at intersections, mobile speed cameras are often used to cover multiple road segments.	5	Medium	None
Alcohol interlocks	Alcohol interlocks, also called *ignition interlocks*, are devices that prevent a vehicle from starting until the driver has blown into a tube and determined that his or her BAC is below the allowable level set by the state (0.02 in most jurisdictions). This intervention calls for interlocks to be installed on the vehicles of convicted repeat DWI offenders, as well as high-BAC and first offenders, depending on state legislation.	5	Medium	Legal in all states; states vary in whether they are mandatory and under which circumstances.
Sobriety checkpoints	At a sobriety checkpoint, teams of police officers stop cars at a specific location to check drivers for alcohol levels. States generally publicize such events to discourage drivers from drinking, particularly during times when drunk driving is more common than usual (such as holiday weekends).	5	Medium	Legal in most states but limited use
Saturation patrols	Saturation patrols consist of an increased police presence in selected locations where they patrol the area looking for suspicious driving behavior. In contrast to sobriety checkpoints, they do not stop every vehicle.	4	High	Legal in all states; can be used in states that prohibit checkpoints

Name of Intervention (Short Name)	Description	Effectiveness	Use	Comments
Bicycle helmet laws for children (bicycle helmet)	To reduce the likelihood of trauma to the head and its related consequences, bicycle helmet laws mandate the use of helmets by children while they are riding bicycles.	5	Medium	None
Universal motorcycle helmet laws (motorcycle helmet)	This law requires all motorcyclists, regardless of age or experience level, to wear a helmet the meets safety standards set by DOT. These laws contrast with partial helmet laws, which typically apply only to riders below a certain age.	5	Medium	None
Primary enforcement of seat belt laws (primary enforcement of seat belt laws)	States with seat belt laws vary in their enforcement. A primary law allows police to ticket an offender exclusively for not wearing a seat belt. A secondary law allows police to write a ticket for not wearing a seat belt only if the driver has been pulled over for a different offense.	5	Medium	None
High-visibility enforcement for seat belts and child restraint laws (seat belt enforcement campaign)	High-visibility enforcement is a technique that combines intense enforcement over a fixed period (for example, one or two weeks) with a publicity campaign. A campaign focused on restraint use generally includes all forms of restraints: seat belts, child safety seats, and booster seats.[a]	5	Medium	This combines four previously separate interventions that all had the same ratings.
License plate impoundment	This intervention requires a driver who has been convicted of DWI to surrender the vehicle's license plate, which is either impounded or destroyed. In some jurisdictions, the license plate is not physically removed; rather, officers place stickers on the license plate to indicate that it is invalid. The stickers are designed so that, if someone tries to remove them, they leave a visible pattern on the plate. Because it is relatively easy for police to observe whether a vehicle has a license plate or the stickers, this intervention deters convicted DWI offenders from driving that vehicle.	4	Medium	None
Limits on diversion and plea agreements (limits on diversion)	Although all states have penalties for DWI, many states have additional programs that allow some offenders to be diverted out of the normal procedures or to plead guilty to a lesser offense and receive a lighter sanction. These programs are most often targeted at first-time offenders, with the goal of reducing the DWI case load by diverting people who are thought to be unlikely to reoffend. Limits on diversion and plea agreements would increase the number of DWI arrestees convicted of more-serious DWI-related charges.	4	Medium	None

Name of Intervention (Short Name)	Description	Effectiveness	Use	Comments
Vehicle impoundment	This intervention results in the vehicle of a DWI offender being confiscated for a period of time and stored in a public impound lot. An offender can either reclaim or surrender his or her vehicle when the impoundment period ends.	4	Medium	Ratings based on all vehicle and license plate sanctions combined
In-person license renewal	This intervention requires all drivers over age 70 to renew their driver's licenses in person at a department of motor vehicles instead of using mail-in or online renewal	2	Medium	None
Higher seat belt fines	This intervention adds $75 to a state's existing fine, which represents a significant increase over existing seat belt fines in most states.	4	Low	None

SOURCES: Effectiveness and use ratings from UNC Highway Safety Research Center, 2011; Goodwin, Kirley, et al., 2013.
NOTE: BAC = blood alcohol concentration. DWI = driving while intoxicated. DOT = U.S. Department of Transportation. State terminology varies; a DWI charge against a drunk driver is the same as a charge of driving under the influence (DUI). For the sake of consistency, this report uses *DWI*. The short name is the same as the intervention name in the tool.
[a] *Child restraint* includes both child car seats and booster seats, For simplicity, we refer generally to *child restraints*.

All of these interventions can be implemented at the state level. In some cases, though, the state may pass a law allowing the use of the intervention (e.g., red-light cameras) but leave it to individual jurisdictions within the state to decide whether to implement it. For the purposes of this tool, we assume a statewide implementation of the interventions. If the state is not considering full implementation, it will need to scale the estimates accordingly. The tool allows the user to conduct analyses using different assumptions about the costs and effects of the intervention if he or she wants to consider a lower level of implementation.

Chapter Three. Cost Data, Estimates, and Analysis

In this chapter, we describe the specific steps we followed to estimate the implementation costs for each of the 14 selected interventions. To generate the estimates, we had to make a set of assumptions about how the intervention would be implemented. Where possible, we based these assumptions on those characteristics of the intervention from which the effectiveness estimates (reported in Chapter Four) are taken. In some cases, the academic literature did not describe the intervention in detail, so we used other sources (e.g., reports, interviews) to inform those assumptions.

Cost-Estimating Methodologies

To estimate the total costs of developing, implementing, and maintaining the different interventions over time, we used a six-step process:

1. Develop a cost-estimating structure that included ten cost components.
2. Gather state statistics for scaling.
3. Review literature for data on the ten cost components.
4. Develop regressions to estimate costs for states with missing data.
5. Develop mean, minimum, and maximum cost inputs.
6. Develop state-specific estimates of the process for implementing each intervention.

In this section, we describe how we implemented each step. This was an iterative rather than a linear process because we both adjusted the cost-estimating structure based on our review of the literature and reviewed the literature to determine appropriate costs.

Step 1. Develop the Cost-Estimating Structure

To estimate the annual costs of each intervention, we calculated ten cost components that are typically involved in developing, implementing, and maintaining an intervention:[6]

- publicity
- police or highway patrol time
- court system
- department of motor vehicles (DMV)
- equipment
- fines and fees
- probation
- education programs

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[6] In some cases, a shortened form of each of these terms was used in the tool itself. For example, “Police Highway” is used in the tool to mean *police or highway patrol time*.

- vehicle impoundment
- program management.

Costs associated with each intervention fall into four categories: (1) costs paid by the state (e.g., the cost of police time), (2) costs paid by individuals that result in revenue to the state or cities (e.g., fines and fees), (3) costs paid by offenders (e.g., alcohol interlocks) but not to the state, and (4) costs paid by individuals to comply with the law (e.g., motorcycle helmet purchase) but not paid to the state.

The cost-effectiveness analysis considers only the first two categories: (1) costs paid by the state and (2) costs paid by individuals that result in revenue to the state or cities (e.g., fines and fees). In fact, when individuals use the tool, they can do so two ways. They can only use the first cost category, thus excluding the costs paid by individuals to the state, so that the only revenues available to implement the interventions are those provided by the state directly. Or they can include the costs paid by individuals to the state, so that those revenues are available to offset the state's implementation costs.

In some cases, interventions that generate revenues may cover not only their own costs but the costs of other interventions as well. However, for political or other reasons, the funds generated by the intervention may not be available for additional interventions to reduce motor vehicle–related injuries. In this case, the user would choose the analysis that excludes fines to generate the more appropriate analysis for his or her state.

The third and fourth categories, costs borne by offenders and costs to comply with the law, are not included in the tool's calculations. They are, however, displayed in the portfolio analysis mode as "offender-borne costs" and "costs to comply with the law." We include information on those costs in this report because a state might want to know the costs borne by individuals, whether to ensure that these costs do not impose undue burden on them or because they may be politically relevant.

We considered estimating the costs of passing legislation to put new countermeasures in place but determined that there was limited information on the cost of passing legislation and that legislative budgets are not well correlated with amount of legislation produced. Therefore, we did not include these costs.

For some interventions, the number of offenders and other factors may change over time. This cost model calculates annual costs based on the number of offenders in 2010; we did not have sufficient evidence to model trends in offenses over time for individual interventions.

In this section, we define each cost component.

Publicity

This component is the cost of publicity used to announce, explain, or address specific interventions (e.g., communication campaigns about seat belt use). Costs associated with these strategies can include advertising or outreach strategies in printed media (magazines and newspapers), outdoor media (billboards), radio, and television announcements. This includes creation of the media in the campaign, as well as paying advertising providers. We used information from the Click It or Ticket (CIOT) campaign (Solomon, Gilbert, et al., 2007; Solomon, Preusser, et al., 2009) and other public health media campaigns to estimate the effort associated with communications to licensed drivers and occupants.[7] This campaign exhibited both high reach and frequency, which are necessary for campaign success.

Unfortunately, there is no single definition of a successful communication campaign, but, for the purposes of our model, we feel that CIOT is a valuable example. Publicity estimates in the tool are then adjusted for smaller populations, depending on the intervention. This is an area in which states actually have a substantial amount of flexibility in the amount that they spend for campaigns, so our estimates are based on the experience of a prior vehicle safety campaign. In addition, it is possible that states will try various mixes of media that are not addressed in the literature, including social media and Internet advertising. Because publicity dollars for public health have been quite stable for the interventions for which we had data, we assume that any dollars spent on social media would be spent in lieu of dollars for another form of media rather than an additional outlay. It is likely that earned media related to these interventions may also have an Internet or social media presence as local news stations post stories online.

Publicity costs are applied to interventions for which the literature discusses the use of paid publicity. Some interventions rely on either unpaid publicity or no publicity, and we therefore do not include publicity costs for these interventions. Including publicity costs only where they appear in the effectiveness literature is intended to better align our estimates of program costs with the existing data on costs and the anticipated benefits of the intervention.

Media costs vary widely by state, but we were unable to find a consistent source for costs by state. Therefore, the costs in the tool may not be the appropriate level of spending for each state.

Police or Highway Patrol Time

Many interventions require active police enforcement. Examples of these include sobriety checkpoints, saturation patrols, and vehicle impoundment. Police time and resources are spent in enforcement strategies. We estimated the time costs for these police enforcement strategies by describing the usual procedures necessary to enforce a specific intervention (Cooper, Chira-Chavala, and Gillen, 2000). As an example, detailed vehicle impoundment procedures are explained in Chapter Five. All the effort invested by police requires the time of a certain number of officers of different ranks (and hence wages). Because detailed studies are not readily available on police pay, we used the mean wage for nonsupervisory police officers from the Bureau of Labor Statistics (BLS). For each relevant intervention, we estimated the number of police officers typically involved in each procedure, as well as the time invested to carry out an enforcement strategy from beginning to end. Then we took the total number of hours estimated

[7] The CIOT campaign in 2005 reached “91% of the target audience (men age 18 to 34) an average of 9.9 times” (Solomon, Gilbert, et al., 2007), which is very high considering that Sunday Night Football reaches only about 11 percent of the population between the ages of 18 and 49 (Nielsen Company, 2012).

and multiplied it by an hourly compensation figure (as shown in Table 3.1), which is equal to the locality-specific hourly salary (as estimated by BLS) plus fringe benefits (also estimated based on BLS statistics).

Table 3.1. Hourly Wages Plus Benefits of Government Office Workers, Police, and Probation Officers, 2011 ($)

State	Government Office Workers	Police	Probation Officers
Alabama	22.48	29.40	25.85
Alaska	28.94	49.56	34.65
Arizona	24.94	43.49	22.13
Arkansas	21.24	26.96	26.10
California	28.06	57.92	18.14
Colorado	26.25	44.68	17.25
Connecticut	29.16	45.83	27.05
Delaware	25.95	44.65	18.43
District of Columbia	33.87	49.72	30.19
Florida	23.04	41.38	18.53
Georgia	24.04	29.22	28.96
Hawaii	25.99	36.33	18.61
Idaho	22.09	33.52	18.28
Illinois	25.47	48.33	20.53
Indiana	23.07	33.07	18.87
Iowa	23.03	35.87	24.81
Kansas	22.60	31.61	26.04
Kentucky	22.37	29.50	29.29
Louisiana	22.00	28.69	15.45
Maine	23.18	29.91	17.68
Maryland	27.02	41.53	18.29
Massachusetts	28.82	40.87	18.27
Michigan	24.27	38.67	29.12
Minnesota	25.86	41.15	35.43
Mississippi	21.02	22.84	31.80
Missouri	23.30	31.07	18.83
Montana	22.00	33.61	29.55
Nebraska	22.42	34.40	18.50
Nevada	24.86	48.94	20.84
New Hampshire	24.95	35.96	22.28
New Jersey	27.06	60.26	17.38
New Mexico	22.66	32.58	23.64

State	Government Office Workers	Police	Probation Officers
New York	27.66	46.18	22.58
North Carolina	23.91	30.23	n/a
North Dakota	22.31	33.88	n/a
Ohio	23.91	39.86	18.34
Oklahoma	21.97	28.33	18.02
Oregon	25.11	43.44	17.21
Pennsylvania	25.06	41.09	18.96
Rhode Island	26.82	38.93	n/a
South Carolina	22.92	28.53	n/a
South Dakota	20.17	30.31	20.56
Tennessee	23.06	30.58	25.43
Texas	24.19	37.48	14.48
Utah	22.55	33.50	24.22
Vermont	24.51	32.54	25.85
Virginia	25.28	37.60	34.65
Washington	27.28	48.93	22.13
West Virginia	20.86	26.65	26.10
Wisconsin	23.87	38.32	18.14
Wyoming	23.35	36.65	17.25

SOURCE: RAND calculations based on BLS wage data (BLS, 2012).
NOTE: n/a = not available; for these states, we used the average wage of $24.22 in relevant calculations. Benefit percentage calculated from a table of employer costs for employee compensation for state and local government. BLS data were downloaded in September 2011, and benefits are 34.8 percent of state and local employer costs. This correlated with BLS series ID CMU3030000000000D and CMU3030000000000P for all workers and total benefits.

It is common for interventions to be over short periods and be funded with grant funding. As a result, many police involved in interventions are being paid overtime. The literature did not provide a percentage of time that police officers would receive overtime, so, for this model, we assume that they are making overtime 50 percent of the time. For those jurisdictions that plan to use overtime exclusively, our model will slightly underestimate costs; for those that will use existing resources, the model will slightly overestimate.

Data are shown in Table 3.1 in 2011 dollars because 2011 was the most recent BLS estimate available at the time we developed the cost estimate. Our cost model applied consumer price index inflation to all dollar values from prior years. All cost-model estimates are in 2012 dollars.

Court System

Some of the DWI-related interventions require offenders to interact with the court system.[8] This requirement means additional time of judges, court personnel, and prosecutors. To estimate

[8] In our model of red-light and speed cameras, we do not list separate prosecution costs despite the fact that this intervention is likely to lead to a small increase in some of these costs if offenders challenge their tickets.

these costs, we relied on data provided under the statutes of different states where specific requirements for court procedures are provided. In addition, we also consulted the websites of specific state court systems to understand the entire administrative process that people must follow for each specific intervention. In doing so, we searched for information on prosecution costs (including personnel involved in processing offenders and approximate time spent for an average procedure). To these, we added all administrative and court fees identified for a typical state. Because statutes and laws vary by state, we selected an average cost based on a search of several state-specific values. We applied this average cost to all states. When state decisionmakers use the tool, they may want to adjust the estimates to reflect their states' current costs, fines, and fees.

Average legal costs borne by offenders are also listed but excluded from the overall calculation of intervention costs, as explained above.

Department of Motor Vehicles

We also collected key data from DMVs in a variety of states. This information, in addition to the court information, is necessary to understand state costs for administrative procedures that are involved in implementing an intervention—namely, in-person license renewal, reinstating drivers' licenses and license plates after DWI charges.

Equipment

Equipment costs include acquisition, replacement, and maintenance costs paid by individuals and by states. In determining the costs to residents of complying with the law, we considered the cost of purchasing such items as bicycle and motorcycle helmets. In determining the costs to the state, the equipment costs may be one-time or longer-term, such as passive alcohol sensors for DWI interventions. For equipment needs for automated enforcement systems, we gathered costs of acquisition, maintenance, and replacement of equipment from published sources (N. Smith, 2012; Word, 2012; Fell, Lacey, and Voas, 2004; Greene, 2003). For automated enforcement systems, the costs include local program management that we were unable to isolate from equipment contract costs using the reports available. Therefore, those costs are included here rather than under other cost-estimating categories.

Fines and Fees

We also included estimates of related administrative fines, fees, or charges, depending on the intervention. Unfortunately, there are no standard databases to capture this detail, nor is there literature summarizing these fees, so we were unable to make fines and fees state-specific. To estimate these, we did Internet searches on such terms as *license reinstatement fee* and *helmet fines* and visited the DMV websites and statutes of multiple states to create these average costs.

Prosecution costs for these programs are included in the cost per camera because the budget data we had did not easily allow for separate accounting.

States often set fine amounts in legislation, so we do not adjust the fines over time for inflation. Because our tool does not estimate trends in offenders over time, it assumes the same number of offenders and therefore fines each year. States may want to update the assumptions to reflect their most current fines and fees when using the tool to estimate multiyear return on investment. All cost subcomponents in this category are considered revenue to the state, and we assume 100-percent collection rates.

Probation

Some of the DWI-related interventions require further supervision of offenders. Probation officers carry out this additional enforcement for these offenders. We identified literature that summarized the cost of a typical probation day, month, or year (Eisen, 2011; Officer, 2013; R. Jones, Wiliszowski, and Lacey, 1999; Tennessee Board of Probation and Parole, 2012; State of Texas Legislative Budget Board, 2013; Alemi et al., 2004) and the typical length of probation (Adams, Bostwick, and Campbell, 2011; Plimack, 2013) and applied that across the states.

We found that the average probation cost per day is around $10. People stay on probation, on average, about 20 months for DWI and substance abuse. There are cost differences for first-time and repeat offenders, but the literature was not specific enough on the percentage of the population that repeats for each intervention, nor on how the probation program changes, for that to be incorporated into this model.

Education Programs

States often require DWI offenders to undergo educational programs along with other penalties. We included a cost to the state for providing these programs, as well as revenue to the state when an offender pays a fee to attend these programs. We include education program costs where the intervention increases the number of people being arrested and or tried for DWI (saturation patrols, sobriety checkpoints, limits on diversion, plea agreements) but not for those DWI interventions that assume that the offender has already been arrested (interlocks, license impoundment, vehicle impoundment). It is likely that not all offenders will complete the education program. In California, researchers found that 81.5 percent of offenders completed DWI programs (Zhang, 2012).

Vehicle Impoundment

The vehicle impoundment intervention requires the use of towing facilities for equipment. For this cost, we looked at personnel and facility costs that would be required to support vehicle impoundment programs and scaled them to the state level, as well as the cost to the offender to recover the vehicle.

Program Management

Although the literature for interventions does not provide much insight into the cost of program management at the state level, some centralized management would be needed for these interventions to be implemented across an entire state. Though the management cost would likely be larger for some interventions than others, there is little information in the literature on which to base any assumptions. Therefore, the model has a rough estimate for program management costs based on wages plus benefits of government office workers.

Similarly, the literature does not provide information on costs associated with information technology necessary for these interventions. It is likely that some states currently have insufficient systems to support these interventions. Given the lack of evidence on cost, these costs are excluded from our model but are real considerations as states incorporate interventions.

Table 3.2 shows the ten cost components and their subcomponents, which subcomponents are associated with which interventions, and whether the cost is considered a cost to the state, a cost paid by individuals to the state, an offender-borne cost, or a cost to comply with the law.

Table 3.2. Cost Components and Subcomponents, by Intervention and Type of Cost

Cost Component and Unit	Type of Cost	Red-Light Camera	Speed Camera	Alcohol Interlock	Sobriety Checkpoint	Saturation Patrol	Bicycle Helmet	Motorcycle Helmet	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impound	In-Person License Renewal	Higher Seat Belt Fines
Publicity cost															
Print advertising, $/1,000 drivers	Cost to state	18	18	—	18	18	18	18	—	—	—	—	—	—	—
Outdoor advertising, $/1,000 drivers	Cost to state	10	10	—	10	10	10	10	—	—	—	—	—	—	—
Radio advertising, $/1,000 drivers	Cost to state	42	42	—	42	42	42	42	—	—	—	—	—	—	—
Television advertising, $/1,000 drivers	Cost to state	119	119	—	119	119	119	119	—	—	—	—	—	—	—
CIOT media campaign	Cost to state	—	—	—	—	—	—	—	—	[a]	—	—	—	—	—
Police or highway patrol time															
Police costs, full-scale sobriety checkpoint, hours/wave	Cost to state	—	—	—	40	—	—	—	—	—	—	—	—	—	—
Police costs, full-scale saturation patrol, hours/patrol	Cost to state	—	—	—	—	40	—	—	—	—	—	—	—	—	—
Police costs, camera enforcement, $/citation	Cost to state	7	7	—	—	—	—	—	—	—	—	—	—	—	—
Police costs, motorcycle helmets, $/citation	Cost to state	—	—	—	—	—	—	928	—	—	—	—	—	—	—
Police costs, seat belt enforcement, hours/citation	Cost to state	—	—	—	—	—	—	—	1.7	1.7	—	—	—	—	—
Court system															
Prosecution costs, sobriety checkpoint, $/offender	Cost to state	—	—	—	2,279	—	—	—	—	—	—	—	—	—	—
Prosecution costs, $/offender	Cost to state	—	—	—	—	2,279	—	—	—	—	—	2,279	—	—	—
Lawyer for DWI, $/offender[b]	Offender cost	—	—	—	2,571	2,571	—	—	—	—	—	2,571	—	—	—
DMV staff															
License reinstatement, hours/occurrence	Cost to state	—	—	—	0.5	0.5	—	—	—	—	—	0.5	—	—	—
License plate reinstatement, hours/occurrence	Cost to state	—	—	—	—	—	—	—	—	—	0.5	—	—	—	—

Cost Component and Unit	Type of Cost	Red-Light Camera	Speed Camera	Alcohol Interlock	Sobriety Checkpoint	Saturation Patrol	Bicycle Helmet	Motorcycle Helmet	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impound	In-Person License Renewal	Higher Seat Belt Fines
In-person licensing, $/additional driver	Cost to state	—	—	—	—	—	—	—	—	—	—	—	—	12	—
Equipment acquisition, replacement, and maintenance															
Camera lease costs, $/camera/month	Cost to state	5,868	5,868	—	—	—	—	—	—	—	—	—	—	—	—
Alcohol interlock, $/interlock	Offender cost	—	—	402	—	—	—	—	—	—	—	—	—	—	—
Police equipment, saturation patrols, $/patrol based on road network	Cost to state	—	—	—	—	100	—	—	—	—	—	—	—	—	—
Police equipment, sobriety checkpoints, $/checkpoint	Cost to state	—	—	—	5,448	—	—	—	—	—	—	—	—	—	—
Passive alcohol sensors, $/patrol	Cost to state	—	—	—	—	1,182	—	—	—	—	—	—	—	—	—
Children's bicycle helmets, $/helmet	Compliance cost	—	—	—	—	—	20	—	—	—	—	—	—	—	—
Motorcycle helmets, $/helmet	Compliance cost	—	—	—	—	—	—	100	—	—	—	—	—	—	—
Infant car seat, $/seat	Compliance cost	—	—	—	—	—	—	—	—	125	—	—	—	—	—
Children's booster seat, $/seat	Compliance cost	—	—	—	—	—	—	—	—	60	—	—	—	—	—
Fines, fees, and charges															
Motorcycle helmet fine, $/citation	State revenue	—	—	—	—	—	—	147	—	—	—	—	—	—	—
Seat belt fine, $/citation	State revenue	—	—	—	—	—	—	—	34	34	—	—	—	—	—
Child or booster seat fine, $/citation	State revenue	—	—	—	—	—	—	—	—	65	—	—	—	—	—
Driver's license reinstatement fee, DWI, $/offender	State revenue	—	—	—	204	204	—	—	—	—	—	204	—	—	—
Driver license plate fee, DWI, $/offender	State revenue	—	—	—	—	—	—	—	—	—	204	—	—	—	—
Moving violations for speed cameras, $/citation	State revenue	—	145	—	—	—	—	—	—	—	—	—	—	—	—
Moving violations for red-light cameras, $/citation	State revenue	120	—	—	—	—	—	—	—	—	—	—	—	—	—

Cost Component and Unit	Type of Cost	Red-Light Camera	Speed Camera	Alcohol Interlock	Sobriety Checkpoint	Saturation Patrol	Bicycle Helmet	Motorcycle Helmet	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impound	In-Person License Renewal	Higher Seat Belt Fines
Court fines related to DWI, $/offender	State revenue	—	—	—	2,000	2,000	—	—	—	—	—	2,000	—	—	—
Vehicle impoundment fees, $/impounded vehicle	State revenue	—	—	—	—	—	—	—	—	—	—	—	520	—	—
Higher seat belt fine, $/citation	State revenue	—	—	—	—	—	—	—	—	—	—	—	—	—	75
Probation cost															
Probation, $/probationer	Cost to state	—	—	—	2,922	2,922	—	—	—	—	—	2,922	—	—	—
Education program															
Alcohol education program, $/attendee paid by attendee	State revenue	—	—	—	294	294	—	—	—	—	—	294	—	—	—
Alcohol education program, $/attendee paid by state	Cost to state	—	—	—	254	254	—	—	—	—	—	254	—	—	—
Impoundment cost															
Tow staffing costs, $/impounded vehicle	Cost to state	—	—	—	—	—	—	—	—	—	—	—	637	—	—
Program management															
Program management, FTE/program	Cost to state	2.5	2.5	2.5	2.5	2.5	1	2.5	2.5	2.5	2.5	2.5	2.5	—	—
Total subcomponents included in cost		8	8	1	16	16	5	7	3	5	3	10	3	1	1

[a] Assumes $39 million (in 2012 dollars) across all states, allocated based on population.

[b] The cost to the offender is not included in the base model. It is provided as information to the state on the potential burden on offenders. This assumes that all offenders will use lawyers. In reality, some offenders will not use lawyers, while others will spend significantly more on representation. So this is just to provide a rough-order-of-magnitude estimate of expenditures by offenders.

NOTE: — = not applicable. FTE = full-time equivalent. All costs are annual and in 2012 dollars unless otherwise noted.

Step 2. Gather State Statistics for Scaling

To develop state-specific estimates of implementation costs for each intervention by state, we collected several statistics needed for scaling or extrapolating costs for each state. These data included population statistics, number of registered motorcycles, Federal Bureau of Investigation (FBI) DWI arrest data, and wage-related information for police forces and correctional facility personnel. We also obtained additional information on the imprisoned population by state.

FBI figures on the number of people arrested in each state for DWI are provided in Table 3.3. Several of the interventions apply only to people with DWIs. We use the information in Table 3.3 to determine the number of offenders that each DWI intervention may affect. Wage rates for government office workers (as a proxy for DMV staff) and police officers are shown in Table 3.1.

Table 3.3. Arrests for Driving While Intoxicated, by State, 2011

State	Total Arrests
Alabama	287
Alaska	4,420
Arizona	35,496
Arkansas	7,758
California	104,345
Colorado	27,314
Connecticut	8,487
Delaware	242
District of Columbia	43
Florida	43,784
Georgia	31,176
Hawaii	5,922
Idaho	9,161
Illinois	3,619
Indiana	20,043
Iowa	11,889
Kansas	11,470
Kentucky	22,973
Louisiana	6,032
Maine	5,802
Maryland	17,402
Massachusetts	9,887
Michigan	29,443
Minnesota	24,543

State	Total Arrests
Mississippi	11,251
Missouri	29,447
Montana	4,251
Nebraska	12,005
Nevada	11,834
New Hampshire	3,616
New Jersey	26,206
New Mexico	11,460
New York	35,541
North Carolina	53,700
North Dakota	4,836
Ohio	36,528
Oklahoma	14,563
Oregon	14,966
Pennsylvania	48,519
Rhode Island	2,508
South Carolina	15,674
South Dakota	5,269
Tennessee	25,559
Texas	85,715
Utah	3,184
Vermont	2,264
Virginia	28,950
Washington	11,101
West Virginia	5,356
Wisconsin	28,798
Wyoming	4,970

SOURCES: FBI, 2011a, Table 69; for Hawaii, not provided in the 2011 report, FBI, 2011b, Table 69.
NOTE: Reported by FBI as arrests for DWI. Alabama provided incomplete information that makes its numbers of arrests seem lower than they really are, but we could not find another data source.

Step 3. Review Literature for Cost Data

We reviewed multiple sources of literature to find cost data for each of the interventions. Reviews of literature included peer-reviewed publications and special reports produced by such agencies as NHTSA, the Federal Highway Administration (FHWA), and selected DMVs. We also consulted online information on private companies and service providers to determine the costs or procedures followed for the implementation of different strategies to prevent traffic-related injury. For several interventions, we directly consulted the state statutes to obtain information about laws, fines, and fees for different states. We also consulted published contractual information from selected cities to gather information on procedures for implementation, maintenance, or repair of equipment. We also looked for cost and revenue data.

For journal article searches, we used PubMed, Google Scholar, Ovid, the Cochrane Library, JSTOR, Web of Science, LexisNexis, and EBSCOhost. We also searched government websites, databases, and publications, including the U.S. Department of Labor, U.S. Census Bureau, DOT, CDC's Web-based Injury Statistics Query and Reporting System (WISQARS) database,[9] NHTSA, and the Fatality Analysis Reporting System (FARS). Additionally we searched for information on the implementation of selected interventions (e.g., red-light and speed-camera systems) from relevant organizations, such as the Insurance Institute for Highway Safety (IIHS), the American Automobile Association (AAA), and the Governors Highway Safety Association (GHSA).

Step 4. Develop Regressions for Estimates of States with Missing Data

The equipment costs for red-light and speed cameras (which we calculated in a similar manner) required the generation of regression models to estimate implementation costs. This was done, for example, because data were available at the city level and we needed to extrapolate to the state level. In addition, information is not systematically collected, and, for many states, the information is incomplete. Moreover, only a few cities provide data. In the case of red-light and speed-camera systems, we used count regression models while adjusting for key variables to predict the number of cameras within each state while also providing confidence limits for the predictions. The specific example of red-light and speed systems is explained later in this chapter, where each intervention is defined more specifically.

Step 5. Develop Mean, Minimum, and Maximum Cost Inputs

Where states have different procedures for implementing the same intervention (which is the case for most interventions), the calculation of averages helps identify what the "typical" development, implementation, or maintenance of an intervention entails. In several cases in which data varied considerably between states or between cities within a state, we generated mean estimates for the cost inputs of interventions, as well as a maximum and minimum range. The generation of these values takes into account the variability within a state (e.g., when interventions are applied differently in cities of the same state) or, in some cases, to address the differences between states due to different economic, legal, and political contexts. In other cases, particularly when the values cluster around particular values, as is the case with fines (e.g., $50, $100), the mode (i.e., the most commonly observed value) is used because it is a better measure of the typical input value.

In cases in which information is unavailable or there is little information on one state (for example, data only from one city), estimates of maximum and minimum can also contribute to

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[9] WISQARS is an interactive database system that provides customized reports of injury-related data.

the establishment of an average measure for a state. The maximum and minimum values are based on actual collected data from states and will contribute to performing sensitivity analyses at different stages of our estimations. The tool uses the mean estimates of costs inputs in calculating cost–benefit ratios and ranking and selecting interventions for implementation under a given budget.

Step 6. Develop Estimates for Each Intervention

For each intervention, we followed a systematic process aimed at gathering all possible relevant information on a specific intervention. In this step, the information gathered and generated from the prior steps (i.e., literature, state statistics, mean costs, and any other assumptions) are incorporated into the cost-estimating structure. Then the costs are fed into the tool for comparison with effectiveness. See individual interventions later in this chapter for further detail.

Intervention Cost Estimate Assumptions

The complexity of the cost estimate varies greatly depending on the intervention and data available. For each intervention, we describe our assumptions about how it would be implemented and explain how we developed the cost estimates. None of the interventions requires all ten cost components; only the components used for the calculations are described. So if the discussion of an intervention lists only equipment and program management, this means the other eight cost components are not used to calculate the costs in the tool.

For some interventions, there may be multiple levels of intervention, rather than a simple yes/no. Although we are able to estimate the costs associated with different levels of implementation, we do not have any evidence to determine what the effect of a scaled-down version of the implementation would be. As such, we use one cost estimate that is associated with full implementation of the intervention. Details on where we use this assumption are included in the description of each intervention below.

For some interventions, we developed a modal, or "most common cost," as opposed to a mean cost input. A mean cost would require knowing all state costs and averaging them, but, for most interventions, cost data availability was restricted to only a few states. Therefore, if there was an obvious modal cost, we used that, but, if there was a range of costs, we took the mean of the observations we had. As noted above, modal costs were most often used for such inputs as fines, for which lawmakers select values around focal points, such as $50 and $100. We also used modal costs where one state appeared to be an outlier with either very low or very high costs. Because this model is intended to inform states that do not currently have a particular intervention implemented, it was prudent to select costs that represent a typical intervention.

For all interventions, we made an assumption about the expected program cost at the state level for staff to oversee or implement the program; these assumptions are documented for each intervention. We were unable to obtain detailed information on other overhead-related costs of such program offices.

For each intervention, we first estimate the cost component or subcomponent by various natural units, e.g., publicity cost via television to reach 1,000 viewers, cost of police time per citation, cost of DMV staff time per person assisted, seat belt fine per offense, and lease cost of a red-light camera system per year. Then, we translate these unit costs into annual costs for a given state. The annual cost estimates are constructed to reflect the annual costs in each of the next five years. One-time costs (e.g., equipment purchase) are spread over this five-year period, so the full equipment costs are not borne in any particular year. In the next chapter, where we estimate the effectiveness in reducing injuries and deaths for each intervention, we also express the monetized benefits from effectiveness in a per-year basis for a given state so that both costs and monetized benefits are measured comparably. Moreover, when it comes to police and other labor costs, the tool assumes 50-percent overtime pay. However, a tool user can add or subtract overtime costs in a sensitivity analysis.

All costs detailed under “fines and fees” are considered revenue to the state because they are paid by individuals to public agencies, and we assume 100-percent collection by the state. Therefore, this estimate is an upper bound on potential state income. All other costs are used by the tool to calculate direct costs to the state, unless otherwise specified.

Tables 3.4 through 3.11 summarize the cost components and subcomponents, units, and assumptions for related groups of interventions. For interventions for which they are used, publicity and program management costs remain the same regardless of the intensity of the intervention or the number of offenders cited. All other costs are calculated on some basis related to intensity (e.g., number of speed cameras) or offenders arrested. The references for the costs are provided in the subsequent section.

Table 3.4. Red-Light and Speed Cameras: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Publicity	Advertising (various channels)	$18 per 1,000 drivers in print, $10 per 1,000 drivers with outdoor, $42 per 1,000 drivers by radio, $119 per 1,000 drivers for television	Number of drivers in state
Police	Police costs, camera violations	$7 per citation	Number of citations
Equipment	Camera lease costs	$5,868 per camera per month	Estimated number of cameras from count regression model
Fine	Moving violations for red-light cameras	$120 per citation	Assume 1,382 citations per camera per year
Fine	Moving violations for speed cameras	$145 per citation	Assume 4,056.6 citations per camera per year
Program management	Program management, state level	2.5 FTE staff per state (per program)	Government wage rates in state, as shown in Table 3.3, converted to 2012 dollars

Table 3.5. Saturation Patrols and Sobriety Checkpoints: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Publicity	Advertising (various channels)	$18 per 1,000 drivers in print, $10 per 1,000 drivers with outdoor, $42 per 1,000 drivers by radio, $119 per 1,000 drivers for television	Number of drivers in state
Police	Police costs, full-scale sobriety checkpoint	40 hours per checkpoint	Assume one checkpoint per 12,500 population per year
Police	Police costs, full-scale saturation patrol	40 hours per patrol	Assume one patrol per 0.00188 miles of road network per year
Court	Prosecution costs, saturation patrols	$2,279 per offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Court	Prosecution costs, sobriety checkpoint	$2,279 per offender[a]	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Court	Lawyer for DWI	$1,363 per DWI offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
DMV staff	License reinstatement	0.5 staff-hours per DWI offender	Government wage rates in state, as shown in Table 3.1, converted to 2012 dollars
Equipment	Police equipment for saturation patrols	$100 per local government	Number of patrols
Equipment	Police equipment for sobriety checkpoints	$5,448 per local government	Number of patrols
Equipment	Passive alcohol sensors	$1,182 per local government (for one or both programs)[b]	Number of patrols
Fine	Driver's license reinstatement fee, $/offense	$204 per DWI offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Fine	Court fines: saturation patrol	$2,000 per DWI offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Probation	Probation, $/probationer	$2,922 per DWI offender, adjusted by state wage rate	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Education	Alcohol education program, $/attendee paid by attendee	$294 per DWI offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Education	Alcohol education program, $/attendee paid by state	$254 per DWI offender	Assume 9.64 offenders arrested per patrol or one offender arrested per checkpoint
Program management	Program management, state level	2.5 FTE staff per state (per program)	Government wage rates in state, as shown in Table 3.1, converted to 2012 dollars

[a] For sobriety checkpoints, the cost estimates in the existing literature included the prosecution costs per checkpoint. For saturation patrols, the data were not similarly calculated, but, for consistency across interventions, we have used the same cost for both.

[b] We assume that this cost is the same regardless of whether the state implements one or both programs.

Table 3.6. Motorcycle and Bicycle Helmet Laws: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Publicity	Advertising (various channels)	$18 per 1,000 drivers or children in print, $10 per 1,000 drivers or children with outdoor, $42 per 1,000 drivers or children by radio, $119 per 1,000 drivers or children for television	Number of drivers in state as a proxy for motorcyclists and number of children as a proxy for number of children who bicycle
Police	Police costs to process motorcycle helmet violations	$928 per citation	Assume that, for every 10,000 registered motorcycles in state, 35 citations are issued
Fine	Motorcycle helmet fine	$147 per citation	Assume that, for every 10,000 registered motorcycles in state, 35 citations are issued
Program management	Program management, state level	For motorcycle helmet law, 2.5 FTE staff per state; for bicycle helmet law, 1 FTE	Government wage rates in state, as shown in Table 3.1, converted to 2012 dollars

NOTE: Because we did not identify any agencies that spend significant police time on enforcement or collect any fines for violating bicycle helmet laws, we did not include police time or fines here.

Table 3.7. Primary Enforcement of Seat Belt Laws and Seat Belt Enforcement Campaigns: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Publicity	CIOT media campaign	Not applicable	Assume national costs of $39 million, allocated by state population

NOTE: This is the one set of interventions for which the tool adjusts cost downward if both interventions are implemented. For details, see the discussion under “High-Visibility Enforcement for Seat Belts and Child Restraint Laws” later in this chapter.

Table 3.8. Alcohol Interlocks and License Plate and Vehicle Impoundment: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
DMV staff	License reinstatement	0.5 staff-hours per DWI offender	License plate impoundment: 88% of state's DWI offenders (assumed conviction rate), as shown in Table 3.3 Vehicle impoundment: All DWI offenders in state, as shown in Table 3.3
Equipment	Alcohol interlock	$402 per DWI offender	88% of state's DWI offenders (assumed conviction rate), as shown in Table 3.3
Fine	Driver's license reinstatement fee	$204 per DWI offender	License plate impoundment: 88% of state's DWI offenders (assumed conviction rate) Vehicle impoundment: All DWI offenders in state
Fine	Vehicle impoundment fee	$520 per DWI offender	All DWI offenders in state
Impoundment	Tow staffing costs	$637 per DWI offender	All DWI offenders in state
Program management	Program management, state level	2.5 FTE staff per state (per program)	Government wage rates in state, as shown in Table 3.1, converted to 2012 dollars

NOTE: No DMV staff, fines, or impoundment for alcohol interlocks.

Table 3.9. Limits on Diversion and Plea Agreements: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Court	Prosecution costs	$2,279 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Court	Lawyer for DWI, $/occurrence	$2,571 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
DMV staff	License reinstatement, hours/occurrence	0.5 staff-hours per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Fine	Driver's license reinstatement fee, $/offense	$204 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Fine	Court-related fines for DWI	$2,000 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Probation	Probation, $/probationer	$2,922 per DWI offender, adjusted by state wage rate	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Education	Alcohol education program, $/attendee paid by attendee	$294 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Education	Alcohol education program, $/attendee paid by state	$254 per DWI offender	Applies to 12% of a state's DWI offenders who are not convicted of a DWI offense
Program management	Program management, state level	2.5 FTE staff per state (per program)	Government wage rates in state, as shown in Table 3.1, converted to 2012 dollars

Table 3.10. In-Person License Renewal: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
DMV staff	Increased license administration	$12.20 per additional in-person renewal that was previously renewed by mail or online	Assume that drivers over 70 years old are required to renew in person every four years. In states with antidiscrimination statutes, apply this assumption to all drivers.

Table 3.11. Higher Seat Belt Fine: Cost Assumptions and Calculations

Cost Component	Subcomponent	Cost or Staff Time per Unit	Underlying Assumptions and Statistics
Fine	Higher seat belt fine	$75/citation	81 citations per 10,000 population per year (assume that the underlying fine remains the same)

Red-Light and Speed-Camera Interventions

Implementation Assumptions

The overall process for implementing both of these interventions includes setting up equipment; developing procedures for obtaining photographic evidence of violators with specific date, time, and vehicle information (time-stamped license plate photograph); and establishing mechanisms for arbitration or payment of fines.[10]

Although the intervention modeled has cameras distributed across local governments in a particular state, it is unlikely that cameras will be cost-effective in low-traffic or rural areas.

Cost Calculations

Several key components are required to implement red-light camera systems. According to FHWA, undated, and the National Campaign to Stop Red Light Running, 2007, the key components are as follows.

Publicity

According to FHWA, undated, education is very important to (1) deter aggressive driving behaviors; (2) gain public support for red-light camera program; (3) communicate how the system works so the motorists are not surprised or confused when they receive a ticket. For our estimate, we assume that there will be a multipronged media approach using print, billboards, radio, and television because existing effectiveness research indicated inclusion of publicity. We used published sources to estimate how to distribute the media buy among various media channels (Solomon, Gilbert, et al., 2007). We anticipate state-to-state and city-to-city variation in media costs but were unable to find literature to estimate these costs. The target audience is licensed drivers in cities of each state. We use the number of licensed drivers provided in *State Transportation Statistics 2010* (Research and Innovative Technology Administration, 2011) to inform the model. This includes creation of the media in the campaign, as well as paying advertising providers. We assume that it is impossible and cost-prohibitive to reach the entire licensed-driver population through the media campaign. The CIOT campaign had success at reaching its target audience, so we based the percentage of the population targeted on their spending. We therefore expect states to purchase enough print media, billboards, radio, and television.

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[10] "A typical [automated red-light camera enforcement] Camera system is made up of multiple cameras, a computer, and triggering mechanisms known as magnetic loops. The technology is intended to photograph events involving vehicles that have entered an intersection after the signal has turned red. Vehicles entering an intersection on a yellow light and still in the intersection when the light changes to red are not photographed" (Orange County Grand Jury, 2004).

Police or Highway Patrol Time

There is a police cost associated with processing each citation that is sent to an offender. We assume that this is $7 per citation, based on a study in Scottsdale (Shin, Washington, and van Schalkwyk, 2009). This is extremely low because most offenders choose to pay their tickets rather than challenging them. Because it is low, we did not adjust on the basis of a state's police wages.

Equipment

Costs are 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 (FHWA and NHTSA, 2008). Early-adopter jurisdictions with red-light cameras would purchase and install their own cameras (Maccubbin, Staples, and Salwin, 2001). However, most jurisdictions contract with private vendors to install and maintain the cameras and use a substantial portion of the income from red-light citations to cover program costs. From information from different states for cities adopting between 2006 and 2012, we find that all costs per camera (labor and equipment) associated with the installation vary between $138,000 and $150,000. A contractor usually absorbs the capital investment. The operation and maintenance of the red-light and speed-camera systems are the responsibility of the local jurisdiction or system contractor. For our model, we assume that the contractor absorbs the acquisition, installation, operation, and maintenance of the equipment, and the city pays a flat fee per month.[11] As a result, the contractors usually cover all tasks needed from the beginning: the site design and installation of complete camera systems, complete citation processing (including the ability to run registration checks on license plates), training of key city employees and adjudication personnel, expert-witness testimony in court, local customer service and maintenance, collection processing, and provision of information to offenders. See Table 3.12 for a summary of all-in-one contract service costs; using this information, we calculated a most common cost of $5,868 per month per camera.

Fines and Fees

Cost is calculated as dollars per violation.[12] These costs are based on state-by-state legislation as defined in state statutes. We calculated minimum, most common, and maximum values of $40, $145, and $300, respectively, for speeding violations. We calculated minimum, most

[11] The steps described in this paragraph are based on data obtained from multiple cities on costs of equipment, management of equipment, and flow of information on red-light or speed violations.

[12] The amount of a fine usually does not change annually, so they are not adjusted for inflation.

common, and maximum values of $50, $120, and $446, respectively for red-light violations (IIHS, 2014b).[13] These costs are included in the tool as revenue to the state.

Program Management

Costs are calculated as staff costs per year. We assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees. City-level personnel costs associated with citation processing are included in the above per-camera costs.

Table 3.12. Selected All-in-One Red-Light and Speed-Camera System Costs

Location	Monthly Cost per Camera System, converted to 2012 Dollars	Year of Original Cost	Source
Menlo Park, Calif.	7,273	FY 2006	City of Menlo Park, 2006
Scottsdale, Ariz.	6,680	FY 2011–2012	Scottsdale City Council, 2011
San Diego, Calif.	5,193	FY 2007	PB Farradyne, 2002
Orange County, Calif.	5,929–7,115	FY 2004–2005	Orange County Grand Jury, 2004
Longview, Wash.	4,520–5,052	FY 2010	"Longview Council Chooses Red-Light Camera Contractor," 2010
Washington, D.C.	1,458	FY 2012	N. Smith, 2012
Jacksonville, Fla.	3,999	FY 2012	Word, 2012

NOTE: FY = fiscal year. The D.C. implementation rate is very high, which probably explains the lower per-camera system cost.

Number of Offenders

Informed by experience from Montgomery County, Maryland (Montgomery County Department of Police, undated [a], undated [b]), we assume that each red-light camera issues 1,382 citations per year. Informed by experience from Scottsdale, Arizona, we assume that each speed-camera issues 4,056.6 citations per year (Retting, Kyrychenko, and McCartt, 2008; Shin, Washington, and van Schalkwyk, 2009).

State Extrapolations

In some cases, red-light and speed cameras are used simultaneously. However, most red-light cameras and speed cameras are separate systems; one camera does not enforce both violations because most speeding violations occur in locations with fewer regular stops. Therefore, all the

[13] Although the minimum and maximum amounts suggest that red-light camera fines should be higher, our calculations of the distribution of fines in the states that currently use such systems find that the most common speeding fine is higher than the most common red-light violation fine.

unit component costs are calculated independently. Costs are based on equipment choices, operational and administrative characteristics of the program, and arrangements with contractors.

The above data provide useful estimates for each city-based system. However, because this tool is meant for state-level decisionmaking, single-city estimates must be extrapolated to the state level. Although whether to use cameras is typically a city-level decision, it is possible for a state to select cameras as a statewide strategy. That said, having cameras at every intersection is not a viable option. Cameras do not make sense in low-traffic rural conditions. For the extrapolation, we used negative binomial count regression models based on state characteristics to predict the number of cameras that a state would have at different levels of adoption of a program. As part of the model development and selection, we considered different options (including a Poisson regression) and selected the model with the best fit. Still, the model predicts the number of cameras for some states better than for others. Moreover, actual implementations at the state level will require specific engineering studies of traffic patterns.

Use of Regression Models to Predict Numbers of Cameras by State

National-level information on red-light and speed-camera systems is not systematically collected. Only two large entities collect some information on the availability of these systems. IIHS has data on the cities that have such systems in place (IIHS, 2014b). A private company called PhotoEnforced.com that collects crowd-sourced data has specific information on the locations of red-light and speed-camera systems throughout the nation. Clients of this private source include some government institutions. Using data from both sources, we identified the cities with red-light and speed-camera systems and calculated the total number of existing cameras.

Because data exist only for cities, we needed to extrapolate the data for use at the state level. Although we tested a variety of indicators, such as state population, length in miles of the road network, and number of local governments, the final model uses state population and road network in miles within the state as explanatory variables in a count regression model that predicts the number of cameras that a state would use.[14] In actual implementations, decisionmakers would probably select areas that studies identified with sufficient traffic or red-light running behavior to have impact, but, at the state level, these data are not easily available and therefore are not included in the simplified regression model. Given the reliance on road network, in such states as Delaware and Hawaii, as well as the District of Columbia, very low numbers of cameras are predicted. In the case of District of Columbia, there are already many more cameras in use than the model would predict. Any model we could have selected would underestimate or overestimate cameras for some states.

[14] The model predicts that some states would have partial cameras. Because this is a rough order of magnitude for each state's investment, we did not round to the nearest integer.

Alcohol Interlocks

Implementation Assumptions

In this intervention, an offender is required to install an alcohol interlock on his or her vehicle in order to drive legally. An interlock prevents the vehicle's ignition from being started unless the device detects a BAC below the preset threshold, often 0.02 BAC. We assume that, for some period of time after being arrested, the offender is not allowed to drive at all. Upon reinstatement of his or her license, the offender must use the interlocks on average for 3.4 months (IIHS, 2011b).[15] Ignition interlocks have two potential levels of use: for all convicted offenders or only for repeat offenders. The tool applies this intervention to all convicted offenders. No costs are assumed beyond equipment and program management because the costs of processing these offenders through court are assumed to be already paid (that is, adding the alcohol interlock intervention does not result in apprehending additional offenders or in additional costs to process offenders beyond this sanction). The costs do not include publicity because the literature did not suggest that this was included in the typical intervention.

Cost Calculations

Equipment

Cost is per offender per year. According to our research, the cost is paid by the offender to an interlock provider rather than to the state. The cost per month ranges from $265 to $638, and we use $402 as the most common cost. This cost may or may not include fees for installation and deinstallation. Generally, the offender contracts individually for this service unless the state has placed limits on equipment costs. The cost of obtaining the interlock is paid by the offender but does not generate revenue for the state, so it is included in the tool only as an offender-borne cost.

Program Management

Cost is per year. We assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

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[15] This average is based on laws as of 2011 according to IIHS on administrative license suspension and how many months of time on average driving privileges are restored during the license suspension. For those drivers with repeat offenses, it is likely that states would want a longer period of interlock, ranging between six months and a year. This would increase the cost to offenders but should have limited impact on the cost of the program unless the state has instituted substantial data reporting and analysis.

Fines and Fees

Some states are requiring offenders to pay fees of $20 to $30 per month to the state, but this was not a characteristic of the majority of the programs we considered, so this cost is set at $0 in our model. States may want to consider a fine or fee to help with program sustainability.

Number of Offenders

We estimated the number of offenders based on FBI statistics (FBI, 2011a) from each state on DWI arrests. Informed by R. Jones, Wiliszowski, and Lacey, 1999, we assumed that 88 percent of DWI arrestees were convicted. Many states choose to apply interlocks to only a small portion of offenders. For the model, the cost assumptions need to align with the effectiveness determination. The model is unable to predict which offenders will be repeat offenders, so this assumes that all offenders are included in the intervention. Therefore, this implementation cost and its associated effects may appear larger than the actual costs to most states with existing implementation.

Sobriety Checkpoints

Implementation Assumptions

Sobriety checkpoints require police officers to conduct them, as well as publicity campaigns to inform the public. The goal is to discourage drivers from drinking, particularly during times when drunk driving is more common than usual (such as holidays).

Cost Calculations

Publicity

This intervention assumes that there will be a major publicity campaign to advertise the sobriety checkpoints, using the same cost estimates as for automated enforcement. Under our assumptions, this publicity push will involve print, billboards, radio, and television advertising because existing effectiveness research indicated inclusion of publicity. Costs of advertising are typically per 1,000 viewers. Most programs cannot reach all of their target audiences because of costs. Therefore, the costs are scaled by state using specific percentages of licensed drivers targeted, based on the success of this mix of media for the CIOT campaigns. This amounts to reaching 5 percent of the target audience via print, 3 percent via outdoor media, 16 percent via radio, and 44 percent via television.

Police or Highway Patrol Time

The number of checkpoints is a function of the population size of the state. We looked at several states' checkpoint numbers and determined that a reasonable number of checkpoints to conduct annually is 0.008 percent of the population. Police time costs can be for full-scale sobriety checkpoints or pared-down sobriety checkpoints. A full-scale sobriety checkpoint typically has ten to 12 police officers for four to five hours, so, for our estimates, we assumed that a full-scale checkpoint would involve ten officers for four hours. We could find less evidence for small-scale checkpoints and therefore assumed that the most common version of the interventions is full scale.

Court

We assume that some court system time is needed to process citations issued during sobriety checkpoints. For sobriety checkpoints specifically, we used data on prosecution costs based on research by the Children's Safety Network, 2005. These prosecution costs of $1,883 were per checkpoint rather than per offender. We also assume there are offender-borne costs (which are not included in the tool) for legal defense. Our research found that this can cost anywhere from $500 to $26,000 (see Office of the Illinois Secretary of State, 2013; Bloch, 2013; and NuStats, 2006), with the most common cost calculated at $2,571.

Department of Motor Vehicles

We assumed a half-hour of a DMV employee's time for license reinstatement.

Equipment

Cost is annual based on the number of checkpoints in the state, which is based on population size. We assume that, on average, five checkpoints share the same equipment, but the reality depends on the number of police department and districts that will carry out the intervention. Although actual equipment lasts for five years or longer, we developed an annualized rate of $5,448 for major equipment (Children's Safety Network, 2005).[16]

Fines and Fees

Offenders pay license reinstatement fees and court fines. We used data from Cass County, Missouri, DWI courts, which charged $2,000 in court fines. Information from other cities, counties, and states supported this figure: Rio Honda, California (MacDonald et al., 2007); Texas ("Texas DWI Penalties, Fines and Sentencing," undated); Multnomah County, Oregon (Finigan, Carey, and Cox, 2007). We found a range of driver's license reinstatement fees posted online between $30 and $704 in a sample of eight states[17] and calculated a most common cost of $204.

Probation

For those offenders who are put on probation, the state assumes the cost of their monitoring. This costs anywhere between $1,127 and $8,610, with $2,922 per DWI or substance abuse offender being most common (Alemi et al., 2004; Adams, Bostwick, and Campbell, 2011; R. Jones, Wiliszowski, and Lacey, 1999; Tennessee Board of Probation and Parole, 2012;

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[16] Based on Children's Safety Network's estimate of $23,000 in equipment adjusted for inflation.

[17] California, Colorado, Illinois, Louisiana, Maine, Nevada, Pennsylvania, and Rhode Island.

Officer, 2013; Plimack, 2013). Probation costs do depend on whether the offender is a first-time offender or a repeat offender. Unfortunately, the data on sobriety checkpoints did not provide insight on what percentage of these were of each type, nor did we have consistent data on probation cost differences specific to DWI, so the model relies on averages that are adjusted by the average salary of probation officers in each state based on information from BLS (see Table 3.1).

Education

DWI offenders are often required to enroll in educational programs. The cost to the state to provide an alcohol education program is $254 per offender. The cost to the offender is $294 (Office of Substance Abuse and Mental Health Services Driver Education and Evaluation Programs, 2014), which the model assumes constitutes revenue to the state. If a state selects a contractor to provide this education, it would not be a source of revenue, but it also would not be a source of cost. Only about 81.5 percent of offenders are assumed to complete the required program (Zhang, 2012).

Program Management

Cost is per year. We assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

Number of Offenders

The number of offenders caught per checkpoint depends on location. Fairfax County, Virginia, had about 2.6 arrests per checkpoint, though others seem to be lower, at around one per checkpoint (Bowman and Stemler, 2005). We assumed one per checkpoint for license reinstatement, lawyers, and alcohol education. For probation calculations, we assumed that only 88 percent would be convicted, so 0.88 people per checkpoint would have probation costs (R. Jones, Wiliszowski, and Lacey, 1999).

Saturation Patrols

Implementation Assumptions

Saturation patrols are used in most states, particularly those where sobriety checkpoints are not allowed, but states can use both interventions simultaneously. Police select locations and patrol those enforcement areas looking for suspicious driving behavior. One instance of this increased presence is considered a saturation patrol wave. There are limited data on the right number of waves to use for enforcement, but we developed an average number of patrols based on the state's road network in miles to apply to each state of 0.00188.[18]

Cost Calculations

Publicity

This intervention assumes that there will be a major publicity campaign to advertise the saturation patrols because existing effectiveness research indicates inclusion of publicity. This publicity will involve print, outdoor, radio, and television advertising that is priced per 1,000 viewers. The program will not be able to reach all of its target audience, so the publicity targets a sample of drivers. The costs are scaled by state using specific percentages of licensed drivers to reach via print (5 percent) outdoor (3 percent), radio (16 percent), and television (44 percent).

Police or Highway Patrol Time

Police time costs can be for large or small saturation patrols. Informed by implementation of sobriety checkpoints, we assumed that a large-scale patrol would involve ten officers for four hours. We could find less evidence for small-scale patrols and therefore assumed that the most common version of the intervention is full scale.

Court

We assume that some court system time is needed to process citations issued during saturation patrols. We created an estimate of $2,279 per offender based on information from three states: New York (Waller et al., 2013), Washington (Aos et al., 2011a, 2011b), and Oregon (Finigan, Carey, and Cox, 2007). We also assume that there are offender-borne costs (which are not included in the tool) for legal defense. Our research found that this can cost anywhere from $500 to $26,000 (see Office of the Illinois Secretary of State, 2013; Bloch, 2013; and NuStats, 2006), with the most common cost calculated at $2,571.

Department of Motor Vehicles

We assumed a half-hour of a DMV employee's time for license reinstatement.

Equipment

We used the cost of a commercially available passive alcohol sensor (PAS),[19] $695, as a starting point. For the implementation, we assume that the same equipment will be used for, on

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[18] This number was based on several states' reporting of how many saturation patrols they had per year, which we plotted against the lengths of their respective road networks. This showed correlation, so we used the average number of patrols per mile in the road network in the model. We considered population, licensed drivers, number of jurisdictions and other factors but concluded that this was the most relevant factor on which to base these estimates.

[19] The PAS IV, the Sniffer LE, is advertised online at $695.

average, five patrol waves per year. We assume that a police department purchases 12 PASs, for an annualized cost of $1,668. We assume an average of $1,182 per year. Additional police equipment is per wave at a minimal cost of about $100 per wave.

Fines and Fees

Offenders pay license reinstatement fees and court fines. We used data from Cass County, Missouri, DWI courts, which charged $2,000 in court fines. Information from other cities, counties, and states supported this figure: Rio Honda, California (MacDonald et al., 2007); Texas ("Texas DWI Penalties, Fines and Sentencing," undated); Multnomah County, Oregon (Finigan, Carey, and Cox, 2007). We found a range of driver's license reinstatement fees posted online between $30 and $704 in a sample of eight states[20] and calculated a most common cost of $204.

Probation

For those offenders who are put on probation, the state assumes the cost of their monitoring. This costs anywhere between $1,127 and $8,610, with $2,922 per DWI or substance abuse offender being most common (Alemi et al., 2004; Adams, Bostwick, and Campbell, 2011; R. Jones, Wiliszowski, and Lacey, 1999; Tennessee Board of Probation and Parole, 2012; Officer, 2013; and Plimack, 2013). Probation costs do depend on whether the offender is a first-time offender or a repeat offender. Unfortunately, the data on saturation patrols did not provide insight on what percentage of these were of each type, nor did we have consistent data on probation cost differences specific to DWI, so the model relies on averages that are adjusted by the average salary of probation officers in each state based on information from BLS (see Table 3.1).

Education

DWI offenders are often required to enroll in educational programs. The cost to the state to provide an alcohol education program is $254 per offender. The cost to the offender is $294 (Office of Substance Abuse and Mental Health Services Driver Education and Evaluation Programs, 2014), which we assume constitutes revenue to the state. If a state selects a contractor to provide this education, it would not be a source of revenue, but it also would not be a source of cost. Only about 81.5 percent of offenders are assumed to complete the required program (Zhang, 2012).

Program Management

Cost is per year. We assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

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[20] California, Colorado, Illinois, Louisiana, Maine, Nevada, Pennsylvania, and Rhode Island.

Number of Offenders

Arrest rates for saturation patrols vary between 6.79 and 9.64 per patrol (Century Council, 2008). We used the higher figure of 9.64 arrests per patrol rather than a median or average between the two because we are concerned that the many cost components and subcomponents derived from or pertaining to this high and low estimate might not be linear. For probation calculations, we assumed that only 88 percent would be convicted, so 0.88 people per checkpoint would have probation costs (R. Jones, Wiliszowski, and Lacey, 1999).

Bicycle Helmet Laws for Children

Implementation Assumptions

Bicycle helmet laws are typically enforced at city levels and more frequently in areas with children, such as residential neighborhoods and near schools. Although some municipalities provide free or reduced-cost helmets, we did not assume that this would be a part of the base program. In many communities, hospitals and volunteers give coupons or gift certificates to children seen wearing helmets. These community programs focus on encouraging participation rather than punishment, but most of those programs are not paid for by the state.

Cost Calculations

Publicity

The effective helmet law on which we modeled this intervention was supported with communications and outreach to parents, children, schools, pediatric health care providers, and law enforcement. We assume that there will be a combined approach of print, outdoor, radio, and television media because existing effectiveness research indicates inclusion of publicity. We used Solomon, Gilbert, et al., 2007, to estimate the combination of media types and the percentage of spending across media types. Solomon et al. did not provide data in terms of the common advertising metric cost per 1,000, so we divided costs by population at the time. Then we used cost per person for each state. Information on the number of parents with children who ride bicycles is unavailable, so we sized the typical media campaign to reach an audience size based on the number of children in the particular state. For this effort, states may choose targeted campaigns through schools rather than television, billboard, and radio advertising, which would reduce the publicity cost by up to 90 percent. Regardless of the method of advertising, it is impractical to reach 100 percent of a target audience, but it is important to reach some of the target audience more than once so they will remember the message. The CIOT campaign evaluations indicated that the program reached members of its target audience multiple times. We based the percentage of the population targeted on the program's spending.

Equipment

Helmets that meet safety requirements can be purchased for under $20; our research on Amazon.com and other commercial outlets showed helmets ranging from $16 to $50. We used $20 as the mean cost.

Program Management

Cost is per state per year. We assume that one state staff person would be involved in marketing, contracting, and managing the program within the state. Several states have bicycling coordinators, and this task is part of their duties. In interviews, we determined that this is a small portion of one employee's duties, so we have assumed that a single FTE could handle this program. The costs of the staff are calculated using state-specific BLS wages of state office employees.

The model does not include any police costs or fines. There is little evidence that police departments spend time specifically enforcing bicycle helmet laws, so we assumed that this cost is effectively zero. Similarly, although several cities and states have small fines in place, many are only for repeat offenders, and there is no evidence that this is a measurable source of revenue for any state (Rosenthal, 2013; Harshfield, 2013). Many states have no fine for offenders, and the maximum fine we have observed is $25. So we assume that the income to the state of fines is zero for this purpose. This is the only one of the 12 interventions with no fines paid by offenders.

Number of Offenders

This is unknown because there are no good studies on how many children are fined or ticketed for not wearing helmets. Therefore, in the model, we assume that zero offenders are caught and that this intervention therefore provides a negligible source of income to the states.

Motorcycle Helmet Laws

Implementation Assumptions

A helmet law requires all motorcycle riders to wear DOT-approved helmets. If a motorcyclist is caught without an approved helmet, police can issue a ticket.

Cost Calculations

Publicity

Helmet laws are often supported with appropriate communications and outreach to riders and enforcement organizations. We assume that there will be a combined approach of print, billboard, radio, and television media. We used Solomon, Gilbert, et al., 2007, to estimate the combination of media types and the percentage of spending across media types. We sized the typical media campaign to reach out to an audience size based on the number of licensed drivers in a particular state. It is possible that a state will select a more targeted campaign to riding clubs and recreational areas. This will likely cost less than the assumptions included in our model. Regardless of the method of advertising, it is impractical to reach 100 percent of a target audience, but it is important to reach some of the target audience more than once so they will remember the message. The CIOT campaign evaluations indicated that the program reached members of its target audience multiple times. So we based the percentage of the population targeted on their spending.

Police and Highway Patrol Costs and Time

Police costs are based on the time to write the citation and the time to appear in court. Informed by experience in Nebraska, we developed a figure of $928 per citation (C. Potts, 2013).

Equipment

We scaled the amount that individuals will pay for equipment according to the number of registered motorcycles as a proxy for motorcycle drivers. Helmet costs range from $25 to $200. For our purposes, we assume that the average rider will purchase a $100 helmet.

Fines and Fees

Helmet fines can range from $50 to $500, depending on the state statutes. We use $147 as a typical fine assumption for the model.

Program Management

Cost is per state per year. In addition, we assume that a small number of state personnel (about 2.5) would be involved in managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

Number of Offenders

We scaled the number of offenders based on the number of motorcycle registrations in the state. We assume that 55 percent of people will wear helmets when there is no law and 96 percent when there is a law. Of the 4 percent who still do not wear helmets, we assume that 8.7 percent of them will be caught in a given year and ticketed. This assumption is based on documented experiences in Omaha, Nebraska (Withrow, 2012).

Primary Enforcement of Seat Belt Laws

Implementation Assumptions

Under primary enforcement, we assume increased police time given that an offender can be ticketed for not wearing a seat belt.

We also assume that implementing this intervention in conjunction with high-visibility enforcement (described in the next section) costs somewhat less than implementing each intervention individually. See the high-visibility enforcement cost calculations for a description.

Cost Calculations

Police

Police time is based on the typical number of seat belt citations written. Each seat belt citation written takes 1.7 hours of police time, according to a 2007 CIOT study (Solomon, Preusser, et al., 2009).

Fines and Fees

Seat belt fines range between $10 and $200; we estimate a most common fine at $34.

Program Management

Cost is per state per year. In addition, we assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

Number of Offenders

Some of the offenders would be ticketed during seat belt enforcement campaign periods, while others would be during normal enforcement periods. In high-visibility campaigns in states with primary enforcement of seat belt laws, studies have found 24 seat belt citations per 10,000 inhabitants (Solomon, Preusser, et al., 2009). Seat belt fines in months without high-visibility enforcement are 2.5 times less, so we assume ten seat belt citations per 10,000 inhabitants.

High-Visibility Enforcement for Seat Belts and Child Restraint Laws

Implementation Assumptions

High-visibility enforcement combines intense enforcement over a fixed period with a publicity campaign, so we assume costs for both police time, as well as publicity. A state with a primary enforcement seat belt law will generally see higher ticketing rates than states with secondary enforcement. CIOT is the national umbrella campaign, and most states participate in this already. Some have additional seat belt enforcement campaign periods as well. We assume that such campaigns are targeted at both adult and child restraint use, as opposed to conducting separate campaigns.

Cost Calculations

Publicity

We based these costs on historical costs for CIOT media campaigns that used print, television, and radio advertising. In 2005, $33 million was spent on one such campaign (Solomon, Gilbert, et al., 2007). We adjusted this for inflation to a little over $39 million in 2012 dollars and spread it across the states according to population. Currently, states spend two-thirds of the money in the campaign, but it is unevenly applied. If states wanted to implement their own successful campaigns, then we would expect spending in the range given in the model.

Police or Highway Patrol Time

Police time is based on the typical number of seat belt citations. Each seat belt citation takes 1.7 hours of police time according to a 2007 CIOT study (Solomon, Preusser, et al., 2009).

Equipment

Costs are for car seats and booster seats. In general, infant car seats range between $70 and $180, with a most common cost of $125. Booster seats typically range between $20 and $100, with a most common cost of $60 (Children's Safety Network and Pacific Institute for Research and Evaluation, 2012; commercial searches for child safety seats and infant car seats).

Fines and Fees

Two types of fines can be paid under this intervention. Seat belt fines for adults range between $10 and $200, with the most common fine being $34. Child restraint fines range between $10 and 500, with $65 being the most common amount (IIHS, 2014d).

Program Management

Cost is per year. We assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees.

If a state implements both primary enforcement of seat belt laws and a high-visibility enforcement campaign, we assume that the costs are somewhat reduced from the cost of each individual intervention. Three cost components are reduced: police time, fines, and program management. For police time and seat belt fines, we assume that each seat belt citation requires 1.7 hours of police time and that one $34 fine is paid per adult seat belt citation. In implementing the two interventions together, we added each set of costs together (that is, the police time costs for primary enforcement of the seat belt law and the police time costs for high-visibility enforcement) and recalculated the impact with high-visibility enforcement at the rate of primary enforcement of seat belt laws during the enforcement wave and without high-visibility enforcement the rest of the year. The net effect is 95 percent of the total police costs and fines of those with the two efforts done separately. The program management time is assumed to be 2.5 state personnel for both programs, rather than five. The estimate for child restraint fines paid is not adjusted.

Number of Offenders

A high-visibility campaign typically produces 22 seat belt citations per 10,000 inhabitants. There is only one child citation per 10,000 inhabitants in a typical CIOT enforcement. In some cases, there have been higher rates for child-specific enforcement activities (Decina, Hall, and Lococo, 2010).

License Plate Impoundment

Implementation Assumptions

License plate impoundment requires someone convicted of a DWI charge to surrender the vehicle's license plate, which is either impounded or destroyed. In many cases, rather than removing the plate, the state will apply a sticker to show that the plate is invalid. This is an equivalent intervention because it makes the plate unusable. When the impoundment period ends, the offender has to obtain a new license plate from the DMV. Although most states do not apply this to all offenders, the model assumes that it will affect all offenders. This allows costs and effectiveness to be aligned in terms of assumptions. We assume that it applies to all convicted offenders.

Cost Calculations

Department of Motor Vehicles

We assume that reinstatement of a license plate takes a half-hour of a DMV staff member's time.

Fines and Fees

Because we were unable to develop a figure that covered the specific cost associated with obtaining a new license plate, we assumed that the fee would be similar to that of driver's license reinstatement: between $30 and $704, with a most common cost of $204.

Program Management

Cost is per year. We assume that a small number of state personnel (about 2.5) would be involved in managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees as a guide.

This intervention does not include any prosecution costs or other fines because we assume that these offenders' interactions with the judicial system are covered under other interventions. Therefore, this includes only those costs directly related to the impoundment itself.

Number of Offenders

We assume that all convicted DWI offenders in the state are subject to license plate impoundment. According to R. Jones, Wiliszowski, and Lacey, 1999, 88 percent of people arrested for DWI are convicted, and we apply that to the number of arrests collected in the FBI report.

Limits on Diversion and Plea Agreements

Intervention Assumptions

Diversion of people arrested for DWI out of the normal judicial process, along with plea-bargaining down to lesser offenses, was, in many cases, originally implemented to reduce DWI case loads. Limiting these diversion programs and plea deals would therefore result in more DWI arrestees facing criminal sanctions for DWI, so our assumptions are based on the increased number of offenders who would be processed through the criminal justice system for DWI rather than lesser offenses and the associated increased marginal costs.

Cost Calculations

Court System

We assume that some court system time (including costs of judges, prosecutors, and court personnel) is needed to process the additional DWI case load created by limits on diversion and plea agreements. We created an estimate of $2,279 per offender based on information from three states: New York (Waller et al., 2013), Washington (Aos et al., 2011a, 2011b), and Oregon (Finigan, Carey, and Cox, 2007). We also assume that there are offender-borne costs (which are not included in the tool) for legal defense. Our research found that this can cost anywhere from $500 to $26,000 (see Office of the Illinois Secretary of State, 2013; Bloch, 2013; and NuStats, 2006), with the most common cost calculated at $2,571.

Department of Motor Vehicles

We assume that those now convicted of DWI offenses would need to go through the license reinstatement process and that a driver's license reinstatement takes a half-hour of a DMV staff member's time.

Fines and Fees

We assume that those now convicted of DWI will need to pay for driver's license reinstatement fees between $30 and $704, with a most common cost of $204.

Probation

Limits on diversion and plea agreements will increase the total number of people convicted of DWI. Offenders will typically not be put in prison for first-time offenses but will be subject to probation. The average DWI or substance abuse–related probation cost per day is around $10. People stay on probation for an average of about 20 months. This costs the state anywhere between $1,217 and $8,610 per offender, with $2,922 per offender being most common (Alemi et al., 2004; Adams, Bostwick, and Campbell, 2011; R. Jones, Wiliszowski, and Lacey, 1999; Tennessee Board of Probation and Parole, 2012; Officer, 2013; Plimack, 2013). To generate state-specific estimates, we then adjust the average cost of probation by the state-specific average salary of probation officers, as reported by BLS and shown in Table 3.1. Specifically, a state-specific probation salary index that reflects the extent to which the state average salary is above or below the national average (e.g., average probation salary in state *x* is 1.2 times the national average) is then used to adjust the average probation cost to reflect differences across states. Because these are first-time offenders, the cost of probation here may overestimate costs.

Education Programs

The cost to the state to provide an alcohol education program is $254 per newly defined offender. The cost to the offender is $294 (Office of Substance Abuse and Mental Health Services Driver Education and Evaluation Programs, 2014), which constitutes revenue to the state. If a state selects a contractor to provide this education, it would not be a source of revenue, but it also would not be a source of cost. Only about 81.5 percent of offenders are assumed to complete the required program (Zhang, 2012).

Program Management

Cost is per state per year. In addition, we assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. The costs of these personnel are calculated using state-specific BLS wages of state office employees as a guide.

Number of Offenders

Limits on diversion and plea agreements affect people who are arrested for DWI, generally for the first time, who might not otherwise have gone through the criminal justice system. Because we did not have data on the proportion of offenders by state who are currently eligible for diversion or pleading to a lesser crime, as a proxy for those affected, we use 12 percent of all people arrested for DWI. According to R. Jones, Wiliszowski, and Lacey, 1999, 88 percent of people arrested for DWI are convicted of DWI offenses, so 12 percent represents the people who are found not guilty or are charged with a lesser offense, such as reckless driving (Hedlund and McCartt, 2002). Actual state-by-state DWI conviction rates vary significantly, and, by their very nature, diversions and plea agreements make tracking DWI offenders difficult. Research on conviction rates is quite dated, with the majority of studies more than ten years old. Unfortunately, there is not a unified data set to allow specific state estimates, so we are limited to a blanket assumption. We apply this 12 percent to the number of DWI arrests collected in the FBI report.

Vehicle Impoundment

Intervention Assumptions

We assume that vehicles are seized from drivers only when they are arrested, to prevent them from driving home. (Although some states have used long-term impoundment, this is explicitly a short-term impoundment intervention.) The state incurs costs for impounding the vehicles of DWI offenders, based on the number of offenders subject to this intervention. With practical limitations on space to impound vehicles and because the fines and fees often exceed the value of the car, many states will only partially implement this intervention. The model assumes that all DWI arrests are impounded to align the cost estimates with the effectiveness evaluation described later in this document.

Cost Calculations

Fines and Fees

These range from $90 to $1,000, depending on the length of time the vehicle is impounded and whether the vehicle is forfeited. We use an average of $520 per car. We located fine and fee data in Cooper, Chira-Chavala, and Gillen, 2000, as well as in state laws and DMV websites.

Impoundment

Towing and storage costs between $485 and $789 per car, with a most common value of $637 (Cooper, Chira-Chavala, and Gillen, 2000; "Managing Your Impound Lot and Understanding Contract Specs," 2002).

Program Management

Cost is per state per year. In addition, we assume that a small number of state personnel (about 2.5) would be involved in marketing, contracting, and managing the program within the state. We calculated the costs of these personnel using state-specific BLS wages of state office employees as a guide.

This intervention does not include any prosecution costs or other fines because we assume that these offenders' interactions with the judicial system are covered under other interventions. Therefore, this includes only those costs directly related to the impoundment itself.

Number of Offenders

We use all DWI arrests, based on annual FBI reporting (FBI, 2011a).

In-Person Driver's License Renewal

Implementation Assumptions

All states require drivers to renew their licenses in person on a certain cycle, which varies from every four years to every 12 years; many states also specify shorter renewal cycles for older drivers. For this intervention, we generally assume that states move from their current schedules for in-person renewals to a new system requiring in-person renewal every four years for drivers who are 70 years of age or older (leaving unchanged the system for younger drivers). The four-year renewal assumption is based on the American Association of Motor Vehicle

Administrators' (AAMVA's) recommendation that all drivers be required to renew their licenses in person every four years (Staplin and Lococo, 2003; Stutts et al., 2005).

We collected information about which states currently have policies in place that meet or exceed these thresholds (as shown in Table B.9). We found 13 states that already have such policies and three that exceed them (*exceed* in that older drivers are required to renew in person on a cycle shorter than every four years). For the states that already have such policies, we created cost estimates that assume as a baseline that current policies do not require in-person renewal. For the states that exceed them, we similarly created a baseline assuming that current policies do not require in-person renewal, and we increased the renewal cycle to four years. As with other interventions, we needed to define a baseline for the states where the policy already is in place to generate an informative cost estimate in case our information about current policies is incorrect.

There is one additional unusual circumstance. Three states (Maryland, Massachusetts, and Nevada) and the District of Columbia have antidiscrimination statutes that specify that all drivers have to renew on the same schedule. For those four jurisdictions, we assume that all drivers switch to the new four-year, in-person renewal schedule. We used data from the AAA Foundation for Traffic Safety, IIHS, expert interviews, and state reports to understand current policy and future costs.

Cost Calculations

Department of Motor Vehicles Staff

States have shifted to an online or mail-in system for some license renewals because these systems save money and time for licensing staff. The amount of savings varies based on the state. We found in-person per-transaction costs between $4.90 and $26.50, with an average of $17.93 (Becker, 2010; Charter, 2010; Griffin, 2011a, 2011b; Gruber, 2010; House, 2010; Martin, 2014; L. Miller, 2011; Sudweeks, 2010). In comparison, costs per transaction online or via mail range between $2.37 and $11.26, with an average of $5.74 (Virginia DMV, 2012; "DMV Needs More Online Services," 2013; California Performance Review, undated). This means that it will cost the state, on average, $12.20 for each person who switches from an online or mail renewal to an in-person renewal.

Number of Drivers

The number of drivers this affects per state depends on two factors. First, it depends on whether current policy has in-person renewals every four, six, eight, or 12 years (IIHS, 2015; AAA Foundation for Traffic Safety, undated). Second, it depends on the number of licensed drivers in the state who are over age 70. This varies by state because some states have much older populations than others, so we used data on licensed drivers, by age, from FHWA to estimate annual renewals (FHWA, 2014).

Higher Seat Belt Fine

This intervention increases the size of the fine assessed on drivers and passengers who violate a state's existing seat belt laws. We assume that no other policies or laws are changed.

Implementation Assumptions

State and local governments continue to enforce existing seat belt laws.

Cost Calculations

Because this intervention consists exclusively of increasing the fine without any other changes in seat belt laws or enforcement, we assume that, for all states, the implementation cost is $0.

Fine

As of 2014, state seat belt fines ranged between $10 and $200, except in New Hampshire, which does not require adults to wear seat belts (see Table B.5 in Appendix B). The literature on increasing seat belt fines indicates that the deterrent effect increases as the fine increases (Houston and Richardson, 2005; Nichols, Tippetts, et al., 2010) but does not propose an ideal ticket increase. We selected a $75 additional increment, which would represent a major increase in 48 states, after considering inflation and the current range of fines.

Number of Offenders

For this intervention, a state might have other seat belt interventions that could affect the number of citations issued—namely, primary seat belt enforcement and high-visibility enforcement. To calculate the likely number of offenders, we used information on citation rates from the 2011 CIOT evaluation for periods of both normal and high-visibility enforcement in states with and without primary laws. For primary enforcement only, the citation rate is assumed to be 84 per 10,000 population per year. For primary enforcement with high-visibility enforcement, the rate increases to 94.5. For secondary enforcement states, the rate is 48, and, when high-visibility enforcement is added, it rises to 54 (Nichols and Solomon, 2013).

Chapter Four. Effectiveness Data and Analysis

In this chapter, we provide the data sources and assumptions used to develop our estimates of the effectiveness of implementing the 14 interventions.

Estimates of Each Intervention's Effect on Injuries and Deaths

There is a range of potential benefits associated with the implementation of motor vehicle interventions. Across all interventions, a primary benefit is the reduction in injuries and deaths associated with crashes. For offender interventions (e.g., alcohol interlocks), however, implementation may also lead to increased employment or quality of life among offenders affected by the intervention who choose not to drive while impaired. Although the full range of benefits should be considered as part of the debate, we have chosen to focus our estimates on the primary benefit of reduced injuries and deaths because that is what the literature best supports.

To estimate the state-specific effect of each intervention, we sought to identify, from the existing literature, the "best" estimate of the intervention's effect on injuries and deaths and apply it to each state. We began by reviewing the literature for each intervention and documenting it in the associated fact sheet. We started with the literature cited in the *Countermeasures That Work* report (UNC Highway Safety Research Center, 2011) and then searched via electronic databases (e.g., MEDLINE, Web of Science, Social Sciences Abstracts) for any additional studies that had been published in the interim. For each intervention, we assessed the existing literature and chose studies based on several criteria, which are described in order of importance below.

First, we included studies that provide information on the primary outcomes of interest, such as crashes, injuries, and deaths, as opposed to less direct outcomes, such as recidivism. Second, we reviewed the methodologies used to estimate the effect of the intervention, selecting those with rigorous study designs. For example, we gave preference to studies that use comparison-group designs with before-and-after measurements to examine the impact of an intervention (rather than, e.g., control states or other geographic areas) over those that use only a before-and-after design. Third, we considered the dates when the interventions were implemented and gave preference to studies that examined interventions that were implemented more recently. We expect that, all else equal, estimates derived from more-recent experiences will be more applicable and provide better estimates of what might be expected to occur if an intervention were implemented in the near future. Fourth, we consider where the intervention was implemented. All else equal, we favored studies looking at interventions in the United States because these estimates are more likely applicable than interventions elsewhere.

In addition, we relied on meta-analyses and systematic reviews when available to identify studies accepted and cited in the field. These were also helpful in understanding whether our selected study was an outlier in the literature. Although we do not always refer specifically to an existing meta-analysis, we have frequently used it as background to inform the selection of the preferred study. In most cases, we selected a single study that was deemed to be the best match to the criteria. This made it easier to ensure that the assumptions underlying the estimate were carried through our calculations.

Once we selected a study, we abstracted several pieces of information. First, we extracted estimates on the intervention's effect on motor vehicle injuries and deaths. In studies in which these outcomes were not examined, we extracted information on the reported outcome, such as the impact on recidivism or crashes. Second, we documented the specific data set and baseline used to generate the effectiveness estimate. This is especially important because many studies use different baselines for their analysis. For example, Fell, Tippetts, and Levy, 2008, found that sobriety checkpoints reduce alcohol-related deaths. It would be incorrect to apply the reduction conclusion to all fatal crashes.

In many cases, the literature on these interventions does not consider the intervention's effect on both motor vehicle injuries and deaths. In these circumstances, we made some assumptions to translate the estimates in the literature to effects that we can use. In many cases, we adopted the methodology applied in Preusser et al., 2008, which assumes proportional impacts on both injuries and deaths; that is, if the intervention reduced deaths by 10 percent, we assumed that injuries were reduced by 10 percent as well. We believe that this is a reasonable assumption for most of the interventions, although we recognize that this is a limitation of our methodology.

We presented our initial selection of estimates from the literature to experts at CDC for review. They provided input on the selected estimates and suggested additional studies and sources of information for several of the interventions. We reviewed the additional information and revised our selected estimates accordingly. The intervention's estimated effect on injuries and deaths, the source for the estimates, and any assumptions made to translate the estimate are presented in Table 4.1. Following Table 4.1, we describe how the effectiveness is empirically determined in the source documents.

Table 4.1. Basis for Estimates of Injury and Death Reduction

Intervention	Estimated Effect	Source
Red-light cameras	17% of deaths at intersections with signals	Hu, McCartt, and Teoh, 2011, conducted panel data analysis and found that red-light cameras reduce fatal crashes by 17%. We assume proportional responses on injuries.
Speed cameras	12% reduction in speed-related crashes	Cunningham, Hummer, and Moon, 2005, studied North Carolina speed limit–enforcement cameras and found a 12% reduction in speed-related crashes. We assume a proportional response in fatalities and injuries.
Alcohol interlocks	24% reduction in crashes of those with previous DWI	DeYoung, Tashima, and Masten, 2005, studied California interlock program, comparing DWI offenders with interlock restrictions and those without. They found a 24% reduction in crashes. We assume a proportional response on both injuries and deaths.
Sobriety checkpoints	8.1% reduction in alcohol-related deaths	Fell, Tippetts, and Levy, 2008, studied demonstration projects using FARS data. They studied 7 programs, and we take the average effect as our main estimate.
Saturation patrols	17.9% reduction in alcohol-related deaths	Fell, Tippetts, and Levy, 2008, cited a 17.9% drop in fatal crashes in Michigan. We assume a proportional response on injuries.
Bicycle helmet laws	15% reduction in cyclist deaths	Grant and Rutner, 2004, studied the effect on juvenile cyclist deaths. We assume a proportional effect on injuries.
Motorcycle helmet laws	28.9% reduction in motorcyclist deaths	Sass and Zimmerman, 2000, looked at the effect on motorcyclist deaths. We assume a proportional effect on injuries.
Primary enforcement of seat belt laws	7% reduction in deaths involving passenger vehicles	Farmer and Williams, 2005, studied the effect on passenger deaths. We assume proportional effect on injuries.
Seat belt enforcement campaign	5.4% reduction in deaths involving passenger vehicles	Solomon, Ulmer, and Preusser, 2002, studied the effects that CIOT campaigns have on seat belt usage. Using Preusser et al., 2008, we converted this to a 5.4% reduction in injuries. We assume proportional effects on both injuries and deaths.
License plate impoundment	27% reduction in recidivism for those with previous DWI	Leaf and Preusser, 2011, studied the effect on recidivism. They estimated that DWI offenders subject to impoundment had a 27% reduction in recidivism relative to offenders not subject to impoundment. We assume proportional effects on both injuries and deaths.
Limits on diversion and plea agreements	11% reduction in recidivism for those with previous DWI	Wagenaar et al., 2000, presented estimates on several outcomes. We use a summary estimate of an 11% reduction that is reported in the *Countermeasures That Work* report. We assume proportional effects on injuries and deaths.

Intervention	Estimated Effect	Source
Vehicle impoundment	30.4% reduction in crashes for those with previous DWI	DeYoung, 1999, studied the decrease of crashes due to DWI offenders. We assume a proportional effect on injuries and deaths due to drivers with a previous DWI.
In-person license renewal	9% reduction in fatal crash involvement rates for drivers ages 55+	Tefft, 2014, compares states with in-person license renewal and those without. The author found a 9% decrease in fatal crashes for ages 55+ with little evidence that this reduction varies significantly by age in this range.
Higher seat belt fines	7.2% reduction in fatalities involving passenger vehicles	Houston and Richardson, 2005, used changes in state-level seat belt fines to estimate that a $1 increase is associated with a 0.152-percentage-point increase in seat belt use, implying an 11.4% increase for a $74 fine. Using Preusser et al., 2008, this increase translates to a 7.2% decrease in injuries and deaths.

NOTE: All effects on injuries are assumed to be the same as those on deaths except with sobriety checkpoints, for which the effect on injuries is 20 percent.

Red-Light Cameras

Hu, McCartt, and Teoh, 2011, compared the change in per capita fatal crash rates between 1992–1996 and 2004–2008 in cities with red-light camera enforcement and those in cities that did not have such enforcement in those years. Their analysis included 62 cities, using FARS data, a Poisson regression model, and accounting for city fixed effects by including pre- and post- periods. They focused on fatal crashes at intersections with signal lights. They found decreases in both the treatment and comparison groups, but the treatment-group decrease was 17 percent larger.

Speed Cameras

Cunningham, Hummer, and Moon, 2005, analyzed the introduction of speed cameras in Charlotte, North Carolina, along 14 key corridors using data from 2000 to 2004 and similar "comparison sites" as controls. This is a differences-in-differences design, meaning that the study compares *changes* in the number of crashes in sites where cameras were introduced and changes in the number of crashes where cameras were not introduced. They estimated a 12-percent reduction in crashes.

Alcohol Interlocks

DeYoung, Tashima, and Masten, 2005, compared California drivers with interlocks and those without, using a propensity-score design to try to adjust for differences between the two groups. Because drivers who receive interlocks may be different from those who do not, the authors controlled for the probability of receiving an interlock based on observable characteristics. They ran a hazard model and looked at days until first crash as the outcome. The results suggest that interlocks reduce the probability of involvement in a crash by 24 percent (p. 20). Other samples were also analyzed and got different results, but this one is the most relevant for our purposes. The literature on interlocks typically focuses on the effect on recidivism, rather than the effect on crashes, due to small sample sizes. DeYoung, Tashima, and Masten, 2005, is one of a small number of studies that looks at the effect on crashes. As such, there is not broad consensus in the literature on interlocks' effects on crashes. Still, the DeYoung study used a solid design and offers insights on the potential effects that alcohol interlock use can have on the outcome of interest.

Sobriety Checkpoints

Fell, Tippetts, and Levy, 2008, using FARS data from 1987 to 2003, reported estimating several interrupted time series to test for effects of the implementation of sobriety checkpoints in seven states. NHTSA had funded these demonstration projects, and the authors tested for changes in the ratio of drinking to nondrinking drivers in fatal crashes. We interpret the results as the effect on alcohol-related deaths, accounting separately for the total number of deaths. In practice, the authors actually used neighboring states as comparison groups. The paper reports only the results for each state. We aggregated the results to arrive at an 8.1-percent reduction.

Elder, Shults, et al., 2002, conducted a systematic review of the effects of sobriety checkpoints. We focus on the paper's evaluation of the effects of selective breath testing (SBT) checkpoints. They reported a median finding in the literature of a 20-percent reduction in fatal and nonfatal injury crashes.

Saturation Patrols

Fell, Langston, et al., 2008, studied the introduction of sobriety checkpoints or saturation patrols in seven states. Michigan implemented highly publicized saturation patrols in 2002 and 2003. Using FARS data, the authors estimated the change in fatal crashes relative to vehicle-miles traveled. They estimated a significant decrease of 18 percent in the number of alcohol-related deaths.

Bicycle Helmet Laws

Grant and Rutner, 2004, used the adoption of bike helmet laws to study their impact on juvenile cyclist deaths in the FARS. They estimated a Poisson model with state and year fixed effects and found a 15-percent reduction in deaths.

Motorcycle Helmet Laws

Sass and Zimmerman, 2000, used panel data for all 50 states for 1976 through 1999, conditioning on state fixed effects and used state-level changes in motorcycle helmet laws to estimate the relationship between such laws and deaths. Their outcome variable was the log of motorcyclist deaths per capita, and they estimated their specification using ordinary least squares

(OLS). Evaluated at the mean death rate in the sample, their estimates suggest that helmet laws reduce the per capita motorcyclist death rate by 28.9 percent.

Primary Enforcement of Seat Belt Laws

Farmer and Williams, 2005, looked at changes in death rates by comparing ten states that switched from secondary enforcement to primary enforcement and 14 states that remained with secondary enforcement between 1989 and 2003. They found a 7-percent decrease in the FARS in the switching states compared with the control states.

Seat Belt Enforcement Campaign

Solomon, Ulmer, and Preusser, 2002, studied how CIOT campaigns affect belt use. They compared changes in belt use in ten states that implemented CIOT and use in four states that conducted enforcement with limited advertising and four other states with only enforcement. They found that the full-implementation states increased seat belt usage rates by 8.1 percentage points relative to the enforcement-only states. We use evidence found in Preusser et al., 2008, regarding the effect that seat belt use has on the risk of death in a crash to translate the increase in seat belt use to a 5.4-percent reduction in deaths.

License Plate Impoundment

Leaf and Preusser, 2011, studied first-time DWI offenders in Minnesota. They compared people with BACs of 0.20 to 0.22 and people with BACs of 0.17 to 0.19. Although these groups should be similar, the Minnesota law allowed for license plate impoundment only for those with BACs of at least 0.20. Their outcome variable was recidivism, and they found that the group subject to license plate impoundment had a lower rate of recidivism. We calculate the decrease as a 27-percent decrease in recidivism, which we use to project a 27-percent decrease in crashes involving people with previous DWI convictions.

Limits on Diversion and Plea Agreements

Wagenaar et al., 2000, reviewed 52 studies of plea-agreement restrictions and found reductions on several measures, including recidivism. The *Countermeasures That Work* report aggregates the findings and reports a reduction of 11 percent, which we apply to drivers with previous DWI convictions. Unfortunately, we do not have much better evidence than this number, so we assume an 11-percent reduction in injuries and deaths due to limits on diversion and plea agreements.

Vehicle Impoundment

DeYoung, 1999, focused on four jurisdictions in California with data on impoundments and driver records. In 1995, California began impounding vehicles for some driving offenses. The author compared the one-year driving records of subjects with impounded vehicles and the records of a control group. This control group was made up of people who would have had their vehicles impounded under 1995 California law but did not because they committed their driving offenses in 1994. We focus on the results using crashes as the outcome. The author found that the group with impounded vehicles was involved in 24.7 percent fewer crashes when selecting on first offenders. For repeat offenders, the reduction was 37.6 percent. According to data published in the study, 55.8 percent of the sample were first-time offenders, so we use a weighted average of the two results to arrive at a reduction of 30.4 percent. We assume that this effect applies to those with suspended or revoked licenses due to DWI convictions.

In-Person License Renewal

Tefft, 2014, uses FARS data from 1985 to 2011 to study the fatality reductions associated with several state-level driver's licensing policies. The author analyzed fatality rates associated with drivers ages 55 and over while also focusing on more-specific age ranges within that group. He estimated that a 9-percent reduction in deaths could be attributed to in-person license renewal while holding other factors constant. Other license renewal policies were not associated with such large effects. He found that the effect is relatively constant for the 55-and-over population, though there is some evidence that it is most effective at ages 85 and up.

Higher Seat Belt Fines

Houston and Richardson, 2005, examines the effects that seat belt laws have on use rates. The authors used panel data on seat belt use, allowing them to study the impacts of changes in laws. They found that primary enforcement has a large effect on use and that states with larger fines observe even larger improvements in seat belt use. The report indicates that each additional $25 for the enforced fine increases belt use by 3.8 percentage points. We assume a $75 increase in the state's fine and use Preusser et al., 2008, to convert this increased use estimate into a fatality and injury reduction estimate (as we did with the seat belt enforcement campaign intervention).

Chapter Five. Tool Integration

Introduction

There are several purposes for building an online web tool to assist decisionmakers in assessing and selecting potential interventions to prevent motor vehicle–related injuries for statewide implementation. First, for a state to implement a new intervention, a decisionmaker would want to know about the costs and effectiveness of this intervention from states that have implemented and experienced it. Yet, these data are hard to come by or scattered in many places. This tool documentation contains all of this evidence in one place.

Second, in addition to performing a conventional cost-effectiveness analysis, our tool conducts a separate analysis using a portfolio approach to account for the interdependencies among interventions. It is clear that interdependencies exist, and the issue is whether their inclusion makes a difference as to which interventions should be selected to yield the greatest benefit (e.g., the largest reductions in injuries and deaths) for a given intervention implementation budget. In some cases, interdependencies would lead to a different selection, so a methodology that incorporates interdependencies would be important in order to get the greatest benefit for a given budget. Even in cases in which interdependencies make no difference in selection, a tool that can show this is still useful in validating that choices made based on independent cost–benefit ratios are appropriate.

Third, this tool is designed to capture state-specific characteristics, such as demographics and traffic crash patterns. Because the cost and effectiveness data for various interventions are typically collected or estimated across only some states, we have developed a methodology to adjust both effectiveness and cost data to suit a decisionmaker for implementation in a particular state.

Fourth, this tool is meant to aid both selection and implementation of interventions. Even after interventions are selected, a state decisionmaker would still need to know what the different implementation activities are and how much each activity would cost. We have classified the cost to implement each intervention into ten components and further classified these into multiple subcomponents. Then, we collected or estimated those cost subcomponents that are relevant to a given intervention. Thus, the costs estimated for each component and subcomponent should be useful not only for intervention selection but also for intervention implementation.

This chapter contains four sections. The first section describes the methodology, assumptions, and model inputs for determining state-specific benefits of interventions in terms of numbers of injuries and deaths reduced. The effectiveness data from Chapter Four are used in this step. The second section discusses how the state-specific projected reductions in injuries and deaths are monetized. The monetary value consists of three parts: physical property damage, injuries, and deaths. The physical property damage is only a small component of the total economic loss from most crashes, but our methodology includes property damage associated with crashes that produce injuries and deaths. The third section of the chapter does the same for determining state-specific costs of implementing interventions. Finally, the fourth section describes how costs and monetized benefits from the preceding sections are used to determine the ranking and selection of interventions employing two different analytical methods. In both this chapter and Chapter Six, we use Ohio as an example to illustrate the various features of the tool.[21]

Methodology for Estimating State-Specific Injury and Death Reductions of Interventions

In this section, we discuss how we applied the effectiveness estimates to state-specific information on motor vehicle–related injuries and deaths. NHTSA provides annual data on fatal injuries due to motor vehicle crashes through FARS. We use the 2010 FARS data in our analysis to generate the baseline number of deaths in each state. These data include a large set of information about the crash, the people involved, and the circumstances. Using the 2010 FARS data, we calculate the number of deaths in each of the following categories:

- total deaths in the state
- deaths that are considered alcohol-related
- deaths involving drivers with previous DWI convictions
- deaths involving motorcycles
- deaths involving bicycles
- deaths occurring at intersections with traffic lights[22]
- deaths of vehicle occupants[23]
- deaths caused by drivers over age 70
- deaths related to speeding.

These categories are necessary because the various estimates from the literature frequently focus on specific types of deaths. These categories help us operationalize the estimates in the literature by providing the correct base with which to work for each state. To estimate the number of deaths that would have been prevented in a state due to a specific intervention, we multiply the number of deaths in the relevant category by the intervention's effect found in the

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[21] Ohio was chosen because it is a populous state and it has not implemented eight of the 12 interventions, which allows for a better demonstration of the tool.

[22] Identified in FARS as locations with traffic control devices; the majority of these are stop lights, but the category also includes railroad crossing gates.

[23] FARS categorizes fatalities in three ways: drivers, passengers, and people outside the vehicle (for example, a pedestrian struck by a car). So this category includes both drivers and passengers in vehicles. It does not include people outside the vehicle (pedestrians, bicyclists, and motorcycle riders).

literature. When a state already has an intervention in place, the effect of the intervention in reducing injuries and deaths would have already been realized and reflected in the FARS data. So a user can assume that any implemented intervention would have already achieved the effectiveness and paid the associated costs. In some cases, however, an intervention may be in place but not fully implemented. In other cases, there may have been changes in the status of the intervention since the data were collected. To address these issues, the tool is designed so that a user can select the set of interventions to be included as candidates for implementation when using the tool.

The deaths by category by state are shown in Table 5.1; note that the sum of the values in each row is higher than the total column because a crash can have multiple causes. Also, some columns include pedestrian deaths, and others do not. If the study on which we relied for a benefit estimate made clear that its fatality reductions included pedestrians, we included pedestrian deaths in that category; if not, we did not include them.

Table 5.1. Deaths per Year, by Category, 2010

State	Total	Alcohol-Related	Previous DWI	Motorcycle	Bicycle	Occurred at Intersection with Light	Vehicle Occupants	Drivers over 70	Speed-Related
Ala.	862	198	78	86	6	118	702	100	313
Alaska	56	19	1	9	0	6	41	4	23
Ariz.	762	172	31	92	19	128	477	150	228
Ark.	563	181	59	84	1	93	439	64	108
Calif.	2,715	818	159	353	99	440	1,531	389	792
Colo.	448	135	25	82	8	155	310	63	159
Conn.	319	106	19	52	7	46	204	38	117
Del.	101	35	13	8	3	16	65	12	41
D.C.	24	7	0	1	2	1	6	1	7
Fla.	2,445	551	105	396	83	1,385	1,375	448	425
Ga.	1,244	290	87	127	18	255	907	194	212
Hawaii	113	43	11	26	3	11	55	13	46
Idaho	209	78	16	28	4	23	163	24	64
Ill.	927	345	30	131	24	182	631	140	405
Ind.	754	187	42	111	13	206	552	125	181
Iowa	390	73	40	60	8	59	294	56	61
Kan.	431	200	14	40	1	74	371	81	98
Ky.	760	221	95	96	7	209	589	94	151
La.	710	233	47	71	10	242	543	61	230
Maine	161	46	17	19	1	34	128	27	82
Md.	493	172	12	82	8	64	293	72	145

State	Total	Alcohol-Related	Previous DWI	Motorcycle	Bicycle	Occurred at Intersection with Light	Vehicle Occupants	Drivers over 70	Speed-Related
Mass.	314	95	34	56	6	26	185	47	64
Mich.	942	281	85	137	29	157	612	156	229
Minn.	411	132	43	48	9	84	309	66	92
Miss.	641	134	29	42	4	81	541	71	129
Mo.	819	274	39	95	7	107	651	124	317
Mont.	189	91	27	26	0	27	155	24	68
Neb.	190	57	28	14	2	28	163	29	34
Nev.	257	77	12	48	6	45	156	55	73
N.H.	128	48	7	28	0	15	91	21	62
N.J.	556	149	36	71	12	62	322	107	133
N.M.	346	121	5	39	8	114	258	35	129
N.Y.	1,200	284	65	184	36	264	631	194	315
N.C.	1,319	432	118	191	23	155	909	178	469
N.D.	105	49	16	15	1	7	80	9	40
Ohio	1,080	402	97	170	11	154	789	159	293
Okla.	688	239	52	78	9	193	503	94	185
Ore.	317	80	13	38	7	33	203	61	92
Pa.	1,324	443	85	223	21	170	908	209	672
R.I.	66	28	4	15	2	7	37	9	26
S.C.	810	338	41	101	14	120	590	79	273
S.D.	140	46	15	27	2	10	100	22	32
Tenn.	1,031	284	78	136	4	105	797	134	222
Texas	2,998	1,052	112	415	42	409	2,141	358	1,149
Utah	236	49	19	20	7	32	176	27	91
Vt.	71	29	3	6	1	5	59	15	27
Va.	740	224	29	86	12	82	553	107	255
Wash.	458	187	14	69	6	55	315	64	171
W.Va.	315	101	4	33	3	18	263	46	130
Wis.	572	223	62	105	9	113	392	97	197
Wyo.	155	61	22	33	0	10	119	20	57
Total	32,885[a]	10,120	2,095	4,503	618	6,435	22,684	4,773	9,914

SOURCE: NHTSA, undated (c).
NOTE: The "Alcohol-Related," "Vehicle Occupants," and "Speed-Related" columns include pedestrian deaths. "Vehicle Occupants" includes people who were occupants of passenger vehicles or large trucks; 98 percent of these were passenger vehicles.
[a] The total is the total of all vehicle crash deaths in a state; it is not the sum of the columns because fatalities can fall into more than one category.

Although the FARS provides a census of motor vehicle–related deaths, we were unable to identify a similar source of comprehensive information on motor vehicle–related injuries. The available data sources provide only a sample of accidents. We chose to use NHTSA's National Automotive Sampling System (NASS) General Estimates System (GES) for 2010, which provides information on crashes, their circumstances, and resulting injuries. We use these data to understand the number and characteristics of motor vehicle–related injuries. Unfortunately, the GES does not provide data for every state, and, even when crashes in a state are sampled, it is not intended to generate state-specific information on motor vehicle crashes. Consequently, we use the GES to generate ratios of injuries to deaths for specific types of crashes. The GES provides information on injuries and deaths for each sampled motor vehicle crash. We create the following categories:

- alcohol-related
- motorcycle
- bicycle
- occurred at an intersection with a light
- vehicle occupants
- drivers over age 70
- speed-related.

For each category, we add all of the relevant injuries and deaths. We then create a ratio of the number of injuries per death, as shown in Table 5.2. To generate the number of injuries in that category in a state, we take the number of deaths in that category calculated in the FARS and multiply by the ratio generated in the GES to obtain our estimate of the number of relevant injuries. The result is an estimate of the baseline number of injuries in the state that are potentially affected by the intervention in question.

Unfortunately, the GES does not provide information about whether the driver has a previous DWI conviction, which is provided in the FARS and is necessary for understanding the effects of interventions targeted at repeat offenders. In this case, we use the alcohol-related injury-to-death ratio as an appropriate proxy to generate our injury numbers. To generate the intervention's estimated state-specific effect on motor vehicle–related injuries, we multiply the number of injuries in the relevant category by the intervention's effect found in the literature.[24]

[24] For ease of replication by others for checking and other purposes, numbers in this report are not rounded.

Table 5.2. Injury-to-Death Ratios

Category	Ratio
Total	106.54120
Alcohol-related	36.18325
Motorcycle	264.54260
Bicycle	171.54700
Occurred at intersection with light	85.86092
Vehicle occupants	105.55530
Drivers over age 70	90.83724
Speed-related	82.60576

SOURCE: Calculated by RAND researchers based on FARS and GES data.

Informed by the available literature, we estimate the reduction in the percentage of injuries and deaths due to the corresponding intervention. Our estimates are shown in Table 5.3. For each intervention, the reduction in deaths does not apply to all motor vehicle deaths, only those with a cause that is affected by the intervention. For example, vehicle impoundment for DWI offenders affects only those deaths caused by drunk drivers. Each study that we have used makes clear the types of deaths that are being affected. If a state has 100 alcohol-related deaths per year and saturation patrols reduce deaths by 17.9 percent (i.e., 0.179 in Table 5.3), then the effectiveness of saturation patrol is the elimination of 18 deaths.

Table 5.3. Injury and Death Reduction Estimates

Baseline	Intervention	Reduction in Injuries	Reduction in Deaths
Occurred at intersection with a light	Red-light cameras	0.170	0.170
Speed-related	Speed cameras	0.120	0.120
Previous DWI conviction	Alcohol interlocks	0.240	0.240
Alcohol-related	Sobriety checkpoints	0.200	0.081
Alcohol-related	Saturation patrols	0.179	0.179
Bike	Bicycle helmet laws	0.150	0.150
Motorcycle	Motorcycle helmet laws	0.289	0.289
Vehicle occupants	Primary enforcement of seat belt laws	0.070	0.070
Vehicle occupants	Seat belt enforcement campaign	0.054	0.054
Previous DWI conviction	License plate impoundment	0.270	0.270
Previous DWI conviction	Limits on diversion and plea agreements	0.110	0.110
Previous DWI conviction	Vehicle impoundment	0.304	0.304
Vehicle occupants	Higher seat belt fines	0.072	0.072
Drivers over 70	In-person license renewal	0.090	0.090

SOURCE: Our analysis of literature as discussed in Chapter Four.

In many cases, the literature does not assess the reduction in the percentage of injuries due to an intervention. In almost all cases, we assumed that the reduction in the percentage of injuries due to an intervention was the same as the reduction for deaths. The only exception was for sobriety checkpoints, for which the literature did allow us to produce a separate estimate. To find the number of injuries eliminated, we multiply the number of injuries that result from a specific crash cause by the percentage of injuries reduced by an intervention.

To illustrate our method, we use sobriety checkpoints as an example. Fell, Tippetts, and Levy, 2008, studied several NHTSA-funded demonstration projects. They found a range of effects, and we take the average (8.1 percent) as our estimate of the intervention's effect on deaths. We referenced Elder, Shults, et al., 2002, to obtain estimates of the effect that sobriety checkpoints have on injuries. This study included a review of the literature that looked at U.S. interventions. The authors reported a median finding in the literature of a 20-percent reduction in fatal and nonfatal injury crashes. For both estimates, the estimated effects refer to the intervention's effect on alcohol-related injuries and deaths.

How does this translate into estimating the effects of implementing sobriety checkpoints in a state where they are not currently used? For example, according to the 2010 FARS, Michigan had 205 alcohol-related motor vehicle deaths. The 2010 GES data tell us that there are 36.2 alcohol-related injuries per alcohol-related death. Consequently, we estimate that there are 7,421 (205 × 36.2) relevant injuries in Michigan. We estimate that implementing sobriety checkpoints would save approximately 16.6 lives and prevent 1,484.2 injuries in Michigan per year.

Methodology for Monetizing Intervention-Related Reductions in Injuries and Deaths at the State Level

Once we estimated the reductions in injuries and deaths, we monetized the effects of the reduction in injuries and deaths associated with a particular intervention. Although this is not a formal cost–benefit analysis, we monetize the effects of the intervention so that we can combine the impact on injuries and deaths and generate a cost-effectiveness estimate that includes both outcomes of interest. We derived the costs per injury and death using a very simple method, relying heavily on estimates already available in the literature. Blincoe, Miller, et al., 2015,[25] provided national unit costs by injury severity or death. The costs are separated into different categories: medical, emergency services, market productivity, household productivity, insurance administration, workplace costs, legal costs, travel delays, and property damage.[26] These costs are then aggregated, and the resulting values are shown in Table 5.4.

[25] The revised report by Blincoe, Miller, et al., 2015, fixed errors in the SAS coding; these lowered its estimates of five of the cost categories in Table 5.4 for injuries but not fatalities.

[26] For more information on the cost categories and what they include, please see Blincoe, Miller, et al., 2015.

Table 5.4. National per-Injury and per-Death Costs (adjusted to 2012 dollars)

Cost Category	Injury	Death
Medical	3,624	11,883
Emergency service	88	947
Market productivity	4,436	979,925
Household productivity	1,501	304,406
Insurance administration	2,662	29,738
Workplace costs	503	12,372
Legal costs	1,225	111,812
Travel delay	1,308	6,006
Property damage	5,044	11,773

SOURCE: Blincoe, Miller, et al., 2014.
NOTE: Blincoe, Miller, et al., 2014, Table 1-2, reported costs by injury severity. We calculate a weighted average using the relative frequencies of each injury severity type (reported in Blincoe, Miller, et al., 2014, Table 5-14) and multiply by 1.05 to adjust for inflation.

We incorporate three important changes to these costs:

- First, we adjust the unit costs for inflation to generate estimates in 2012 dollars.
- Second, we adjust some of the costs because we believe that there is important variation at the state level.
- Third, we aggregate the costs by injury severity into one metric.

The literature rarely provides us with any information about interventions' effects on different types of injuries by severity. Instead, our analysis has considered interventions' effect on injury and death rates. This is a nice balance between evaluating the heterogeneous impacts of different interventions and using available estimates in the literature.

We believe that state-level cost heterogeneity is especially important for market productivity, household productivity,[27] and medical costs, so we adjusted these three categories by state. To do this, we use the state-specific price adjustments employed by CDC's WISQARS cost-of-injury reports computed using the ACCRA Cost of Living Index data and population data.[28] We use the values in the medical column to adjust the national estimates for medical costs in Table 5.4. We multiply the medical national cost by the medical state-specific adjustments for each state to derive a state-adjusted medical cost. Similarly, we use the productivity adjustments in Table 5.5 to adjust the market productivity and household productivity values from Table 5.4.

[27] *Market productivity* refers to lost earnings, whereas *household productivity* refers to work done in the home. Essentially, these terms measure the losses of not being able to work in the labor market or perform household duties.

[28] *ACCRA* previously stood for American Chamber of Commerce Research Association. The organization is now called the Council for Community and Economic Research, and it compiles the ACCRA Cost of Living Index.

Table 5.5. State-Specific Price Adjusters

State	Productivity (Market and Household)	Medical
Alabama	0.839	0.898
Alaska	1.045	1.282
Arizona	0.855	0.976
Arkansas	0.779	0.893
California	1.077	1.071
Colorado	1.063	1.010
Connecticut	1.402	1.119
Delaware	1.052	1.160
District of Columbia	1.582	1.058
Florida	0.996	0.979
Georgia	0.867	0.989
Hawaii	1.016	1.061
Idaho	0.808	0.919
Illinois	1.044	0.993
Indiana	0.871	0.890
Iowa	0.907	0.893
Kansas	0.952	0.893
Kentucky	0.806	0.938
Louisiana	0.900	0.923
Maine	0.873	1.019
Maryland	1.192	1.005
Massachusetts	1.271	1.250
Michigan	0.909	0.937
Minnesota	1.063	0.986
Mississippi	0.747	0.978
Missouri	0.891	0.936
Montana	0.841	0.969
Nebraska	0.945	0.906
Nevada	1.048	1.038
New Hampshire	1.075	1.205
New Jersey	1.274	1.043
New Mexico	0.815	0.963
New York	1.227	1.070
North Carolina	0.871	1.004
North Dakota	0.902	0.926
Ohio	0.903	0.947
Oklahoma	0.885	0.947

State	Productivity (Market and Household)	Medical
Oregon	0.901	1.043
Pennsylvania	1.005	0.974
Rhode Island	1.022	1.114
South Carolina	0.803	1.000
South Dakota	0.878	0.932
Tennessee	0.862	0.912
Texas	0.963	0.95
Utah	0.808	0.918
Vermont	0.950	1.008
Virginia	1.071	0.935
Washington	1.047	1.149
West Virginia	0.765	0.915
Wisconsin	0.934	1.030
Wyoming	1.120	0.954

SOURCE: CDC, 2014b.

For the six other factors in Table 5.4, we use the national estimates for all states. We then simply add up the values for the nine cost categories to derive the cost of injuries and deaths in the state.

To arrive at total costs per injury, we need to aggregate the different costs reported by injury severity. Table 1-3 in Blincoe, Miller, et al., 2014, reports the relative frequencies of each injury type (based on severity). We translate these into the fraction of all injuries that are each injury severity type. For example, we calculate the fraction of all injuries with the maximum abbreviated injury score (MAIS) of 2. We add the costs of all injury types, weighted by these fractions, to arrive at the total cost of an average injury.

Finally, we multiply the cost of an injury in a state by the number of injuries that an intervention is estimated to prevent in that state. We do a similar calculation for deaths. We then add these numbers to arrive at the potential monetary savings associated with reducing injuries and deaths by implementing the intervention in each state.

The effectiveness of a particular intervention for preventing motor vehicle crashes is the number of deaths in a state prevented by the intervention multiplied by the state-specific cost per death, then added to the number of injuries prevented by the intervention, then multiplied by the state-specific cost per injury.

Table 5.6 indicates which states had the various interventions in place in most cases as of 2011.[29] A cell is coded 1 if the state has the intervention, 0 if not, and 9 if unknown, according to

[29] The state law data can quickly become out of date as new laws are passed and existing ones repealed. To address this problem, the tool allows users to select which interventions to consider. The information provided in Table 5.6 is the default, but a user can update if he or she knows the status of a particular law in a jurisdiction.

our information on each state. For the two interventions coded as 9 (saturation patrols and seat belt enforcement campaigns), the tool allows a user to place either or both of them as implemented interventions or interventions to be considered for implementation. (See the fact sheets on these interventions in Appendix B for further information on their use.)

Table 5.6. Intervention Status, by State

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impoundment	In-Person License Renewal	Higher Seat Belt Fines
Ala.	1	0	1	1	9	1	0	1	9	0	0	1	0	0
Alaska	0	0	1	0	9	0	0	1	9	0	0	1	1	0
Ariz.	1	1	1	1	9	0	1	0	9	0	1	1	1	0
Ark.	0	0	1	1	9	0	0	1	9	1	1	0	0	0
Calif.	1	0	1	1	9	1	0	1	9	0	1	1	0	0
Colo.	1	1	1	1	9	0	0	0	9	0	1	0	0	1
Conn.	0	0	1	1	9	1	0	1	9	0	0	1	0	0
Del.	1	0	1	1	9	1	0	1	9	1	0	1	0	0
D.C.	1	1	0	1	9	1	1	1	9	0	0	0	0	0
Fla.	1	0	1	1	9	1	0	1	9	0	1	1	0	0
Ga.	1	0	1	1	9	1	1	1	9	1	0	0	0	0
Hawaii	0	0	1	1	9	1	0	1	9	1	0	0	1	0
Idaho	0	0	0	0	9	0	1	0	9	0	0	0	1	0
Ill.	1	1	1	1	9	0	0	1	9	1	0	1	1	0
Ind.	0	0	0	1	9	0	1	1	9	0	0	0	0	0
Iowa	0	0	0	0	9	0	0	1	9	1	0	1	0	0
Kan.	0	0	1	1	9	0	0	1	9	1	1	1	1	0
Ky.	0	0	0	1	9	0	0	1	9	1	1	0	1	0
La.	1	1	1	1	9	1	1	1	9	0	0	0	1	0
Maine	0	0	0	1	9	1	0	1	9	1	0	1	0	0
Md.	1	1	1	1	9	1	1	1	9	1	0	1	0	0

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impoundment	In-Person License Renewal	Higher Seat Belt Fines
Mass.	0	0	1	1	9	1	1	0	9	1	1	0	1	0
Mich.	0	0	1	0	9	0	1	1	9	1	1	0	0	0
Minn.	0	0	1	0	9	0	0	1	9	1	0	1	1	0
Miss.	0	0	0	1	9	0	1	1	9	0	1	1	1	0
Mo.	0	0	1	1	9	0	1	0	9	0	0	1	1	0
Mont.	0	0	1	0	9	0	0	0	9	0	0	0	0	0
Neb.	0	0	1	1	9	0	1	0	9	1	0	1	0	0
Nev.	0	0	0	1	9	0	1	0	9	0	1	0	0	0
N.H.	0	0	1	1	9	1	0	0	9	0	0	0	0	0
N.J.	1	0	1	1	9	1	1	1	9	0	0	1	0	0
N.M.	0	0	1	1	9	1	0	1	9	0	1	1	1	0
N.Y.	1	0	1	1	9	1	1	1	9	0	1	0	1	0
N.C.	1	0	1	1	9	1	1	1	9	0	0	0	0	0
N.D.	0	0	0	1	9	0	0	0	9	1	0	0	0	0
Ohio	0	0	0	1	9	0	0	0	9	1	0	0	1	0
Okla.	0	0	1	1	9	0	0	1	9	0	0	0	1	0
Ore.	1	1	1	0	9	1	1	1	9	0	1	1	0	0
Pa.	1	0	1	1	9	1	0	1	9	0	0	0	0	0
R.I.	1	0	0	0	9	1	0	1	9	0	9	0	0	0
S.C.	0	0	1	1	9	0	0	1	9	0	0	0	0	0
S.D.	0	0	0	1	9	0	0	0	9	0	0	0	0	0
Tenn.	1	0	1	1	9	1	1	1	9	0	1	0	0	0
Texas	1	0	1	0	9	0	0	1	9	0	0	0	0	1

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaign	License Plate Impoundment	Limits on Diversion	Vehicle Impoundment	In-Person License Renewal	Higher Seat Belt Fines
Utah	0	1	1	1	9	0	0	1	9	0	0	0	0	0
Vt.	0	0	0	1	9	0	1	0	9	0	0	0	0	0
Va.	1	0	1	1	9	0	1	0	9	0	0	1	0	0
Wash.	1	1	1	0	9	0	1	1	9	0	0	1	0	1
W.Va.	0	0	1	1	9	1	1	0	9	0	0	0	0	0
Wis.	9	0	1	0	9	0	0	1	9	0	0	1	0	0
Wyo.	0	0	1	0	9	0	0	0	9	0	1	1	0	0

SOURCES: Red-light and speed cameras, alcohol interlocks, bicycle and motorcycle helmets, primary enforcement of seat belt laws, IIHS, 2014d; sobriety checkpoints, GHSA, undated; license plate and vehicle impoundment, NCSL, 2014a, 2014b, and McKnight et al., 2008; limits on diversion and plea agreements, NHTSA, 2011b; in-person license renewal, AAA Public Affairs, 2010; higher seat belt fines, IIHS, 2014d.
NOTE: 1 = in force. 9 = unknown. 0 = not in force. Data are current as of 2011 for all interventions except in-person license renewal and high seat belt fines. For in-person license renewal, data are current as of 2009. For higher seat belt fines, data are current as of 2014.

To illustrate how we calculate and monetize the effect of a particular motor vehicle intervention, we use vehicle impoundment in Ohio as an example.

DeYoung, 1999, found that first-time DWI offenders with impounded cars had 24.7 percent fewer crashes than a similar group of DWI offenders who did not have their cars impounded. The reduction was 37.6 percent for repeat offenders. Using the relative rates stated in DeYoung's paper, we calculate that the average reduction is 30.4 percent (Table 5.3). We assume that this reduction leads to proportional reductions in injuries and deaths.

According to the 2010 FARS, Ohio had 97 deaths involving drivers with prior DWI convictions (Table 5.1). We do not have a figure on injuries involving drivers with prior DWIs, so we impute this value using the 2010 GES. Because the GES does not report prior DWI status, only whether a crash involved alcohol, we use the ratio of injuries to deaths in crashes involving alcohol to estimate the ratio for crashes involving prior DWI convictions. For every death involving alcohol, there are 36.18325 injuries (Table 5.2). Consequently, we assume that Ohio had 3,509.5 injuries (97 deaths × 36.18 injuries per death) due to prior-DWI drivers in 2010. Implementation of vehicle impoundment in Ohio, then, is predicted to reduce the number of deaths by 29.49 (i.e., 97 × 30.4 percent) and the number of injuries by 1,066.97 (i.e., 3,509.5 × 30.4 percent) per year.

Then we take the national costs associated with the nine categories (Table 5.4) for injuries and deaths derived from Blincoe, Miller, et al., 2015. As described above, we then adjust three of the nine components by state-specific ratios (Table 5.5). The derived costs per injury and per death for Ohio are $19,794 per injury and $1,343,652 per death.

Finally, we multiply the number of injuries saved by the costs per injury and add the number of deaths saved multiplied by the costs per death. This is (1,066.97 × $19,794) + (29.49 × $1,343,652) = $60,740,834. This is the model's estimate of the intervention's monetized annual benefit of implementing vehicle impoundment in the state of Ohio.

Methodology for Estimating State-Specific Costs of Implementing Interventions

To calculate the total costs of developing, implementing, and maintaining the different interventions, we developed a cost-estimating structure and gathered the necessary data from a wide review of literature sources, addressing processes and costs, as well as from the different legal statutes and procedures pertaining to each intervention (e.g., state statutes addressing seat belt laws, fines, and administrative procedures). Data points were normalized so units would be consistent and costs would be expressed in 2012 dollars. Then we gathered relevant statistics for calculating implementation estimates at a state level (e.g., number of licensed drivers in a state).

The costs are broken down into ten components as described in Chapter Three. These ten cost components are broken down into 38 subcomponents and associated with specific interventions, as shown in Table 3.1 in Chapter Three.[30]

The model combines all of the aforementioned data to estimate the costs for each intervention in each state. To illustrate this, we walk through a sample state, Ohio, and an example intervention, vehicle impoundment. Vehicle impoundment has three basic cost elements: tow staffing, fines, and program management.

First, we calculate the costs associated with the tow portion of the program. As noted above, the most common cost paid by a city or state to tow a vehicle is $637. There were 36,528 DWI arrests in Ohio according to FBI statistics (FBI, 2011a). Under this intervention, we assume that each DWI arrest results in an impounded vehicle, so this amounts to about $23,271,000 in direct costs. Second, each person arrested must pay a fine to retrieve the vehicle or forfeit the car to the impound lot. The average income to the state from fines or forfeitures is about $520 per vehicle. With $520 multiplied by 36,528 arrests, the total potential income after rounding is $18,995,000. Finally, the state needs program oversight by a state employee for coordination and contracting purposes. We assume that the appropriate estimate is 2.5 state employees, with a full-time employee working 2,000 hours per year. Using BLS data for office workers, we selected an hourly cost of $24.59 per hour in 2012 dollars (converted from $23.91 in 2011 dollars in Table 3.3), including benefits, for government employees as representative of Ohio. This hourly wage is similar to the mean for the states ($25.14). This equals a total program staff cost of about $123,000, as shown in Table 5.7.

Table 5.7. Sample Cost Estimate, Ohio Vehicle Impoundment

Cost Element	Cost Per Unit ($)	Unit	Number of Units	Cost ($)
Tow staffing	637.06	Arrest	36,528	23,271,000
Program staff	24.59	Hour	5,000	123,000
Cost to state without fines	Not applicable	Not applicable	Not applicable	23,394,000
Fines	519.97	Arrest	36,528	–18,995,000
Cost to state with fines	Not applicable	Not applicable	Not applicable	4,400,000
Cost to offenders	Not applicable	Not applicable	Not applicable	18,995,000

NOTE: Costs have been rounded to the nearest $1,000.

The cost of the program varies based on whether the revenues generated by the intervention are included in the calculation. Without fines, the cost to state is almost $23,394,000. When fines are included and can be used to fund the program, the net cost to the state is $4,400,000. We display the fines as a negative cost because they constitute revenue to the state. The tool also

[30] During the course of the project, we developed additional cost components and subcomponents that may be used if additional interventions are added to the tool.

uses this convention: Positive costs are those that are actual costs paid by the state, and negative costs are revenues to the state. When the revenues exceed the cost of implementation, the total cost of implementing the intervention will be negative. This indicates that there is a net gain to the state: The revenue received is greater than the cost incurred.

This model provides insight into one possible budget outcome of the vehicle impoundment intervention. The range of costs discovered in our research suggests that some states have budget-neutral vehicle impoundment programs, while others do not. It depends on the combination of costs incurred and revenues generated. For example, if fines are too high for offenders to retrieve their vehicles, then more people will forfeit their vehicles, which are often worth very little at auction. Each state needs to develop its own budget and fine strategy based on its experience.

The annual cost for each intervention in each state for the case in which fines are included is shown in Tables 5.8 and 5.9. The annual cost for each intervention in each state for the case in which fines are excluded is shown in Tables 5.10 and 5.11.

Table 5.8. Annual Cost for Each Intervention for the Case in Which Fines Are Included: Red-Light Cameras, Speed Cameras, Alcohol Interlocks, Sobriety Checkpoints, Saturation Patrols, Bicycle Helmets, and Motorcycle Helmets ($)

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets
Ala.	–5,027,973	–57,703,364	115,577	2,139,000	4,939,000	257,910	1,135,632
Alaska	–677,799	–8,973,802	148,835	542,000	1,022,000	94,926	368,575
Ariz.	–2,678,931	–35,390,444	128,236	3,239,000	3,719,000	357,764	1,470,115
Ark.	–5,507,422	–59,528,858	109,209	1,144,000	4,346,000	177,046	653,416
Calif.	–5,775,300	–99,144,291	144,275	14,941,000	13,588,000	951,240	8,516,672
Colo.	–4,478,120	–52,250,492	134,997	2,770,000	4,944,000	286,265	1,301,070
Conn.	–586,314	–12,149,733	149,936	2,364,000	1,935,000	211,722	965,699
Del.	–112,697	–3,512,175	133,425	579,000	534,000	91,985	361,699
D.C.	154,434	–660,120	174,152	494,000	559,000	89,566	249,894
Fla.	–4,547,304	–70,245,276	118,486	8,406,000	7,933,000	797,606	5,174,880
Ga.	–6,020,052	–71,982,686	123,597	3,665,000	6,199,000	519,013	1,763,105
Hawaii	38,822	–2,322,032	133,661	789,000	951,000	110,691	459,452
Idaho	–2,562,984	–28,427,372	113,611	731,000	2,289,000	126,050	494,587
Ill.	–6,698,577	–82,196,092	130,987	7,238,000	10,250,000	634,145	3,129,204
Ind.	–4,588,855	–56,337,657	118,643	2,908,000	4,100,000	348,189	1,735,495
Iowa	–6,350,381	–68,173,132	118,408	1,647,000	6,253,000	183,486	1,081,362
Kan.	–7,958,840	–84,060,912	116,206	1,230,000	5,115,000	182,224	724,651
Ky.	–4,069,576	–46,691,045	115,027	1,714,000	3,810,000	239,412	827,123
La.	–2,981,511	–36,046,989	113,140	1,913,000	3,242,000	256,368	855,830
Maine	–1,063,503	–13,419,285	119,194	646,000	931,000	98,461	445,307
Md.	–1,014,021	–18,000,583	138,928	2,944,000	2,314,000	309,157	1,163,785
Mass.	–1,152,134	–20,692,769	148,206	3,217,000	2,558,000	323,568	1,568,776
Mich.	–5,861,683	–71,711,200	124,776	4,986,000	7,321,000	481,477	2,363,563
Minn.	–7,573,467	–82,392,819	132,953	2,851,000	8,753,000	293,786	1,638,932
Miss.	–4,034,076	–44,564,765	108,108	1,040,000	3,389,000	184,618	521,688

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets
Mo.	–6,890,670	–77,097,644	119,823	2,441,000	5,483,000	313,979	1,171,275
Mont.	–4,210,661	–44,354,370	113,140	510,000	3,478,000	87,371	572,148
Neb.	–5,263,319	–55,930,741	115,263	859,000	3,704,000	132,872	496,522
Nev.	–1,593,913	–19,945,461	127,842	1,606,000	2,034,000	175,783	729,904
N.H.	–639,933	–9,302,890	128,314	768,000	1,071,000	103,962	572,010
N.J.	–1,076,854	–22,051,214	139,164	5,790,000	3,654,000	441,130	2,155,883
N.M.	–3,738,533	–40,750,132	116,521	927,000	3,369,000	143,871	504,833
N.Y.	–4,611,562	–66,567,998	142,231	10,276,000	8,610,000	863,482	3,670,502
N.C.	–4,975,883	–61,860,976	122,968	3,795,000	5,576,000	482,062	1,653,421
N.D.	–5,020,725	–52,022,383	114,712	401,000	3,205,000	74,483	293,733
Ohio	–5,781,153	–72,338,059	122,968	5,394,000	6,457,000	555,850	2,899,828
Okla.	–6,268,510	–67,603,612	112,982	1,437,000	4,992,000	221,585	818,504
Ore.	–2,900,622	–34,968,610	129,100	2,035,000	3,351,000	214,267	1,056,339
Pa.	–5,561,783	–71,468,671	128,864	6,028,000	6,563,000	572,380	3,194,579
R.I.	–106,899	–3,572,948	137,906	632,000	558,000	96,349	386,685
S.C.	–3,252,953	–39,111,729	117,857	2,052,000	3,602,000	250,733	974,104
S.D.	–4,725,702	–49,187,359	103,705	423,000	2,796,000	79,511	363,963
Tenn.	–4,584,229	–54,471,195	118,565	2,577,000	4,765,000	327,238	1,347,170
Texas	–15,415,909	–181,251,518	124,383	9,997,000	15,667,000	1,360,279	4,429,251
Utah	–2,249,919	–26,445,690	115,970	1,209,000	2,259,000	212,476	604,009
Vt.	–646,293	–8,452,481	126,034	404,000	778,000	74,012	299,079
Va.	–3,309,447	–43,308,105	129,965	3,746,000	4,421,000	401,215	1,405,514
Wash.	–3,938,717	–49,146,191	140,265	3,446,000	4,806,000	353,276	2,109,913
W.Va.	–1,956,058	–22,767,506	107,243	919,000	2,088,000	115,586	461,869
Wis.	–6,014,047	–68,170,739	122,732	2,325,000	3,465,000	297,608	1,926,534
Wyo.	–1,493,613	–16,704,935	120,059	381,000	1,465,000	73,493	293,615

NOTE: A negative number indicates that, where fines are included, the state receives revenue that exceeds the cost.

Table 5.9. Annual Cost for Each Intervention for the Case in Which Fines Are Included: Primary Enforcement of Seat Belt Laws, Seat Belt Enforcement Campaigns, License Plate Impoundments, Limits on Diversion and Plea Agreements, Vehicle Impoundments, In-Person License Renewals, and Higher Seat Belt Fines ($)

State	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaigns	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impounds	In-Person License Renewals	Higher Seat Belt Fines
Ala.	1,538,736	949,761	67,267	191,000	149,182	1,459,000	–1,589,000
Alaska	706,077	337,212	–582,586	1,778,000	666,385	63,000	–239,000
Ariz.	4,199,547	1,686,737	–5,808,208	10,705,000	4,284,562	406,000	–2,145,000
Ark.	810,487	589,000	–1,200,891	1,572,000	1,017,614	743,000	–972,000
Calif.	18,295,951	8,120,761	–17,163,446	53,680,000	12,362,320	1,815,000	–6,205,000
Colo.	3,492,330	1,368,929	–4,417,264	9,358,000	3,333,269	707,000	–1,693,000
Conn.	2,596,108	1,031,770	–1,253,693	4,186,000	1,143,703	735,000	–1,185,000
Del.	727,979	351,336	93,060	201,000	161,761	189,000	–300,000
D.C.	653,098	335,996	167,130	189,000	179,187	1,133,000	–205,000
Fla.	11,140,252	4,414,619	–7,240,592	9,611,000	5,245,276	4,699,000	–6,306,000
Ga.	2,989,640	1,846,708	–5,102,734	6,450,000	3,774,082	520,000	–3,248,000
Hawaii	765,363	407,671	–854,000	2,244,000	827,085	140,000	–455,000
Idaho	736,844	416,574	–1,429,962	2,141,000	1,186,298	345,000	–525,000
Ill.	9,682,837	3,476,252	–473,412	1,599,000	554,746	578,000	–4,259,000
Ind.	2,613,092	1,360,169	–3,249,853	4,586,000	2,465,534	148,000	–2,157,000
Iowa	1,492,397	738,213	–1,879,938	4,709,000	1,510,524	412,000	–1,013,000
Kan.	1,115,936	643,220	–1,913,873	2,687,000	1,459,260	680,000	–950,000
Ky.	1,419,207	879,559	–3,753,004	5,145,000	2,804,999	962,000	–1,446,000
La.	1,391,322	894,129	–903,459	1,646,000	819,444	1,079,000	–1,514,000
Maine	528,552	354,889	–855,637	1,443,000	798,566	369,000	–440,000
Md.	3,530,661	1,460,551	–2,755,506	5,732,000	2,176,577	11,487,000	–1,929,000
Mass.	3,879,752	1,642,231	–1,488,426	2,954,000	1,305,902	9,098,000	–2,180,000
Mich.	5,206,963	2,279,651	–4,808,064	10,151,000	3,572,339	1,199,000	–3,268,000

State	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaigns	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impounds	In-Person License Renewals	Higher Seat Belt Fines
Minn.	3,195,231	1,340,983	–3,961,775	9,741,000	3,006,761	1,232,000	–1,769,000
Miss.	530,479	543,458	–1,792,917	2,072,000	1,425,519	628,000	–968,000
Mo.	2,136,899	1,219,966	–4,826,169	13,661,534	3,567,854	1,215,000	–1,433,000
Mont.	507,799	304,531	–603,300	1,044,000	610,901	257,000	–330,000
Neb.	878,302	474,612	–1,905,812	2,742,000	1,520,962	332,000	–610,000
Nev.	2,188,387	831,760	–1,851,706	4,728,000	1,513,518	2,573,000	–901,000
N.H.	722,607	399,442	–476,411	1,325,000	551,722	97,000	–308,000
N.J.	9,164,624	2,877,385	–4,219,089	11,430,000	3,207,698	2,017,000	–2,919,000
N.M.	889,524	503,294	–1,811,567	2,724,000	1,458,404	285,000	–689,000
N.Y.	13,601,192	5,019,053	–5,759,177	14,204,000	4,303,825	4,910,000	–6,441,000
N.C.	3,172,188	1,824,280	–8,882,167	12,070,000	6,410,850	620,000	–3,195,000
N.D.	389,553	243,979	–699,669	1,367,000	680,973	176,000	–226,000
Ohio	6,388,226	2,688,366	–6,002,537	10,411,000	4,400,133	2,765,000	–3,820,000
Okla.	1,140,897	749,808	–2,341,580	3,096,000	1,818,204	876,000	–1,255,000
Ore.	2,556,622	1,044,681	–2,372,745	4,664,000	1,881,511	726,000	–1,281,000
Pa.	7,411,398	3,011,831	–7,982,969	14,025,000	5,810,089	1,775,000	–4,217,000
R.I.	685,333	367,468	–279,463	849,000	431,575	138,000	–348,000
S.C.	1,408,352	909,273	–2,517,423	4,561,000	1,953,169	771,000	–1,548,000
S.D.	365,411	250,678	–788,557	1,262,000	720,667	67,000	–273,000
Tenn.	2,193,610	1,266,280	–4,177,139	5,612,000	3,111,340	449,000	–2,119,000
Texas	12,615,015	5,446,913	–14,239,076	17,465,000	10,160,990	2,544,000	–8,496,000
Utah	1,222,716	658,991	–419,872	847,000	488,794	127,000	–932,000
Vt.	357,913	244,452	–253,029	768,000	391,132	999,000	–207,000
Va.	4,092,261	1,821,386	–4,707,424	8,340,000	3,519,801	1,190,000	–2,679,000
Wash.	5,305,613	1,909,722	–1,704,869	2,970,000	1,440,112	422,000	–2,260,000
W.Va.	536,742	407,108	–798,129	1,879,000	734,392	149,000	–614,000

State	Primary Enforcement of Seat Belt Laws	Seat Belt Enforcement Campaigns	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impounds	In-Person License Renewals	Higher Seat Belt Fines
Wis.	3,014,634	1,345,988	–4,707,083	4,718,000	3,494,770	1,007,000	–1,890,000
Wyo.	385,415	235,249	–714,614	1,671,000	702,010	69,000	–188,000

Table 5.10. Annual Cost for Each Intervention for the Case in Which Fines Are Excluded: Red-Light Cameras, Speed Cameras, Alcohol Interlocks, Sobriety Checkpoints, Saturation Patrols, Bicycle Helmets, and Motorcycle Helmets ($)

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets
Ala.	17,407,943	21,642,142	115,577	3,314,000	6,606,000	257,910	1,200,310
Alaska	2,855,699	3,522,555	148,835	719,000	1,560,000	94,926	382,836
Ariz.	11,253,813	13,883,258	128,236	4,824,000	4,046,000	357,764	1,538,322
Ark.	17,501,811	21,844,208	109,209	1,862,000	6,173,000	177,046	689,708
Calif.	33,993,153	41,498,420	144,275	19,527,000	15,327,000	951,240	8,895,027
Colo.	15,869,463	19,709,543	134,997	4,021,000	5,926,000	286,265	1,361,518
Conn.	4,338,868	5,268,369	149,936	3,240,000	2,586,000	211,722	999,129
Del.	1,335,235	1,608,494	133,425	801,000	741,000	91,985	374,161
D.C.	501,375	566,851	174,152	645,000	1,240,000	89,566	250,456
Fla.	23,435,291	28,716,281	118,486	13,066,000	9,429,000	797,606	5,515,482
Ga.	22,075,270	27,377,535	123,597	6,066,000	8,146,000	519,013	1,858,440
Hawaii	1,044,375	1,234,147	133,661	1,125,000	2,056,000	110,691	485,328
Idaho	8,453,379	10,532,433	113,611	1,119,000	3,017,000	126,050	527,347
Ill.	25,457,917	31,526,623	130,987	10,385,000	20,187,000	634,145	3,298,733
Ind.	17,452,401	21,612,118	118,643	4,502,000	9,831,000	348,189	1,839,859
Iowa	19,981,650	24,951,140	118,408	2,396,000	9,699,000	183,486	1,174,153
Kan.	24,455,151	30,572,453	116,206	1,932,000	12,319,000	182,224	767,672
Ky.	14,084,094	17,510,129	115,027	2,783,000	5,335,000	239,412	860,308

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets
La.	11,101,997	13,759,895	113,140	3,032,000	4,345,000	256,368	890,803
Maine	4,199,169	5,192,362	119,194	971,000	2,706,000	98,461	473,154
Md.	6,221,029	7,586,457	138,928	4,369,000	2,885,000	309,157	1,204,371
Mass.	7,170,767	8,741,499	148,206	4,828,000	3,835,000	323,568	1,647,122
Mich.	22,185,459	27,478,631	124,776	7,401,000	13,780,000	481,477	2,501,251
Minn.	24,294,178	30,308,371	132,953	4,158,000	18,366,000	293,786	1,765,735
Miss.	13,229,073	16,487,046	108,108	1,769,000	4,466,000	184,618	536,072
Mo.	23,012,435	28,655,872	119,823	3,911,000	10,083,000	313,979	1,221,835
Mont.	12,887,662	16,114,528	113,140	754,000	3,948,000	87,371	629,499
Neb.	16,317,346	20,390,138	115,263	1,310,000	7,285,000	132,872	518,685
Nev.	6,222,523	7,697,673	127,842	2,271,000	2,103,000	175,783	762,955
N.H.	3,049,862	3,746,215	128,314	1,090,000	1,922,000	103,962	613,208
N.J.	7,856,709	9,542,687	139,164	7,947,000	5,714,000	441,130	2,239,327
N.M.	12,025,738	15,000,837	116,521	1,436,000	3,736,000	143,871	528,770
N.Y.	21,777,409	26,757,644	142,231	15,036,000	14,239,000	863,482	3,843,912
N.C.	19,253,062	23,825,648	122,968	6,156,000	7,570,000	482,062	1,715,507
N.D.	14,998,590	18,776,717	114,712	568,000	9,307,000	74,483	309,576
Ohio	22,567,287	27,917,321	122,968	8,217,000	14,630,000	555,850	3,088,211
Okla.	19,855,817	24,786,107	112,982	2,364,000	7,153,000	221,585	877,521
Ore.	10,758,027	13,335,744	129,100	2,982,000	4,232,000	214,267	1,108,565
Pa.	22,509,795	27,807,578	128,864	9,144,000	15,885,000	572,380	3,397,518
R.I.	1,369,388	1,647,999	137,906	889,000	699,000	96,349	403,034
S.C.	12,020,298	14,902,729	117,857	3,196,000	4,577,000	250,733	1,026,571
S.D.	14,211,755	17,785,710	103,705	625,000	7,254,000	79,511	393,728
Tenn.	16,664,018	20,674,074	118,565	4,142,000	6,028,000	327,238	1,424,456
Texas	55,218,094	68,548,434	124,383	16,276,000	20,067,000	1,360,279	4,651,605
Utah	8,055,733	10,000,658	115,970	1,897,000	3,139,000	212,476	633,524

State	Red-Light Cameras	Speed Cameras	Alcohol Interlocks	Sobriety Checkpoints	Saturation Patrols	Bicycle Helmets	Motorcycle Helmets
Vt.	2,678,579	3,306,062	126,034	557,000	1,804,000	74,012	313,520
Va.	13,727,095	16,942,302	129,965	5,726,000	5,255,000	401,215	1,447,690
Wash.	15,316,405	18,950,311	140,265	5,117,000	5,828,000	353,276	2,229,138
W.Va.	6,908,117	8,581,000	107,243	1,373,000	2,933,000	115,586	486,599
Wis.	20,460,218	25,456,550	122,732	3,721,000	10,200,000	297,608	2,085,038
Wyo.	4,985,312	6,208,042	120,059	520,000	1,825,000	73,493	309,189

NOTE: Because no fines or fees are associated with alcohol interlocks, these data are the same as in Table 5.8.

Table 5.11. Annual Cost for Each Intervention for the Case in Which Fines Are Excluded: Seat Belt Enforcement Campaigns, Primary Enforcement of Seat Belt Laws, License Plate Impoundments, Limits on Diversion and Plea Agreements, Vehicle Impoundments, In-Person License Renewals, and Higher Seat Belt Fines ($)

State	Seat Belt Enforcement Campaigns	Primary Enforcement of Seat Belt Laws	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impoundments	In-Person License Plate Renewals	Higher Seat Belt Fines
Ala.	1,336,877	3,442,059	118,415	296,000	298,414	1,459,000	0
Alaska	395,465	992,490	205,127	3,399,000	2,964,656	63,000	0
Ariz.	2,209,248	6,768,559	517,737	23,725,000	22,741,446	406,000	0
Ark.	825,810	1,974,806	181,707	4,417,000	5,051,548	743,000	0
Calif.	9,632,127	25,726,837	1,432,473	91,954,000	66,618,676	1,815,000	0
Colo.	1,781,360	5,520,113	450,520	19,377,000	17,535,752	707,000	0
Conn.	1,320,387	4,015,141	258,824	7,299,000	5,556,695	735,000	0
Del.	424,454	1,087,476	136,188	290,000	287,594	189,000	0
D.C.	385,808	898,009	174,793	205,000	201,546	1,133,000	0
Fla.	5,950,718	18,692,743	562,405	25,671,000	28,011,679	4,699,000	0
Ga.	2,637,846	6,879,401	453,319	17,885,000	19,984,692	520,000	0
Hawaii	518,485	1,310,199	201,393	4,417,000	3,906,352	140,000	0
Idaho	544,329	1,364,972	202,672	5,501,000	5,949,751	345,000	0
Ill.	4,513,556	14,782,916	171,551	2,926,000	2,436,520	578,000	0

State	Seat Belt Enforcement Campaigns	Primary Enforcement of Seat Belt Laws	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impoundments	In-Person License Plate Renewals	Higher Seat Belt Fines
Ind.	1,885,454	5,195,744	322,125	11,938,000	12,887,309	148,000	0
Iowa	985,045	2,705,988	238,869	9,070,000	7,692,457	412,000	0
Kan.	874,651	2,253,806	230,261	6,894,000	7,423,325	680,000	0
Ky.	1,231,743	3,150,780	341,146	13,571,000	14,750,289	962,000	0
La.	1,262,875	3,204,326	171,538	3,859,000	3,955,908	1,079,000	0
Maine	461,945	1,054,912	178,371	3,572,000	3,815,437	369,000	0
Md.	1,930,330	5,840,408	345,804	12,115,000	11,225,109	11,487,000	0
Mass.	2,173,207	6,490,388	273,593	6,581,000	6,446,854	9,098,000	0
Mich.	3,075,703	9,120,889	439,141	20,950,000	18,881,840	1,199,000	0
Minn.	1,771,796	5,313,396	412,173	18,743,000	15,768,405	1,232,000	0
Miss.	783,536	1,710,861	212,188	6,199,000	7,275,711	628,000	0
Mo.	1,704,447	4,518,931	421,749	24,462,743	18,879,435	1,215,000	0
Mont.	384,989	903,385	154,295	3,704,267	2,821,297	257,000	0
Neb.	623,135	1,608,539	233,668	10,249,898	7,763,212	332,000	0
Nev.	1,051,268	3,267,638	257,299	13,946,904	7,666,853	2,573,000	0
N.H.	505,693	1,245,006	168,017	3,953,189	2,431,936	97,000	0
N.J.	3,588,399	12,660,442	451,232	32,837,814	16,834,053	2,017,000	0
N.M.	671,128	1,714,708	230,785	9,982,517	7,417,270	285,000	0
N.Y.	6,588,011	21,315,236	574,788	42,106,441	22,784,108	4,910,000	0
N.C.	2,602,617	6,999,013	688,017	45,829,535	34,333,283	610,000	0
N.D.	299,106	660,595	162,182	4,567,681	3,195,552	176,000	0
Ohio	3,618,926	10.963,482	507,327	35,329,126	23,393,627	2,765,000	0
Okla.	1,055,416	2,643,469	253,775	12,020,380	9,390,539	876,000	0
Ore.	1,356,766	4,091,037	294,431	20,206,617	9,663,394	726,000	0
Pa.	4,038,949	12,461,395	663,879	47,329,287	31,038,553	1,775,000	0
R.I.	452,206	1,101,963	167,502	2,564,556	1,735,662	138,000	0

State	Seat Belt Enforcement Campaigns	Primary Enforcement of Seat Belt Laws	License Plate Impoundments	Limits on Diversion and Plea Agreements	Vehicle Impoundments	In-Person License Plate Renewals	Higher Seat Belt Fines
S.C.	1,286,434	3,262,728	275,930	15,279,787	10,103,192	771,000	0
S.D.	317,101	691,994	150,462	4,562,084	3,460,393	67,000	0
Tenn.	1,782,411	4,731,254	377,876	11,562,834	16,401,274	449,000	0
Texas	7,516,374	22,789,874	1,036,684	38,446,166	54,730,289	2,544,000	0
Utah	886,068	2,339,179	147,567	2,869,416	2,144,381	127,000	0
Vt.	294,944	606,167	150,451	2,316,286	1,568,346	99,000	0
Va.	2,473,999	7,300,940	451,921	28,138,258	18,572,956	1,190,000	0
Wash.	2,460,245	8,012,352	273,504	10,272,686	7,212,308	422,000	0
W.Va.	556,656	1,272,021	156,394	5,771,310	3,519,356	149,000	0
Wyo.	281,044	610,576	171,118	5,197,424	3,286,265	69,000	0

NOTE: Because no fines or fees are associated with in-person license renewals, these data are the same as in Table 5.9.

Methodology for Identifying the Optimal Portfolio of Interventions

The portfolio analysis component of the tool helps define the best group of interventions for a state to implement within a given budget. The tool identifies which of the 12 interventions that have not yet been implemented in the state can yield the largest benefit, measured as the greatest reduction in the costs of injuries and deaths. The effectiveness and cost for each intervention estimated in Chapters Three and Four are used as inputs for this final step of optimization.

This optimization can be performed in two ways: the traditional cost-effectiveness analysis and our portfolio analysis. The difference between them is how they treat the interdependencies between interventions. The cost-effectiveness analysis ignores the interdependencies, while portfolio analysis incorporates them. Take the example of primary enforcement of seat belt laws and seat belt enforcement campaigns, both of which encourage occupants in passenger vehicles to wear seat belts. The interdependency between these two interventions is easiest to explain with an extreme hypothetical case, in which each intervention alone can reduce traffic deaths to zero (i.e., a 100-percent reduction). If so, it is clear that implementing both interventions would still cause the reduction to be only 100 percent, not 200 percent. Thus, in the case of two interdependent interventions with the same targeted population and reduction rates in deaths of R_1 and R_2, the reduction rate for both interventions implemented would be

$$1-(1-R_1)\times(1-R_2).$$

Generalizing it to a combination of *n* such interdependent interventions, we get the combined reduction rate to be

$$1-(1-R_1)\times(1-R_2)\times\ldots\times(1-R_n).$$

On a different issue, there has been controversy about the real purpose of implementing interventions, such as red-light camera enforcement. Is it to generate income to the state? To improve traffic safety at an intersection? Both? To address this issue, we perform an analysis, whether cost-effectiveness or portfolio, under two cases: standard run with fines included and standard run with fines excluded. Fees, charges, and other income generated from interventions under consideration for implementation are also included in the definition of fines here.

Because the types of model runs that can be made and the kinds of screenshots that are displayed are detailed in the user manual (Chapter Six), here we focus on the description of methodology for the two types of analyses.

Cost-Effectiveness Analysis

This analysis is performed under the assumption that the interdependencies among interventions are ignored, as is typically done by traditional analytical methods. The analysis starts by asking for which state the user wants to perform the analysis. We will use Ohio as our example. For each of the 12 candidate interventions, we start with its Ohio-specific effectiveness and cost from Chapters Three and Four and take a ratio of its effectiveness to its cost. The ranking of interventions is based on the ratio; a larger ratio is more attractive and is ranked higher (i.e., more lives saved and more injuries prevented per dollar spent). In cases in which fines are included, the cost can be negative. This signifies that the fines, charges, and other incomes generated by the intervention exceed the costs of implementing the intervention. A negative cost will lead to a negative ratio. Clearly, a negative ratio ranks higher than a positive ratio because the former can generate effectiveness-monetized benefit and net income at the same time, while the latter would cost money to get the benefit.

How do we rank interventions that all have negative ratios? We start with the following observation and assumption. When implementing an intervention generates more in fines than in expenses, we assume that the net cash flow can be used to fund other interventions. Because of this possibility, we add the benefit, which has already been expressed monetarily in dollars, to the absolute value of the cost (i.e., the net cash flow) as a measure of the value generated by the intervention. One with the higher such value is more attractive and ranks higher than one with lower value. It should be emphasized that this ranking scheme applies only to interventions with negative ratios.

After a user identifies a state, the tool displays a screen showing which of the 12 interventions were already implemented in the state around 2010, the year of the traffic fatality data we used. The user can update the list of interventions that have not been implemented and that should stay in the pool for selection by simply clicking all such interventions. Once the user submits an annual implementation budget available and clicks the button to run the model, another screen is displayed. Interventions will be selected for implementation in ranking order according to their cost–benefit ratios, and the cost will be subtracted from the budget until the budget is fully consumed.[31]

Portfolio Analysis

Portfolio analysis differs from the traditional cost–benefit analysis by including interdependencies among interventions. There are two types of interdependencies: those between implemented and not-yet-implemented interventions and those between not-yet-implemented interventions only. Because the traffic fatality data have already reflected the impacts of interventions that existed at the time the traffic crashes occurred, the first type of interdependencies are ignored, and we focus only on the second type.

Of the 12 interventions, we have identified the following pairs and groups as having interdependencies among them because they target the same population based on crash cause:

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[31] Should the cost be negative (i.e., a net positive cash flow), the remaining budget will actually increase after selecting the intervention for implementation. Further, should there be insufficient funds to select the next ranked intervention, the model would skip it and check the intervention ranked immediately below until the budget is fully committed or the list of candidate interventions for implementation has been exhausted.

- alcohol interlock, license plate impoundment, limits on diversion and plea agreements, and vehicle impoundment (previous DWI convictions)
- saturation patrols and sobriety checkpoints (alcohol-related offenses)
- primary enforcement of seat belt laws, seat belt enforcement campaigns, and higher seat belt fines (vehicle occupants).

The portfolio optimization model is built with mixed-integer linear programming from the SAS software library. The user selects the state where the selected interventions will be implemented. The model's inputs are the candidate interventions' annual state-specific benefits and costs, estimated in Chapters Three and Four. The above three sets of interdependencies constitute the constraints in the model. Once a user provides the annual budget available for implementation, the model searches for the optimal combination or portfolio of selected candidate interventions that would produce the greatest effectiveness (i.e., the largest reduction in traffic deaths and injuries as expressed in dollars) for the budget provided. The mixed integer reflects that a candidate intervention is either wholly selected (1) or not selected (0), and the current version of the model does not allow selecting an intervention partially for implementation. The portfolio optimization is a linear-programming model, which has the objective function of maximizing effectiveness subject to constraints in interdependencies. Further, all the decision variables (i.e., which candidate interventions to choose) appear linearly in the objective function and the constraints. The traditional branch-and-bound search algorithm, which is periodically improved by SAS, is used in the model to find the optimal solution or portfolio.

Example of Cost-Effectiveness Analysis and Portfolio Analysis Calculations

To provide a concrete example of the calculations for both types of analyses, we illustrate the calculation of the deaths for interventions in Ohio.

We focus on the three of the four interventions listed above that affect people with previous DWI convictions that are not already implemented in Ohio (Table 5.6). These are alcohol interlock, limits on diversion and plea agreements, and vehicle impoundment. From Table 5.1, we find that, in 2010, 97 people were killed in motor vehicle crashes related to drivers with previous DWI. From Table 4.1 in Chapter Four, we find that alcohol interlocks reduce deaths by 24 percent so that the number of deaths avoided by implementing this intervention alone would be 97 × 0.24 = 23.[32] Limits on diversion and plea agreements would reduce deaths by 11 percent so that the number of deaths avoided by implementing this intervention alone would be 97 × 0.11 = 11. Vehicle impoundment would reduce deaths by 30.4 percent so that the number of deaths avoided by implementing this intervention alone would be 97 × 0.304 = 29.

If all three interventions are implemented together, the cost-effectiveness analysis would simply add these three estimates for reductions in deaths together and estimate the total reduction

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[32] For display purposes, fatality and injury estimates are rounded to the nearest whole number.

in deaths to be 63 (23 + 11 + 29). However, the portfolio analysis would take into account the interdependency between these three interventions and use the calculation method shown at the beginning of this section to find the total reduction in deaths to be only 51 ($97 \times 1 - [1 - 0.24] \times [1 - 0.11] \times [1 - 0.304]$). Thus, ignoring interdependencies would lead to a total reduction in deaths that is 24 percent larger than is accurate. Further, because the injury reduction rates are the same as their corresponding death reduction rates for all three interventions, ignoring interdependencies would also lead to the same 24-percent difference in effectiveness for injuries.

Chapter Six. User Manual with Example

In this chapter, we provide an example of how to use the web tool and illustrate its features. The tool allows users to change five broad parameters: the state, the list of interventions to analyze, the analysis type (cost-effectiveness or portfolio), the run type (with or without fines and fees), and budget. This example uses only one state, but the parameters are the same for all states. Finally, we show how the sensitivity analysis works; this is available only with portfolio analysis.

Figure 6.1 shows the home page. From the home page, a new user would probably want to proceed to the introduction for an explanation of the various features of the web tool. Repeat users can skip the introduction and proceed to one of the two types of analysis, the basic cost-effectiveness analysis or the portfolio analysis, by selecting a state from the drop-down menu, clicking the button next to the desired analysis, and clicking *Submit*. Some users may want to use the library, which contains reports providing detailed information about the input data, assumptions, and methodology. After leaving the home page, the user can navigate through the tool using the menu in the upper left corner of the screen.

Figure 6.1. Screenshot of the Home Page

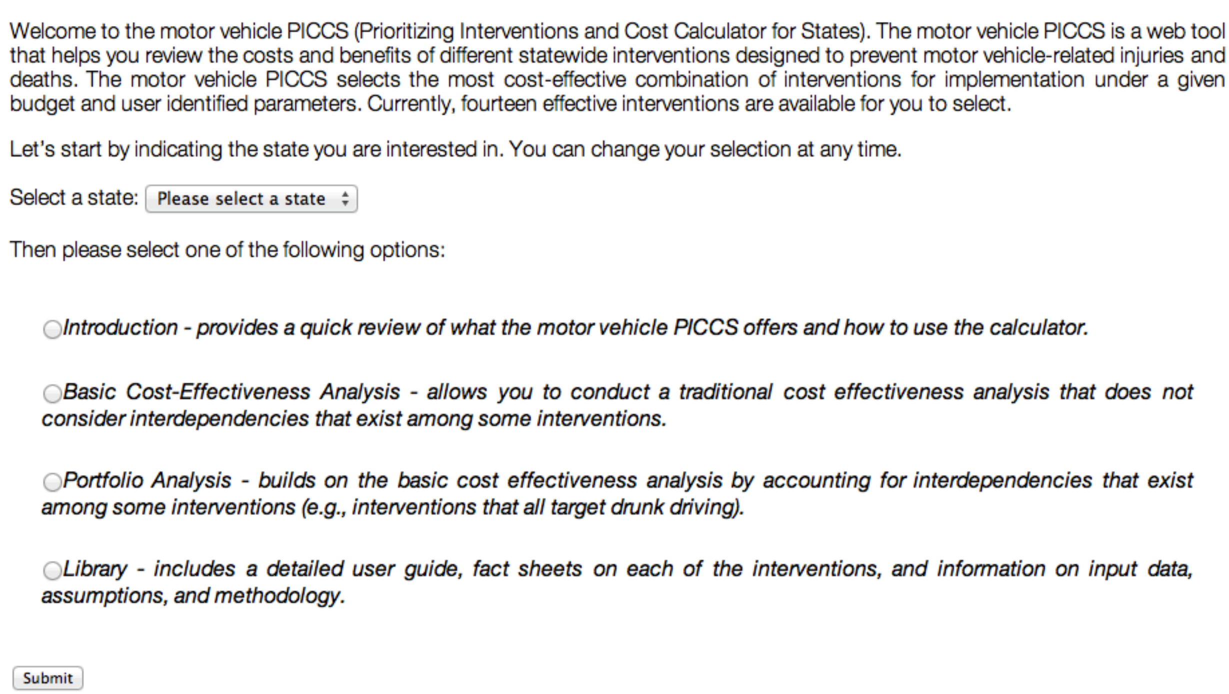

Figure 6.2 shows the introduction, which briefly explains how to use either cost-effectiveness analysis or portfolio analysis.

Figure 6.2. Screenshot of the Introduction

Overview

This tool will help you find the most cost-effective interventions for reducing motor vehicle-related injuries and deaths. The model allows two types of analysis. The Basic Cost-Effectiveness Analysis provides a ranking of interventions based on cost-effectiveness ratio. The Portfolio Analysis takes interdependencies among some interventions into account. More information regarding interdependencies can be found in Chapter Four of the Project Report and Online-Tool Documentation (hereafter called the "Project Report") in the library. Further, detailed instructions for using the motor vehicle PICCS and the meanings of the results can be found in Chapter Six of the Project Report in the library.

You can visit the library, Basic Cost-Effectiveness Analysis, and Portfolio Analysis in any order and any number of times. If this is your first visit to the motor vehicle PICCS, you may want to read the introduction here first. After that, you can decide whether to read more about the tool in the library documents or to go directly to the Basic Cost-Effectiveness Analysis and finally proceed to the Portfolio Analysis. Of course, you can read any of the library documents at any time.

Basic Cost-Effectiveness Analysis

The initial screen will list fourteen interventions and indicate, in the Currently Implemented column, which are currently implemented in the chosen state (based on the data we have assembled). Note that these data are not continually updated, so users may wish to consult current state laws. The Candidate Intervention column gives you the option to select the interventions you would like to consider for inclusion in the analyses. You can set the available budget to any value including zero.
It also allows the user a way to automatically prioritize interventions for the implementation under a given budget.

Result

Running the model will produce a ranked list with the most suitable interventions highlighted in light-green. All the candidate interventions are ranked and the Cumulative Cost column indicates available budget. The Cost-Effectiveness Ratio column is the basis for the ranking. A negative cost-effectiveness ratio results from a negative cost. A negative cost means that the revenues received by the state in the form of fines and fees exceed the costs of implementing the intervention. Use the Print Report button to save or print your results as a PDF file.

Next step

Once you have reviewed the table, you have several options for your next run:

1. Select different interventions or budget. Make another run by starting with a different set of candidate interventions and/or changing the budget.
2. Exclude fees/fines/charges. Since the implementation cost in the (default) Standard Run includes the fees, fines, charges and other incomes to the state, you may wish to make another run by excluding these incomes.
3. Pick a different state. Ask the tool to start Basic Cost-Effectiveness Analysis on another state so that you can compare the results with those in your state.
4. Proceed to the Portfolio Analysis, which accounts for interdependencies that exist among some interventions.

Portfolio Analysis

The Candidate Intervention column on the first display allows you to choose the candidate interventions considered for implementation. If you are transferring from the Basic Cost-Effectiveness Analysis, your previous selections are pre-populated. When providing a budget, please take into account that the standard run includes the fees and fines, which are assumed to fund the implementation of other selected interventions.

Result

The results are presented in three tables. The first table shows the interventions selected by the model within the constraints of the chosen budget. For each intervention, the table also lists the benefit and implementation cost in dollars per year. The second output table shows the aggregated values for all interventions selected; total cost in dollars per year, the total benefit in dollars per year, the expected total number of deaths prevented and the expected total number of injuries prevented. The third output table presents the total cost broken up into ten cost components. This table also shows the offender cost for those who are interested, even though this is not a cost to the state and is not included in any of the analysis. For more information on the offender cost please see Chapter Three in the Project Report. Use the Print Report button to save or print your results as a PDF file.

Next Step

Once you have reviewed the tables, you have several options for your next step:

1. Select different interventions or budget. Make another run by starting with a different set of interventions and/or changing the budget.
2. Exclude fees/fines/charges. Since the implementation cost in the (default) Standard Run includes the fees, fines, charges and other incomes to the state, you may wish to exclude these incomes. (Standard Run with Fines-Excluded)
3. Conduct sensitivity analysis. Perform sensitivity analysis by checking the box sensitivity analysis. Forty-five model inputs can be changed. The default value used by the model and the valid input range are shown, and the blank column allows you to input a user-defined value for the sensitivity analysis. You can change as many or as few values as you wish.
4. Pick a different state. Ask the tool to start Portfolio Analysis on another state so that you can compare the results with those in your state.

For the examples in this section, we use Georgia. We start with a basic cost-effectiveness analysis. On the opening page (shown in Figure 6.1), the user selects Georgia from the drop-down menu of states, selects *Basic Cost-Effectiveness Analysis*, and clicks *Submit*. Figure 6.3 shows the initial cost-effectiveness analysis page, with Georgia selected as the state for analysis. In the top table, the first two columns show that all interventions are selected (this is the default), while the second column indicates those that are already implemented in Georgia.[33] The third column ranks the interventions in the order of their cost–effectiveness ratio, and the fourth column shows the names of the interventions. The fifth and sixth columns show the estimated effectiveness and costs per year, and the seventh column shows the cumulative cost as each intervention is added to the preceding ones. The last two columns show the annual reductions in deaths and injuries. The footnote text appears on each screen; we have included it in Figure 6.3 but deleted it from subsequent figures.

[33] Although saturation patrols and seat belt enforcement campaign are not shown as already implemented, their actual status is not known according to our assembled record of state laws. The user should first provide the status for each by leaving it checked in the second column if it has been implemented or by checking it in the first column if it has not been implemented.

Figure 6.3. Screenshot of Sample Basic Cost-Effectiveness Analysis for Georgia, Input Screen

Georgia
Basic Cost-Effectiveness Analysis
(Interdependencies Ignored)

Candidate Intervention	Currently Implemented[1]	Cost-Effectiveness Ratio	Intervention Name	Benefit $/year	Cost $/year[2]	Cumulative Cost $/year	# of Fatalities Reduced	# of Injuries Reduced
☑	☐	-94.39	Increased Seat Belt Fine	220,834,000	-2,340,000	-2,340,000	65	6893
☑	☐	-1.04	Speed Camera	74,504,000	-71,983,000	-74,323,000	25	2102
☑	☑	-21.55	Red Light Camera	129,736,000	-6,020,000	-80,343,000	43	3722
☑	☑	-9.26	License Plate Impound	47,264,000	-5,103,000	-85,446,000	23	850
☑	☑	339.92	Alcohol Interlocks	42,013,000	124,000	-85,322,000	21	755
☑	☑	135.73	Motorcycle Helmet	239,298,000	1,763,000	-83,559,000	37	9709
☑	☐	103.76	In Person Renewal	53,970,000	520,000	-83,039,000	17	1586
☑	☐	89.69	Seat Belt Enforcement Campaign	165,626,000	1,847,000	-81,192,000	49	5170
☑	☑	87.72	Primary Enforcement Seat Belt Law	214,700,000	2,448,000	-78,744,000	63	6702
☑	☑	24.37	Bicycle Helmet	12,647,000	519,000	-78,225,000	3	463
☑	☑	19.62	Sobriety Checkpoints	71,911,000	3,665,000	-74,560,000	23	2098
☑	☐	16.85	Saturation Patrols	104,448,000	6,199,000	-68,361,000	52	1878
☑	☐	14.1	Vehicle Impoundment	53,216,000	3,774,000	-64,587,000	26	957
☑	☐	2.99	Limits on Diversion	19,256,000	6,450,000	-58,137,000	10	346

Summary Results of the Interventions Chosen

Category	Value	Units
Total Cost	-58,137,000	$ per year
Total Benefit	1,449,423,000	$ per year
Total # of Fatalities Reduced	457	units
Total # of Injuries Reduced	43,231	units

Annual implementation budget available: $ 0

- (●) Make a Standard Run with Fines-Included Georgia
- ( ) Make a Standard Run with Fines-Excluded
- ( ) Repeat run with a different state: [Please select a state]

[Run the model] [Print Report]

[Transfer to Portfolio Analysis]

1. This is our record of which interventions have already been implemented in this state. However, we could not determine whether "saturation patrols" or "seat belt enforcement campaign" have been implemented in any state. In the first screen, these two interventions are shown, by default, as currently implemented. The user has the option to select or deselect any of the fourteen interventions in the first column.↩
2. Costs are negative, when the fines and fees collected by a state exceed what the state has to pay to implement the intervention. Thus, a negative cost means that the intervention is expected to generate revenue for the state. This money may be available to fund other interventions.↩

For our example, we deselect three of the interventions that Georgia already has in place (primary enforcement seat belt law, bicycle helmets, and sobriety checkpoints) and keep the other 11 interventions for inclusion in the analysis. The user does this by deselecting the box associated with the intervention in the first column. Interventions with checks in the first column will be included in the analysis. The user is not required to deselect the interventions that are already in place and can leave them in to see what effect they have or if the user believes that the information about the current implementation status is incorrect. In many cases, a state may have an intervention in place, but it is not fully implemented. In this case, a user might choose to include that intervention in the analysis to see what the costs and effects of full implementation would be.

Beneath the summary result table is a box in which the user can set the annual implementation budget and select the run type. For this example, we make a run with fines excluded, so that button is selected. Because this means that no fine or fee revenues can defray the costs of implementation, we also add a budget of $10 million.[34] We then click *Run the model*. The results of this analysis are shown in Figure 6.4.

[34] All budget figures must be entered as numerals with no spaces or dollar signs.

Figure 6.4. Screenshot of Sample Basic Cost-Effectiveness Analysis for Georgia, Fines Excluded and $10 Million Budget

Georgia
Basic Cost-Effectiveness Analysis

(Interdependencies Ignored)

Candidate Intervention	Currently Implemented[1]	Cost-Effectiveness Ratio	Intervention Name	Benefit $/year	Cost $/year[2]	Cumulative Cost $/year	# of Fatalities Reduced	# of Injuries Reduced
☑	☐	0	Increased Seat Belt Fine	220,834,000	0	0	65	6893
☑	☑	339.92	Alcohol Interlocks	42,013,000	124,000	124,000	21	755
☑	☑	128.76	Motorcycle Helmet	239,298,000	1,858,000	1,982,000	37	9709
☑	☑	104.26	License Plate Impound	47,264,000	453,000	2,435,000	23	850
☑	☐	103.76	In Person Renewal	53,970,000	520,000	2,955,000	17	1586
☑	☐	62.79	Seat Belt Enforcement Campaign	165,626,000	2,638,000	5,593,000	49	5170
☑	☐	12.82	Saturation Patrols	104,448,000	8,146,000	13,739,000	52	1878
☑	☑	5.88	Red Light Camera	129,736,000	22,075,000	35,814,000	43	3722
☑	☐	2.72	Speed Camera	74,504,000	27,378,000	63,192,000	25	2102
☑	☐	2.66	Vehicle Impoundment	53,216,000	19,985,000	83,177,000	26	957
☑	☐	1.08	Limits on Diversion	19,256,000	17,885,000	101,062,000	10	346
☐	☑	24.37	Bicycle Helmet	12,647,000	519,000	101,062,000	3	463
☐	☑	11.86	Sobriety Checkpoints	71,911,000	6,066,000	101,062,000	23	2098
☐	☑	31.21	Primary Enforcement Seat Belt Law	214,700,000	6,879,000	101,062,000	63	6702

Summary Results of the Interventions Chosen

Category	Value	Units
Total Cost	5,593,000	$ per year
Total Benefit	769,005,000	$ per year
Total # of Fatalities Reduced	212	units
Total # of Injuries Reduced	24,963	units

Annual implementation budget available: $ 10000000

○ Make a Standard Run with Fines-Included Georgia
◉ Make a Standard Run with Fines-Excluded
○ Repeat run with a different state: Please select a state

Run the model | Print Report

Transfer to Portfolio Analysis

Of the 11 interventions selected for analysis, six are shown in green and five in pink, separated by a bold line. This means that the given budget of $10 million can cover the implementation of six interventions. The total cost of these six is $5.6 million, which is within our budget. (The row with the last intervention that the tool selected—that is, the last green row—will always equal the summary cost because this is the cumulative total of all selected interventions.) Four of the five interventions in pink exceed $10 million, so the tool does not select those; the fifth, saturation patrols, costs $8.1 million but has a far lower cost-effectiveness ratio than those that were selected.[35] If we include increased seat belt fines for analysis, the tool will always select it because the cost of implementation is $0 (see "Higher Seat Belt Fine" under "Intervention Cost Estimate Assumptions" in Chapter Three for an explanation). These six interventions together save 212 lives and prevent 24,963 injuries.

For the next run, we retain these 11 interventions for analysis and include fines and fees. In the tool, we can do this by changing the radio button from *Make a Standard Run with Fines-Excluded* to *Make a Standard Run with Fines-Included*. We leave the budget at $10 million and run the model.

[35] The increase seat belt fine intervention always has a cost-effectiveness ratio of 0 because there is no cost.

Figure 6.5. Screenshot of Sample Basic Cost-Effectiveness Analysis for Georgia, Fines Excluded, $10 Million Budget

Georgia
Basic Cost-Effectiveness Analysis
(Interdependencies Ignored)

Candidate Intervention	Currently Implemented[1]	Cost-Effectiveness Ratio	Intervention Name	Benefit $/year	Cost $/year[2]	Cumulative Cost $/year	# of Fatalities Reduced	# of Injuries Reduced
☑	☐	-67.99	Increased Seat Belt Fine	220,834,000	-3,248,000	-3,248,000	65	6893
☑	☐	-1.04	Speed Camera	74,504,000	-71,983,000	-75,231,000	25	2102
☑	☑	-21.55	Red Light Camera	129,736,000	-6,020,000	-81,251,000	43	3722
☑	☑	-9.26	License Plate Impound	47,264,000	-5,103,000	-86,354,000	23	850
☑	☑	339.92	Alcohol Interlocks	42,013,000	124,000	-86,230,000	21	755
☑	☑	135.73	Motorcycle Helmet	239,298,000	1,763,000	-84,467,000	37	9709
☑	☐	103.76	In Person Renewal	53,970,000	520,000	-83,947,000	17	1586
☑	☐	89.69	Seat Belt Enforcement Campaign	165,626,000	1,847,000	-82,100,000	49	5170
☑	☐	16.85	Saturation Patrols	104,448,000	6,199,000	-75,901,000	52	1878
☑	☐	14.1	Vehicle Impoundment	53,216,000	3,774,000	-72,127,000	26	957
☑	☐	2.99	Limits on Diversion	19,256,000	6,450,000	-65,677,000	10	346
☐	☑	24.37	Bicycle Helmet	12,647,000	519,000	-65,677,000	3	463
☐	☑	71.81	Primary Enforcement Seat Belt Law	214,700,000	2,990,000	-65,677,000	63	6702
☐	☑	19.62	Sobriety Checkpoints	71,911,000	3,665,000	-65,677,000	23	2098

Summary Results of the Interventions Chosen

Category	Value	Units
Total Cost	-65,677,000	$ per year
Total Benefit	1,150,165,000	$ per year
Total # of Fatalities Reduced	368	units
Total # of Injuries Reduced	33,968	units

Annual implementation budget available: $ 10000000

◉ Make a Standard Run with Fines-Included Georgia
○ Make a Standard Run with Fines-Excluded
○ Repeat run with a different state: Please select a state

Run the model | Print Report

Transfer to Portfolio Analysis

Now the tool selects all 11 interventions. In the *Cost $/year* column, we see that the speed-camera intervention has negative $71.9 million in costs because of the collection of fines that provide revenue to the state.[36] If we add to this the fine and fee revenue from three other interventions that also have negative costs (increased seat belt fines, red-light cameras, and license plate impoundments), this is a total of $86.4 million available to defray the

[36] As noted in Chapter Five, fines are displayed as a negative cost, because they constitute revenue to the state.

implementation costs. We can also see that the cost for some other interventions has declined as well; for example, motorcycle helmet laws had a cost of $1.86 million in Figure 6.4 and a cost of $1.76 million in Figure 6.5. This is because some fines and fees are collected from offenders, but the cost is still positive because the revenues do not cover the full cost of implementation.

Assuming that the revenues can be used for implementing other interventions, the $86.4 million that these interventions generate provides sufficient revenues to fund all 11 interventions. As can be seen in the summary results table, the state still gains roughly $65.7 million even if it implements all 11 interventions. The $10 million budget that the state provides would not be needed in this case. These 11 interventions also prevent 33,968 injuries and 368 deaths annually. Monetizing the potential loss from these injuries and deaths means that the interventions produce a collective benefit of more than $1.15 billion.[37]

To illustrate how the portfolio analysis works, we use the same example. We select *Transfer to Portfolio Analysis* from the options at the bottom of the screen. The initial screen is shown in Figure 6.6. This screen is a streamlined version of the initial screen for standard analysis. The selection of interventions remains in the far left column. When the user arrives at this screen from a cost-effectiveness analysis, all the previously selected interventions remain selected.

[37] This benefit does not include the net cash flow of $65.7 million from the cost side.

Figure 6.6. Screenshot of Sample Portfolio Analysis for Georgia, Input Screen

Georgia
Portfolio Analysis

(Interdependencies Incorporated)

Candidate Intervention	Currently Implemented[1]	Intervention Name	Benefit $/year[2]	Cost $/year[3]
☑	☑	Alcohol Interlocks	42,013,000	124,000
☐	☑	Sobriety Checkpoints	71,911,000	3,665,000
☐	☑	Bicycle Helmet	12,647,000	519,000
☑	☑	Motorcycle Helmet	239,298,000	1,763,000
☑	☑	Red Light Camera	129,736,000	-6,020,000
☑	☐	Speed Camera	74,504,000	-71,983,000
☑	☐	Saturation Patrols	104,448,000	6,199,000
☐	☑	Primary Enforcement Seat Belt Law	214,700,000	2,448,000
☑	☑	License Plate Impound	47,264,000	-5,103,000
☑	☐	Limits on Diversion	19,256,000	6,450,000
☑	☐	Seat Belt Enforcement Campaign	165,626,000	1,847,000
☑	☐	Vehicle Impoundment	53,216,000	3,774,000
☑	☐	In Person Renewal	53,970,000	520,000
☑	☐	Increased Seat Belt Fine	220,834,000	-2,340,000

Annual implementation budget available: $ 10000000

Run the model | Print Report

At the bottom of the table, we retain the previous budget of $10 million per year. We then select *Run the model*. This initial portfolio analysis run is always a standard run with fines included.

The results of this run are shown in Figure 6.7. As with the similar run in the cost-effectiveness analysis (see Figure 6.5), the model selects all 11 interventions. Again, the revenue provided by the fines from the speed-camera, red-light camera, increased seat belt fine, and license plate impoundment interventions, if allocated to other interventions, would allow all interventions to be funded. As the summary table shows, the revenue to the state is the same as with the cost–effectiveness ratio analysis, about $65.7 million annually.

In the cost-effectiveness analysis, funding all 11 interventions resulted in an estimate of 33,968 injuries prevented and 368 lives saved, for a monetized savings of about $1.15 billion annually (Figure 6.5). However, that analysis does not take into account the interdependencies of the various interventions and therefore double-counts some of the effectiveness. This problem is avoided in the portfolio analysis (Figure 6.7), in which the 11 interventions have slightly lower effectiveness: 32,754 injuries and 343 deaths prevented and a monetized annual benefit of about $1.09 billion.[38]

Generally speaking, the total cost in cost-effectiveness and portfolio analysis should be the same, although rounding the numbers occasionally results in a slight difference. There is one exception: If more than one seat belt intervention is included, the costs are adjusted slightly downward because their implementation costs overlap.

The "Breakdown of Total Cost" table shows the ten cost components. The first ten lines sum to the total cost line in the summary table. Two lines of the ten will always be negative or zero. "Fines and Fees" includes all monies that offenders pay to the state, so this is revenue to the state and shown as negative. This line could be zero if the only selected interventions were among the three that do not carry any fines or fees (alcohol interlocks, bicycle helmets, and in-person license renewal). "Education Programs" will likewise always be negative or zero because our cost assumption is that the fee that an offender required to take a class pays is higher than the cost that the state pays to provide the class.

This table also includes two additional lines that are not included in the total costs. "Offender-Borne Cost" shows costs that offenders pay but not to the state, such as the cost of having a private company install an alcohol interlock. "Cost to Comply with the Law" is the sum of the costs that individuals pay to avoid violating laws, such as the cost to purchase a motorcycle or bicycle helmet. Table 3.2 in Chapter Three shows all four types of costs: state costs, state revenues (paid by individuals to the state), offender-borne costs, and costs to comply with the law.

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[38] In addition to being more accurate, portfolio analysis can serve other purposes. First, it can be used to see whether the simpler cost–benefit ratio analysis serves as a good approximation. Second, when each intervention can be funded at different levels but produces benefits at different degrees correspondingly, cost–benefit ratio analysis can break down and portfolio analysis is a much better approach.

Figure 6.7. Screenshot of Sample Portfolio Analysis for Georgia, Fines Included, $10 Million Budget

Georgia
Portfolio Analysis

(Interdependencies Incorporated)

Candidate Intervention	Currently Implemented[1]	Intervention Name	Benefit $/year[2]	Cost $/year[3]	Selected by Model
☑	☐	Increased Seat Belt Fine	220,834,000	-3,248,000	☑
☑	☐	Speed Camera	74,504,000	-71,983,000	☑
☑	☑	Red Light Camera	129,736,000	-6,020,000	☑
☑	☑	License Plate Impound	47,264,000	-5,103,000	☑
☑	☑	Alcohol Interlocks	42,013,000	124,000	☑
☑	☑	Motorcycle Helmet	239,298,000	1,763,000	☑
☑	☐	In Person Renewal	53,970,000	520,000	☑
☑	☐	Seat Belt Enforcement Campaign	165,626,000	1,847,000	☑
☑	☐	Saturation Patrols	104,448,000	6,199,000	☑
☑	☐	Vehicle Impoundment	53,216,000	3,774,000	☑
☑	☐	Limits on Diversion	19,256,000	6,450,000	☑
☐	☑	Bicycle Helmet	12,647,000	0	☐
☐	☑	Primary Enforcement Seat Belt Law	214,700,000	0	☐
☐	☑	Sobriety Checkpoints	71,911,000	0	☐

Summary Results of the Interventions Chosen

Category	Value	Units
Total Cost	-65,677,000	$ per year
Total Benefit	1,091,384,000	$ per year
Total # of Fatalities Reduced	343	units
Total # of Injuries Reduced	32,754	units

Breakdown of Total Cost

Cost Component	Value	Units
Publicity	6,009,000	$ per year
Police/Highway Patrol Time	12,908,000	$ per year
Department of Motor Vehicles	921,000	$ per year
Probation and Parole	9,708,000	$ per year
Program Management	1,112,000	$ per year
Equipment	36,124,000	$ per year
Education Programs	-138,000	$ per year
Fines and Fees	-165,732,000	$ per year
Impoundment	19,861,000	$ per year
Court System	13,550,000	$ per year
Offender-Borne Cost [4]	23,828,000	$ per year
Cost to Comply with the Law [4]	13,715,000	$ per year

Annual implementation budget available: $ 10000000

It is also possible to run sensitivity analysis for the portfolio analysis. The sensitivity analysis allows the user to change many of the key input values. If we select *Run a sensitivity analysis* and then click the *Run the model* button, the sensitivity analysis portion is shown in Figures 6.8 and 6.9. (Note that the sensitivity run defaults to a model run that includes fines and fees. In this case, because we just did this type of run, the output table is identical to that in Figure 6.7). There are 45 inputs (the relevant injury-to-fatality ratios, injury reductions, state-adjusted costs, fatality reductions, and implementation costs) and the model's default selections ("Default Value") for each. The user can substitute a value for any or all of these inputs.[39] For example, if the user has information about a difference between estimated injuries and deaths for a particular intervention, he or she can override the tool's current use of proportional estimates and assign different estimates to each.

[39] For background on choosing values for sensitivity runs, review different values, such as minimum, most common, and maximum, discussed in Chapter Three.

Figure 6.8. Screenshot of Sensitivity Analysis Table Inputs for Sample Portfolio Analysis for Georgia, Fines Included, $10 Million Budget, Part 1 of 2

Item	Default Value	Valid Input Range[5]	User Value
Injury to Fatality Ratio - Bike Helmet	171.55	≥ 0	
Injury to Fatality Ratio - Motorcycle	264.54	≥ 0	
Injury to Fatality Ratio - Alcohol	36.18	≥ 0	
Injury to Fatality Ratio - Passenger Vehicle	105.56	≥ 0	
Injury to Fatality Ratio - Older Driver	90.84	≥ 0	
Injury to Fatality Ratio - Speed	82.61	≥ 0	
Injury to Fatality Ratio - Intersection	85.86	≥ 0	
Injury Reduction - Sobriety Checkpoints	0.2	0 to 1	
Injury Reduction - Bicycle Helmet	0.15	0 to 1	
Injury Reduction - Motorcycle Helmet	0.289	0 to 1	
Injury Reduction - Redlight Camera	0.17	0 to 1	
Injury Reduction - Speed Camera	0.12	0 to 1	
Injury Reduction - Alcohol Interlocks	0.24	0 to 1	
Injury Reduction - Saturation Patrols	0.179	0 to 1	
Injury Reduction - Primary Enforcement Seat Belt Law	0.07	0 to 1	
Injury Reduction - License Plate	0.27	0 to 1	
Injury Reduction - Limits on Diversion	0.11	0 to 1	
Injury Reduction - Seat Belt Enforcement Campaign	0.054	0 to 1	
Injury Reduction - Vehicle Impoundment	0.304	0 to 1	
Injury Reduction - In Person Renewal	0.090	0 to 1	
Injury Reduction - Increased Seat Belt Fine	0.072	0 to 1	
State-adjusted Cost per Fatality in $	1297915	≥ 0	
State-adjusted Cost per Injury in $	19740	≥ 0	

Figure 6.9. Screenshot of Sensitivity Analysis Table Inputs for Sample Portfolio Analysis for Georgia, Fines Included, $10 Million Budget, Part 2 of 2

Fatality Reduction - Sobriety Checkpoints	0.081	0 to 1	
Fatality Reduction - Bicycle Helmet	0.15	0 to 1	
Fatality Reduction - Motorcycle Helmet	0.289	0 to 1	
Fatality Reduction - Redlight Camera	0.17	0 to 1	
Fatality Reduction - Speed Camera	0.12	0 to 1	
Fatality Reduction - Alcohol Interlocks	0.24	0 to 1	
Fatality Reduction - Saturation Patrols	0.179	0 to 1	
Fatality Reduction - Primary Enforcement Seat Belt Law	0.07	0 to 1	
Fatality Reduction - License Plate	0.27	0 to 1	
Fatality Reduction - Limits on Diversion	0.11	0 to 1	
Fatality Reduction - Seat Belt Enforcement Campaign	0.054	0 to 1	
Fatality Reduction - Vehicle Impoundment	0.304	0 to 1	
Fatality Reduction - In Person Renewal	0.090	0 to 1	
Fatality Reduction - Increased Seat Belt Fine	0.072	0 to 1	
Implementation Cost in $ - Red Light Camera	-6020052	Any	
Implementation Cost in $ - Speed Camera	-71982690	Any	
Implementation Cost in $ - Alcohol Interlocks	123597	Any	
Implementation Cost in $ - Sobriety Checkpoints	3665442	Any	
Implementation Cost in $ - Saturation Patrols	6199078	Any	
Implementation Cost in $ - Bicycle Helmet	519013	Any	
Implementation Cost in $ - Motorcycle Helmet	1763105	Any	
Implementation Cost in $ - Seat Belt Enforcement Campaign	1846708	Any	
Implementation Cost in $ - Primary Enforcement Seat Belt Law	2989640	Any	
Implementation Cost in $ - License Plate	-5102734	Any	
Implementation Cost in $ - Limits on Diversion	6450013	Any	
Implementation Cost in $ - Vehicle Impoundment	3774082	Any	
Implementation Cost in $ - In Person Renewal	520131	Any	
Implementation Cost in $ - Increased Seat Belt Fine	-3533476	Any	

For our example, we change the annual implementation cost for speed cameras from –$72.9 million to $0 and for red-light cameras from –$6 million to $0, to test what happens if the state sets fines from automated enforcement equal to costs such that the program covers its own costs but nothing more. We then click *Run the model* to get the results. This is still a standard run with fines included, 11 interventions selected, and an annual implementation budget of $10 million.

The results of the run are shown in Figure 6.10. Despite not having the funds available from the speed and red-line cameras and a $10 million annual implementation budget, the model now selects ten interventions shown in green at the top of the upper table. The removal of limits on diversion means that the number of injuries and deaths prevented has decreased slightly. The funds come from the fines generated by the license plate impoundment and increased seat belt fines, along with the $10 million budget.

The “Breakdown of Total Cost” table now excludes the costs associated with the limits on diversion because the tool did not select that intervention. However, this table does not reflect the changes to the speed and red-light camera costs because the sensitivity analysis does not break down any changes to total cost for an intervention into its individual cost components.

Figure 6.10. Screenshot of Sample Portfolio Analysis with Sensitivity Analysis for Georgia, Fines Included, $10 Million Budget, $0 in Speed-Camera and Red-Light Camera Fines Collected

Georgia
Portfolio Analysis

(Interdependencies Incorporated)

Candidate Intervention	Currently Implemented[1]	Intervention Name	Benefit $/year[2]	Cost $/year[3]	Selected by Model
☑	☑	Alcohol Interlocks	42,013,000	124,000	☑
☑	☑	Motorcycle Helmet	239,298,000	1,763,000	☑
☑	☑	Red Light Camera	129,736,000	0	☑
☑	☐	Speed Camera	74,504,000	0	☑
☑	☐	Saturation Patrols	104,448,000	6,199,000	☑
☑	☑	License Plate Impound	47,264,000	-5,103,000	☑
☑	☐	Seat Belt Enforcement Campaign	165,626,000	1,847,000	☑
☑	☐	Vehicle Impoundment	53,216,000	3,774,000	☑
☑	☐	In Person Renewal	53,970,000	520,000	☑
☑	☐	Increased Seat Belt Fine	220,834,000	-3,248,000	☑
☐	☑	Sobriety Checkpoints	71,911,000	0	☐
☐	☑	Bicycle Helmet	12,647,000	0	☐
☐	☑	Primary Enforcement Seat Belt Law	214,700,000	0	☐
☑	☐	Limits on Diversion	19,256,000	0	☐

Summary Results of the Interventions Chosen

Category	Value	Units
Total Cost	5,876,000	$ per year
Total Benefit	1,083,959,000	$ per year
Total # of Fatalities Reduced	339	units
Total # of Injuries Reduced	32,621	units

Breakdown of Total Cost

Cost Component	Value	Units
Publicity	6,009,000	$ per year
Police/Highway Patrol Time	12,908,000	$ per year
Department of Motor Vehicles	876,000	$ per year
Probation and Parole	1,291,000	$ per year
Program Management	989,000	$ per year
Equipment	36,124,000	$ per year
Education Programs	-15,000	$ per year
Fines and Fees	-155,193,000	$ per year
Impoundment	19,861,000	$ per year
Court System	5,024,000	$ per year
Offender-Borne Cost [4]	14,209,000	$ per year
Cost to Comply with the Law [4]	13,715,000	$ per year

Annual implementation budget available: $ 10000000

At the bottom of each page is a *Print Report* button, which generates a printer-friendly PDF of the current analysis.

The user can move from state to state in two ways: selecting the radio button for *Repeat run with a different state* or going back to the home page.

Chapter Seven. Potential Effects and Future Refinements

The potential effects of this study can be classified into two categories. One is in methodology development for analyzing the costs and effects of interventions to reduce motor vehicle–related injuries. In this project, we have provided transparent calculations starting from the input assumptions and ending with the estimated cost and effectiveness outcomes. The other is in assistance to state decisionmakers in determining the best mix of interventions to reduce motor vehicle crashes based on a given implementation budget. We discuss both categories in turn, before proceeding to possible future refinements of the tool.

Potential Effects on Methodology Development

This project has departed from traditional methodologies and provided a new way to look at analyzing the costs and effectiveness of interventions in several ways.

First, methods for assessing and ranking the attractiveness of interventions are typically based on cost–effectiveness ratio. The idea is that more effectiveness for each dollar expended is better. However, this ratio approach ignores the interdependencies among interventions and overestimates the total effectiveness when interdependent interventions are implemented. For this project, we calculated results both with and without consideration of such interdependencies. For the 12 interventions assessed in this study, ignoring interdependencies may amount to as large as a 39-percent overestimation of benefits. In the future, when this tool is applied to other cases, the errors may be smaller or larger, depending on the number of interdependent interventions and the degrees of their interdependencies.

Second, as to the best package of interventions to implement for a given budget, the traditional cost-effectiveness approach would first arrange all the candidate interventions into a ranked list: the one with the highest calculated cost–effectiveness ratio at the top and the one with the lowest ratio at the bottom. Then, one would merely select the interventions from the top down until the implementation budget is fully committed. However, significant interdependences could alter the order in which interventions should be selected.

More importantly, as discussed below under “Future Refinements of the Tool,” planners could be interested in not only the binary (i.e., full or no) implementation options for an intervention but also partial implementations at various funding levels for corresponding lesser levels of effectiveness. Partial funding of one or more interventions can result in a larger total effectiveness than full funding of a smaller set of interventions for the same implementation budget. The simple cost–effectiveness ratio method is ill-suited to determine the optimal combination (portfolio) of interventions that are interdependent or can be partially funded for lesser effectiveness. On the other hand, the methodology used in this study employs a mixed-integer linear programming model specifically designed to address these more-complicated and realistic cases.

Third, evidence about the effectiveness of interventions predominantly comes from empirical studies of only several states or localities. Studies, such as Preusser et al., 2008, have developed methods to express these empirically determined effects on injuries and deaths generically so that they can be combined with state-specific characteristics to estimate the effects for a given state. This is an important step because, when decisionmakers consider implementing a new intervention, they do not typically have empirical data on its efficacy in their state and therefore must rely on data from other states. However, on the cost side (unlike the effectiveness side), there has been no systematic study of the extrapolation of empirical data to draw conclusions for other states. For this study, we first designed a structure consisting of ten cost components and 62 cost subcomponents. We then broke these costs into unit costs, such as the cost of advertising per 1,000 viewers or the annual lease fee for a red-light camera. Because only some cost subcomponents are relevant to any intervention, we developed a table showing which subcomponents are pertinent. Further, we adjusted these costs for every state by accounting for its specific characteristics, such as demographics and crash deaths, which determine (for example) how many viewers need to see the publicity campaign and how many red-light cameras are needed. These costs in component and subcomponent form are useful not only for informing the decision of which interventions to select but also planning, for each intervention, which costs will be incurred during implementation.

Finally, this web tool provides an end-to-end method to track and display the effectiveness and costs of interventions. It serves as a library of relevant information, such as where interventions have been implemented and what the experiences have been. The relevant data are stored as input parameters to the model. Any update of the inputs can be immediately available to estimate the impact on effectiveness and costs for implementing various interventions. As noted in the "Future Refinements of the Tool" section, the tool owner can update the tool periodically, and the tool user can update it in real time. Consequently, when using this tool to rank and select new interventions, a state planner can use the most-recent data available and see the expected effectiveness and cost of interventions under consideration in near-real time.

Potential Effects of the Tool in Its Current Version

The tool was developed to help states understand the trade-offs and prioritize the most cost-effective interventions to reduce motor vehicle–related injuries and deaths. States can use the tool to do the following:

- Determine and compare the costs and effects of individual interventions without considering their interdependencies in a conventional cost-effectiveness analyses.

- Determine the optimal portfolio (i.e., the combination) of interventions that would generate the largest total effectiveness for a given budget, accounting for interdependencies.
- Determine the total effectiveness in terms of reductions in injuries and deaths for the optimal portfolio of interventions selected.
- Determine the total effectiveness and costs both with and without the collection of fines and fees.
- Determine the cost structure of the optimal portfolio.
- Perform sensitivity analysis by changing the input values, such as the costs of various components, the value of a life saved or an injury prevented, and the estimated reductions in injuries and deaths.

This tool contributes to the national effort to reduce motor vehicle–related injuries and deaths. It provides state decisionmakers with the information needed to prioritize and select the most cost-effective interventions for their state.

Limitations

Building state-specific cost-effectiveness estimates for 12 interventions was an ambitious undertaking, and there are many challenges associated with developing the cost and effectiveness estimates. In particular, many assumptions are needed to generate these estimates. For example, the effectiveness estimates from the literature are typically associated with a particular jurisdiction and reflect the effect of the intervention as implemented there. We have tried to reflect that in our calculations of implementation costs. However, the literature does not always provide sufficient detail to do this, so we made many assumptions to build the estimate. Moreover, the cost-effectiveness estimates based on these assumptions reflect the level and characteristics (e.g., whether there was a publicity campaign) of implementation of the successful intervention. If the intervention is not implemented at the same level (e.g., not as much publicity about a seat belt enforcement) as assumed in the tool, the estimated costs and effects reported in the tool will not be a good match.

As another example, the existing studies do not always report the intervention's effect on the outcomes of most interest. In fact, we have an estimate of the effect on injuries for only one intervention, so we assume that the reductions in injuries for other interventions are proportional to the reductions in deaths.

There are also limitations associated with the data that are used in the analysis. For example, we could not identify a data set that provides comprehensive information on motor vehicle–related injuries. The available data sources that provide information on injuries describe only a sample of crashes. We therefore had to make a set of assumptions to translate the available data into the information needed for the tool, which included an assumption that the proportion of injuries reduced was equivalent to the proportion of deaths reduced, in the absence of injury-specific information.

In many cases, the literature does not provide as much information as would be ideal, and there is certainly room for reasonable disagreement about the assumptions we have made. We have tried to mitigate this problem in several ways. First, we have worked to find the best available data and evidence off which to build the assumptions. Second, we have also been very transparent, describing our assumptions and calculations in detail, so readers can assess the assumptions themselves. Finally, those who disagree with the assumptions can conduct sensitivity analyses with the tool by adjusting many of the model parameters and use that analysis to inform their selection of the most cost-effective interventions.

The estimates provided by the tool are approximations. They are meant to give decisionmakers a sense of the relative costs and effects of different interventions under consideration. There may be other costs and benefits not captured by the tool that should be considered (e.g., the improved employment or quality of life among people who are deterred from driving while drunk, effects on civil liberties) or political issues that make some interventions more feasible than others. In essence, they are designed to be one category of information in a decisionmaking process about which interventions to implement.

Despite the necessary reliance on assumptions to build the model, we believe that the tool will be of great use to state decisionmakers. Although information about which interventions are effective has been generally available, this is the first effort to estimate the implementation costs across a broad array of interventions and to translate these costs to the state level according to a specific state's demographics and traffic crash profile. States need information on both the potential costs and effects of interventions to make informed resource allocation decisions.

Future Refinements of the Tool

This tool could be refined in a variety of ways. First, this tool reports top-level results based on the default assumptions. The current sensitivity analysis allows changes be made to a limited number of model parameters. In the future, one might want to expand the sensitivity analysis options to include the ten implementation cost components and potentially even to include the 38 cost subcomponents so that a user can see how changes at the more granular level would affect the cost. Similarly, we could expand the sensitivity analysis to allow for changes in the default assumptions about the intervention. For example, for in-person license renewal, we could allow the user to change the age threshold (e.g., from 70 to 75) or the required frequency (e.g., from four to six years), or both.

A second potential refinement is to incorporate new estimates of reductions in injuries and deaths. At the current time, with one exception, all of the estimated reductions in injuries are the same as for deaths because we were unable to locate any studies that directly measured the reduction in injuries due to a particular intervention. However, for example, if we learned of a study that estimated injury reductions of 25 percent at red-light camera intersections, we would incorporate that figure into the calculations rather than the current 17 percent, which is based on reductions in deaths. In this way, we could refine the tool with more-detailed estimates of effectiveness. Tools users would benefit from having such updates programmed into the tool rather than waiting for publications or searching out such information themselves.

Finally, it would also be useful if the expected cost and effectiveness of an intervention could be refined for multiple levels of partial implementation in addition to the full implementation that is currently included. Because cost-effectiveness consideration may find a less-than-full implementation of some interventions to yield bigger bang for the buck, a model that allows scaled-down implementation of interventions (e.g., fewer speed cameras, fewer saturation patrols) may turn out to be more useful because it would better reflect implementation choices available to a state. Our methodology facilitates the estimation of effectiveness for implementation at different funding levels. For example, our method for estimating cost is based on unit costs, such as annual lease payments for red-light cameras. Different funding levels imply that different numbers of red-light cameras are leased. A city could install cameras only at intersections with the most red-light–running incidents or at the majority of intersections; these two courses of action would require different levels of funding. The tool could estimate the different levels of effectiveness at both levels of implementation funding.

Appendix A: Details of Intervention Selection

RAND and CDC worked together closely to select the interventions for consideration. Although we began with a list of 16 interventions that met our three criteria—implementable at the state level, demonstrated to be effective, and not already in widespread use—we both added to and subtracted from this initial list. The two main reasons for doing so were the availability of data and the fact that the *Countermeasures That Work* report occasionally combined multiple interventions that we need to define more precisely to develop cost estimates. The reasons for including or excluding interventions that met the above criteria are provided here:

- **Saturation patrols:** Although these were not on the original list, because they can be used in states that forbid the use of sobriety checkpoints, we decided to include them.
- **DWI courts:** We dropped this from consideration because evidence for their effectiveness is limited and it is difficult to design a methodologically sound study or determine their costs.
- **Red-light cameras:** Despite conflicting literature, including some recent evidence suggesting that they are not as effective as initially thought, we retained this intervention on the grounds that it would be helpful to conduct work on their costs and benefits because many states and localities have considered red-light cameras. In addition, a majority of the literature reports that red-light cameras are effective.
- **Vehicle and license plate sanctions:** The *Countermeasures That Work* report lists five types of sanctions under this heading. (Other sources include alcohol interlocks as a type of sanction, but, because these have been extensively studied, we retained them as a separate intervention.) We considered license plate sanctions separately from vehicle sanctions. Three vehicle sanctions are commonly used: vehicle impoundment, vehicle forfeiture, and vehicle immobilization. Vehicle impoundment has received the most study, so we retained this intervention. Two license plate sanctions are in use: special plates and license plate impoundment. Of the seven states with special license plates, six also have impoundment laws. Although both studies of impoundment laws were carried out in the same state (Minnesota), the more recent was conducted in 2011. Both studies of impoundment laws found positive results, and the most recent study was conducted in 2001.
- **Communications and high-visibility enforcement of seat belt and child restraint laws:** All states conduct such enforcement campaigns, but some more extensively than others, making it difficult to determine an appropriate metric for how widely used this intervention currently is. We spoke with Richard Compton, director of the Office of Behavioral Safety Research at NHTSA, on February 16, 2012. In this conversation, he noted that, for high-visibility enforcement to work, both increased enforcement and publicity are needed. In our previous research, we did not find any references to child restraint high-visibility enforcement campaigns conducted independently of seat belt campaigns. The UNC report notes, “NHTSA typically includes child restraint and booster seat use and enforcement as a part of their Click It Or Ticket campaigns” (pp. 2–36).

Therefore, we decided to combine these previously separate interventions into one covering all enforcement campaign activity for seat belts and child restraints.

- **Referring older drivers to licensing agencies:** We found relatively little literature on the effectiveness of referring older drivers for additional testing to retain a driver's license, so we did not retain this intervention.
- **Lower BAC limits for repeat offenders:** The main study on this intervention (R. Jones and Rodriguez-Iglesias, 2004) identified five states that use this intervention. This is the main source cited in UNC Highway Safety Research Center, 2011. However, our subsequent review of NHTSA's *Digest of Impaired Driving and Selected Beverage Control Laws*, 2011, found that only one state retains such a law. We have been unable to determine precisely why this law was apparently repealed in the other states. Given the apparent difficulty in implementing and enforcing this intervention, we decided not to include it in the tool.
- **Bicycle and pedestrian interventions:** Although we had hoped to include an intervention that specifically addressed these groups of road users, we could not identify one that met our criteria. Almost all the effective interventions we researched were changes in roadway configuration (e.g., shortened curb radii or raised medians). Although we considered pedestrian countdown signals, we could not develop a sound method for determining how many would be required to be effective.
- **Cell phone and texting bans:** These bans have received a good deal of attention as a potential means of countering distracted driving because of device use. However, although some evidence supports their effectiveness (Sampaio, 2010), other studies have found only a short-term or mixed effect (Jacobson et al., 2012; Lim and Chi, 2013). Although these might be considered useful interventions in the future, perhaps combined with specific types of enforcement, at the time we conducted this research, there was insufficient evidence of their general effectiveness.

Appendix B: Intervention Fact Sheets

Our main source for identifying interventions was the *Countermeasures That Work* report (UNC Highway Safety Research Center, 2011). At the time this research began, the 2011 version was the most recent available (an update was published in 2013 [Goodwin, Kirley, et al., 2013]). Because the information was useful, instead of writing entirely new fact sheets, we simply updated them based on the new research findings. For all of the fact sheets, unless otherwise noted, quoted material is from UNC Highway Safety Research Center, 2011. The references include both.

Automated Red-Light Enforcement

History

The first red-light camera bill was signed in New York City in 1993 after several years of testing (Retting, 2010). Since then, many states and local jurisdictions have adopted red-light cameras, known along with speed cameras as *automated enforcement*.

> 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. (UNC Highway Safety Research Center, 2011, p. 3-12)

Use

> Red-light cameras are used extensively in other industrialized countries. . . . [As of December 2011,] [a]ccording to the Insurance Institute for Highway Safety, red-light cameras are used in nearly 500 United States communities in 25 States and the District of Columbia. . . . Information on States' laws authorizing or restricting use of automated enforcement is provided by the GHSA ([2014c]) and by IIHS ([2014b]). (UNC Highway Safety Research Center, 2011, p. 3-12)

Effectiveness

The effectiveness of red-light camera programs has been a source of controversy in the research community. The methodologies used to assess effectiveness have varied, as have the conclusions drawn from different studies.

In one review of the literature, the UNC Highway Safety Research Center, 2011, p. 3-12, concluded that red-light cameras

> increase rear-end crashes, reduce side-impact crashes (the target [crash type]), and reduce overall crash severity[40] ([Aeron-Thomas and Hess, 2005]; [Decina, Thomas, et al., 2007]; [Maccubbin, Staples, and Salwin, 2001]; [McGee and Eccles, 2003]; [Retting, Ferguson, and Hakkert, 2003]; [Peden et al., 2004]). Because there tend to be increases in lower-severity rear end crashes that somewhat offset reductions in the target group of higher-severity [right-angle] crashes, cameras were found to be more beneficial at intersections with a higher ratio of angle crashes to rear-end crashes. Intersections with high total volumes, higher entering volumes on the main road, short signal cycle lengths, protected left turn phases, and higher publicity may also increase the aggregate cost benefits of red light camera enforcement ([Council et al., 2005]).

Several additional studies also found positive results in red-light camera studies. Hu, McCartt, and Teoh, 2011, analyzed data on fatal crashes from 14 large U.S. cities with red-light camera enforcement programs and 48 cities without camera programs for the years 1992–1996 and 2004–2008. The average annual citywide rate of fatal red-light–running crashes declined for both groups, but the rate for cities with camera enforcement declined more (35 percent versus 14 percent). During 2004–2008, the rate of fatal red light running crashes citywide and the rate of all fatal crashes at signalized intersections were 24 percent and 17 percent lower, respectively, than what would have been expected without cameras. By examining citywide crash rates for cities with camera programs and using similar control cities, the study accounted for two common weaknesses of red-light camera research: regression to the mean and spillover effect.

Another study focused on red-light citations at the intersection with the highest incidence of traffic crashes in Louisiana following the installation of red-light cameras (Wahl et al., 2010). Over the eight-month study period, the researchers found a significant and sustained reduction in the mean number of citations per week (from 2,428 violations per week to 356 citations per week) and a nonsignificant reduction in collisions (122 to 97, $p = 0.18$) at the one intersection.

Two other studies also found positive results, although their research designs were not as strong. Newman, 2010, presented findings at the Institute of Transportation Engineers (ITE) 2010 Annual Meeting and Exhibit on the effectiveness of 16 red-light cameras at the busiest intersections in Springfield, Missouri. Following an extensive public education campaign and the installation of the cameras, there was a 20.5-percent reduction in right-angle collisions at photo-enforced signals. There was also an 11.4-percent increase in the number of rear-end crashes, although this increase was not as large as the 15.8-percent increase at the citywide level. Matched control intersections were not used in this study. A thesis from a James A. Baker III Institute research project using seven years of data from 50 intersections in Houston, Texas,

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[40] This UNC report forms the basis of our series of fact sheets. Although, for most fact sheets, our team has relied on UNC's overall effectiveness assessment, for this intervention, we have located studies that appear to contradict the UNC ratings. Automated enforcement received five of five stars, indicating "demonstrated to be effective by several high-quality evaluations with consistent results."

concluded that red-light cameras reduced the monthly number of collisions by approximately 28 percent at intersections with a single camera. Installing two cameras per intersection resulted in reductions in collisions coming from all directions, even the two approaches that were not monitored with cameras (Loftis, Ksiazkiewicz, and Stein, 2011).

Other research has found effects in the opposite direction. Burkey and Obeng's, 2004, analysis of 303 intersections in Greensboro, North Carolina, over a 57-month period found a 40-percent increase in total crash rates resulting from increases in the number of rear-end crashes, sideswipes, and collisions involving cars turning left on the same roadway. They found no decrease in severe crashes (those that included fatal, disabling, and nondisabling injuries) and a 40- to 50-percent increase in possible-injury crashes (those reported in police records as possibly causing injury). Another study examined seven years of data from camera programs in five jurisdictions in Virginia and found a significant 18-percent increase in injury crashes (Garber et al., 2007). In addition, another group of researchers replicated a frequently cited study by Retting and Kyrychenko, 2002, found no significant effect at the $p = 0.05$ level, and concluded the original authors had incorrectly reported a reduction in crashes after the installation of red-light cameras (Large, Orban, and Pracht, 2008).

A recent meta-analysis found favorable results for red-light cameras only in studies with weaker research designs (Erke, Goldenbeld, and Vaa, 2009). Results of the meta-analysis showed a 15-percent increase in total crashes, a 40-percent increase in rear-end collisions, and a 10-percent decrease in right-angle crashes, although none of these results was significant. The author concluded that red-light cameras may have limited effectiveness; however, others have countered that their analyses overweighted non–peer-reviewed studies (Lund, Kyrychenko, and Retting, 2009).

The studies reviewed used a variety of methodologies, data sources, time periods, comparisons, and metrics to reach their conclusions, so it is difficult to compare them directly. However, it does seem that it is premature to conclude that red-light cameras have been widely found to be highly effective.

Measuring Effectiveness

Effectiveness of red-light cameras can be measured in a variety of ways. Common measures include the number or rate of collisions, right-angle crashes, and red-light violations at monitored intersections, as well as measures of crash severity. Studies have also used the number of red-light–running citations as a metric.

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 ([FHWA and NHTSA, 2008]). In 2001, [35-mm wet-film] red-light cameras cost about $50,000 to $60,000 to purchase and $25,000 to install. Monthly

> operating costs were about $5,000 [per camera system] ([Maccubbin, Staples, and Salwin, 2001]). (UNC Highway Safety Research Center, 2011, p. 3-13)

A standard digital camera system costs $100,000 for the equipment and installation; information on operating costs for the digital system was not reported (Maccubbin, Staples, and Salwin, 2001).

> Most jurisdictions contract with private vendors to install and maintain the cameras and use a substantial portion of the income from red-light citations to cover program costs. Speed camera costs probably are similar. (UNC Highway Safety Research Center, 2011, pp. 3-13–3-14)

However, most red-light cameras and speed cameras are separate systems; one camera does not enforce both violations.

Time to Implement

Once any necessary legislation is enacted, automated enforcement programs generally require four to six 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, 2014c]; [IIHS, 2014b]). See NCUTLO [National Committee on Uniform Traffic Laws and Ordinances] (2004) for a model automated enforcement law. (UNC Highway Safety Research Center, 2011, p. 3-14)

Public Acceptance

> Public surveys typically show strong support for red-light cameras and somewhat weaker support for speed cameras ([IIHS, 2014a]; 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). (UNC Highway Safety Research Center, 2011, p. 3-14)

Although a recent report by Madsen and Baxandall, 2011, noted that such practices are less common, contracts may still link revenue to citations through a predetermined proportion of revenue; a variable proportion of revenues based on timeliness of fine collection, quotas, and volume-based payments; and surcharges from fine alternatives, such as traffic school.

Legality

"State courts have consistently supported the constitutionality of automated enforcement" (UNC Highway Safety Research Center, 2011, p. 3-14).

Halo Effects

"More research is needed to shed light on spillover effects (positive or negative) of automated enforcement programs" (UNC Highway Safety Research Center, 2011, p. 3-14). In addition, drivers may start to avoid monitored intersections and increase traffic on neighboring streets.

Automated Speed-Camera Enforcement

> Automated enforcement is used in some jurisdictions to reduce red-light running and speeding. . . . 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, 2008i]; [FHWA and NHTSA, 2008]). (UNC Highway Safety Research Center, 2011, p. 3-12)

History

The first automated speed limit–enforcement program was implemented in Paradise Valley, Arizona, in 1987 (Retting, 2010). Since then, at least 92 jurisdictions (state and local) have adopted automatic enforcement, although speed cameras are not as widely used as red-light cameras. Several jurisdictions, including the State of Maryland and Cincinnati, Ohio, that previously adopted speed cameras have repealed or considered repealing or restricting their speed-camera laws, following legal challenges, as well as negative sentiment among constituents ("Speed Camera Repeal Effort an Easy Sell," 2009).

Use

"Speed cameras have been used in 12 States and the District of Columbia ([IIHS, 2010a]), but not all of these programs may be active at present" (UNC Highway Safety Research Center, 2011, p. 3-12) because local jurisdictions generally contract private firms for the operation of these systems and contract durations vary. For example, the Arizona Department of Public Safety allowed a two-year freeway speed-camera program contract to expire in 2010 (city cameras continue to remain in effect). A compilation of industry listings shows that 92 local governments and authorities had active automated speed cameras as of September 2011, but exact numbers are difficult to obtain because of the lack of federal regulatory oversight (Madsen and Baxandall, 2011). “Speed cameras also are used extensively in other countries” (UNC Highway Safety Research Center, 2011, p. 3-12), such as Australia, Norway, and the United Kingdom (Peden et al., 2004). “Information on States’ laws authorizing or restricting use of automated enforcement is provided by the GHSA ([2014c]) and by IIHS ([2014b])” (UNC Highway Safety Research Center, 2011, p. 3-12).

Effectiveness

> Speed cameras can reduce crashes substantially. [Decina, Thomas, et al., 2007] reviewed 13 safety impact studies of automated speed enforcement internationally, including one study from a United States jurisdiction. The best-controlled studies suggest injury crash reductions are likely to be in the range of 20 to 25 percent at conspicuous, fixed camera sites. Covert, mobile enforcement programs also result in significant crash reductions area-wide ([L. Thomas et al., 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 and Kinra, 2005]; [C. Wilson, Willis, Hendrikz, and Bellamy, 2006]). Recent crash-based studies from the United States have reported positive safety benefits through crash and speed reductions from mobile camera enforcement on 14 urban arterials in Charlotte, NC ([Cunningham, Hummer, and Moon, 2008]), and from fixed camera enforcement on an urban Arizona freeway ([Shin, Washington, and van Schalkwyk, 2009]). (UNC Highway Safety Research Center, 2011, pp. 3-12–3-13)
>
> 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 [crashes during nonpeak periods that are materially affected by camera enforcement] were reduced by an estimated 44 to 54 percent, injury crashes by 28 to 48 percent, and property damage only crashes by 46 to 56 percent during the nine 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 [a measure related to the range of speeds and the amount of variability around the average speed] was also decreased around the enforced zones. (UNC Highway Safety Research Center, 2011, p. 3-13)
>
> [In addition, an] economic analysis suggested that the total estimated safety benefits [including medical, quality of life, and other costs (emergency responders, insurance, wage loss, household work loss, legal fees, and property damage)] were from $16.5 [million] to $17.1 million per year, although other economic impacts were not considered. 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. (UNC Highway Safety Research Center, 2011, p. 3-13)
>
> 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, and 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, and McCartt, 2008]). In the latter case, speed reductions attributed to spillover from the automated enforcement program were also observed on unenforced comparison streets ([Retting, Farmer, and McCartt, 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. (UNC Highway Safety Research Center, 2011, p. 3-13)

Recent Research on Effectiveness

A 2010 update to a 2006 Cochrane systematic review on the effectiveness of speed cameras included an additional nine high-quality studies and maintained the qualitative results from the previous review (C. Wilson, Willis, Hendrikz, Le Brocque, and Bellamy, 2010). The studies reported reductions in average speed of between 1 percent and 15 percent and reductions in the proportion of speeding vehicles of between 14 percent and 65 percent, relative to similar controls. Speed cameras also reduced total crashes 8 percent to 49 percent and fatal and serious-injury crashes 11 percent to 44 percent, in studies that compared pre- and postcrash data collected near camera sites.

Measuring Effectiveness

Effectiveness of speed cameras is typically measured in outcomes related to speed or collisions. Speed outcomes include reductions in average speed, distribution or variance of speed, or percentage of vehicles speeding. Studies varied in their definition of *speeding*—some included any vehicle exceeding the posted limit, while others considered vehicles only at or above a threshold above the legal limit, such as 15 mph above the limit. Collision outcomes include the number or rate of crashes stratified by severity (property damage only, injury, or fatality). It is not clear what the appropriate surveillance area is, but common areas range from 0.15 to 1.25 miles from the camera locations.

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 ([FHWA and NHTSA, 2008]). In 2001, red-light cameras cost about $50,000 to $60,000 to purchase and $25,000 to install. Monthly operating costs were about $5,000 [per camera system] ([Maccubbin, Staples, and Salwin, 2001]). . . . Speed camera costs probably are similar [to those for red-light cameras, but speed cameras are single-purpose—that is, speed cameras cannot be used for red-light enforcement]. [G. Chen, 2005] provides an extensive analysis of the costs and benefits of the British Columbia, Canada speed camera program. [Gains et al., 2004] reported on costs and benefits and program factors of a cost-recovery program used in the U.K. (UNC Highway Safety Research Center, 2011, pp. 3-13–3-14)

Time to Implement

"Once any necessary legislation is enacted, automated enforcement programs generally require 4 to 6 months to plan, publicize, and implement" (UNC Highway Safety Research Center, 2011, p. 3-14).

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, 2014c]; [IIHS, 2014b] [see Table B.1]). See NCUTLO (2004) for a model automated enforcement law. (UNC Highway Safety Research Center, 2011, p. 3-14)

Public Acceptance

> Public surveys typically show strong support for red-light cameras and somewhat weaker support for speed cameras ([IIHS, 2014a]; 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). (UNC Highway Safety Research Center, 2011, p. 3-14)

Although a recent report by the U.S. Public Interest Research Group (U.S. PIRG) (Madsen and Baxandall, 2011), a federation of state Public Interest Research Groups (PIRGs), noted that such practices have become less common, but contracts may still link revenue to citations through a predetermined proportion of revenue; a variable proportion of revenues based on timeliness of fine collection, quotas, and volume-based payments; and surcharges from alternatives, such as traffic school.

> 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, and Cameron, 2003]; [Delaney, Ward, et al., 2005]). (UNC Highway Safety Research Center, 2011, p. 3-14)

Legality

Where cases have been brought, state courts have "consistently supported the constitutionality of automated enforcement" (UNC Highway Safety Research Center, 2011, p. 3-14).

Covert Versus 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 speed cameras by taking alternate routes or speeding up after passing cameras, but data are lacking to confirm this idea ([L. Thomas et al., 2008]). Public acceptance [of speed cameras] may be somewhat harder to gain with more covert forms of enforcement ([FHWA and NHTSA, 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. The recent operational guidelines outline other considerations of overt and covert speed enforcement and signing strategies ([FHWA and NHTSA, 2008]). (UNC Highway Safety Research Center, 2011, p. 3-14)

Halo Effects

C. Wilson, Willis, Hendrikz, Le Brocque, and Bellamy, 2010, refer to the time halo and the distance halo. *Time halo* refers to the effect on speed after the enforcement has ended, and *distance halo* refers to the effect on speed at and around an active enforcement site.

> 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 [an increase in crashes at adjacent non-enforced sites] related to conspicuous, fixed camera enforcement ([Decina, Thomas, et al., 2007]). There is also a possibility of negative spillover [in the form of crash migration] resulting from mobile camera enforcement, but signing and random deployment practices may reduce that possibility ([L. Thomas et al., 2008]). (UNC Highway Safety Research Center, 2011, pp. 3-14–3-15)

Table B.1. State Laws on Enforcement Cameras, as of December 2011

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
Ala.	Red light	Montgomery	$100 fine, 3 points	$110 fine, 0 points
Alaska	Not applicable	No state law	Not applicable	Not applicable
Ariz.	Red light	Statewide	$250 fine, 2 points	$165 fine, 2 points
Ariz.	Speed	Statewide	$250 fine, 3 points	$165 fine, 3 points
Ark.	Use of photo radar by county or state government prohibited except at school zones and railroad crossings; officer must be present, and citation must be issued at time of offense.	Not applicable	Not applicable	Not applicable
Calif.	Red light	Statewide	$100 fine, 1 point	$100 fine, 1 point
Colo.	Red light	Statewide	$110 fine (including surcharge), 4 points	$75, 0 points and no record change
Colo.	Speed	Restricted to construction and school zones, residential areas, and areas adjacent to municipal parks	$151 (including surcharge), 4 points	$40 maximum fine ($80 in school zones); 0 points and no record change; warning only for first photo radar offense if speed is within 10 mph of limit
Conn.	Not applicable	No state law	Not applicable	Not applicable
Del.	Red light	Statewide	$75–$230 fine	$110 maximum fine; not a record or conviction offense; not to be used by insurers
D.C.	Red light	District-wide	$75 fine, 2 points	$75 fine, 0 points
D.C.	Speed	District-wide	$75 fine, 2 points	$75 fine, 0 points
Fla.	Red light	Statewide	$125 fine, 3 points	$158 fine, 0 points
Ga.	Red light	Statewide	$1,000 maximum fine, 3 points	$70 maximum fine; not a conviction or record offense; 0 points; not a moving violation; not to be used by insurers
Hawaii	Not applicable	No state law	Not applicable	Not applicable
Idaho	Not applicable	No state law	Not applicable	Not applicable

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
Ill.	Red light	Cook, DuPage, Kane, Lake, Madison, McHenry, St. Clair, and Will counties; requires local ordinance	$500 maximum fine, 20 points	$100 or the completion of a traffic education program or both; not a moving violation or record offense
Ill.	Speed	Statewide only in construction zones or Illinois State Toll Highway Authority roads. Local authorities are prohibited from using speed cameras; state may use speed cameras, but only when a law enforcement officer is present and witnesses the event.	In construction and toll-authority zones, mandatory $250 fine, 20 points. Not addressed for other situations.	In construction and toll-authority zones, $250 fine or 25 hours community service. Not addressed for other situations.
Ind.	Not applicable	No state law	Not applicable	Not applicable
Iowa	Not applicable	No state law	Not applicable	Not applicable
Kan.	Not applicable	No state law	Not applicable	Not applicable
Ky.	Not applicable	No state law	Not applicable	Not applicable
La.	State law provides that convictions resulting from camera enforcement shall not be reported for inclusion in driver record; the law is silent on other issues.	Not applicable	Not applicable	Not applicable
Maine	All photo enforcement prohibited	Not applicable	Not applicable	Not applicable
Md.	Red light	Statewide	$500 maximum fine, 2 points	$100 maximum civil penalty; 0 points and no record change; not a moving violation; may not be used by insurers
Md.	Speed	Montgomery County school zones and residential districts, Prince George's County school zones, statewide in school zones by local ordinance and work zones	Maximum fine $500 in residential district, $1,000 in school zone; points depend on speed	$40 maximum fine, 0 points
Mass.	Not applicable	No state law	Not applicable	Not applicable
Mich.	Not applicable	No state law	Not applicable	Not applicable

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
Minn.	Not applicable	No state law	Not applicable	Not applicable
Miss.	All localities prohibited from using automated enforcement; all current programs prohibited effective March 20, 2009	Not applicable	Not applicable	Not applicable
Mo.	Not applicable	No state law	Not applicable	Not applicable
Mont.	All localities prohibited from using red-light cameras; rail crossings excepted	Not applicable	Not applicable	Not applicable
Neb.	Not applicable	No state law	Not applicable	Not applicable
Nev.	Prohibits use of imaging equipment unless it is hand held by an officer or installed in a vehicle or facility of a law enforcement agency	Not applicable	$1,000 maximum fine, 4 points	Not applicable
N.H.	Prohibited unless there is specific statutory authorization	Not applicable	Not applicable	Not applicable
N.J.	Red light	Local jurisdictions must pass an ordinance and apply to the transportation commissioner to participate in a pilot program.	$85 fine	$85 fine, 0 points
N.J.	Speed	Speed cameras are prohibited	Not applicable	Not applicable
N.M.	No state law specifically authorizing automated enforcement; NMDOT has banned red-light cameras and mobile enforcement vans on state and federal roadways; state law requires counties and municipalities using camera enforcement to post a warning sign and a warning beacon	Not applicable	Not applicable	Not applicable

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
N.Y.	Red light	Cities of at least 1 million people, up to 150 intersections in each city; effective May 28, 2009, counties of Nassau and Suffolk, the cities of Rochester and Buffalo, by local ordinance, up to 50 intersections; Yonkers, by local ordinance, up to 25 intersections	$100 maximum fine, 3 points	$50 fine; not a record or conviction offense; may not be used by insurers
N.C.	Red light	Where specified by statute (Albemarle, Charlotte, Chapel Hill, Cornelius, Durham, Fayetteville, Greensboro, Greenville, High Point, Huntersville, Lumberton, Matthews, Nags Head, Newton, Pineville, Rocky Mount, Spring Lake, and Wilmington)	$100 maximum fine, 3 points	$75 civil penalty, 0 points
N.D.	Not applicable	No state law	Not applicable	Not applicable
Ohio	Not applicable	No state law	Not applicable	Not applicable
Okla.	Not applicable	No state law	Not applicable	Not applicable
Ore.	Red light	Cities statewide	$300 maximum fine	$300 maximum fine
Ore.	Speed	Albany, Beaverton, Bend, Eugene, Gladstone, Medford, Milwaukie, Oregon City, Portland, and Tigard (may not be used for more than four hours per day in any one location)	$300 maximum fine	$300 maximum fine
Pa.	Red light	Philadelphia	$25 fine, 3 points	$100 maximum; not on operating record
R.I.	Red light	Statewide	$75 fine	$75 fine; not a criminal or record offense; not a moving violation; not to be used by insurers until there is a final adjudication of the violation

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
S.C.	Photo enforcement prohibited with narrow exception; citations for violating traffic laws relating to speed or disregarding traffic-control devices may only be used when the state declares an emergency, and citations must be served in person within one hour of the violation	Not applicable	Not applicable	Not applicable
S.D.	Not applicable	No state law	Not applicable	Not applicable
Tenn.	Traffic violation; right-turn-on-red violations limited to signed intersections	Statewide except for interstate highways that are not work zones	$50 fine, number of points not specified	$50, 0 points
Texas	Red light	Statewide; requires local ordinance	$200 maximum fine	$75; not a criminal or record offense
Texas	Speed	A Texas municipality may not use an automated traffic-control system to enforce speed.	Not applicable	Not applicable
Utah	Speed	Statewide only in school zones or where limit is 30 mph or less; officer must be present; requires local ordinance	$1,000 maximum fine, 50 points	not reportable; no points may be assessed
Vt.	Not applicable	No state law	Not applicable	Not applicable
Va.	Red light	Counties, cities, and towns may operate cameras at no more than one intersection for every 10,000 residents; requires local ordinance; the exception is the Washington, D.C., metropolitan area, which permits up to ten camera sites or one site per 10,000 residents, whichever is greater.	$200 maximum fine, 4 points	$50 maximum fine; no prosecution costs; not a criminal offense; 0 points; may not be used by insurers

State	Violation	Where Permitted	Traditional-Enforcement Penalty and Record Changes	Automated-Enforcement Penalty and Record Changes
Wash.	Red light	Cities and counties statewide where two arterial roads intersect	$250 maximum fine	Fine up to the maximum for parking violations in the jurisdiction; no record; 0 points
Wash.	Speed	School zone	$250 maximum fine	Fine up to the maximum for parking violations in the jurisdiction; no record; 0 points
W.Va.	All	All photo enforcement prohibited	Not applicable	Not applicable
Wis.	Speed	Speed cameras are prohibited	Not applicable	Not applicable
Wyo.	Not applicable	No state law	Not applicable	Not applicable

SOURCE: IIHS, 2010a.
NOTE: IDOT = Illinois Department of Transportation. ICC = Illinois Commerce Commission. NMDOT = New Mexico Department of Transportation.

Alcohol Interlocks

> 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. (UNC Highway Safety Research Center, 2011, p. 1-32)
>
> 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, [McGee and Eccles] (2003, Strategy C2), and presentations from the 10th Annual International Alcohol Interlock Symposium ([Robertson, Holmes, and Vanlaar, 2010]). NHTSA offers an ignition interlock toolkit to assist policymakers, highway safety professions, and advocates (Sprattler, 2009). In addition, TIRF [the Traffic Injury Research Foundation] offers an alcohol interlock curriculum for practitioners ([Robertson, Holmes, and Vanlaar, 2010]). (UNC Highway Safety Research Center, 2011, p. 1-32)

History

The first interlock was developed in 1969. Interlocks with alcohol-sensing devices (instead of performance-based devices) became the standard in the 1980s (Marques and Voas, 2010). Some states implemented pilot programs in the mid-1980s; California was the first to enact legislation allowing interlock use (DeYoung, Tashima, and Masten, 2005). NHTSA issued the first standards in 1992. Interlock programs became more popular as the effectiveness of license sanctions declined, as more-effective devices became available, and as states sought more-targeted solutions than vehicle impoundment (Marques, Voas, et al., 2010).

Use

As of February 2012, all states have laws either mandating or allowing the use of alcohol interlocks (NCSL, 2014b). Laws vary between states; interlocks may be required for all first offenders, only high-BAC offenders (meaning that the driver's BAC was substantially above the legal limit of 0.08), or repeat offenders. Where they are not mandated by the state, courts or DMVs may impose them. States may also allow interlocks in conjunction with other sanctions, such as allowing an offender to drive during a license suspension but only if he or she installs interlocks (IIHS, 2011b).

"Thirty-six States considered legislation pertaining to interlocks in 2010, with new laws passing in 18 States ([NCSL, 2014b])" (UNC Highway Safety Research Center, 2011, p. 1-32).

> Despite widespread laws, only a small percent 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 212,000 in 2010 (Roth, 2010). 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 percent installed interlocks once they qualified for reinstatement ([Voas, Tippetts, et al., 2010]). Use of interlocks is also higher when interlocks are offered as an alternative to home confinement via electronic monitoring ([Roth, Marques, and Voas, 2009]). (UNC Highway Safety Research Center, 2011, p. 1-32)

Effectiveness

> Beirness and Marques (2004) summarized 10 evaluations of interlock programs in the United States and Canada. Interlocks cut DWI recidivism at least in half, and sometimes more, compared to similar offenders without interlocks. After the interlock was removed, the effects largely disappeared, with interlock and comparison drivers having similar recidivism rates. A Cochrane review of 11 completed and 3 ongoing studies reached similar conclusions (Willis, Lybrand, and Bellamy, 2004). 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 an effective method for preventing alcohol-impaired driving while they are installed. (UNC Highway Safety Research Center, 2011, pp. 1-32–1-33)

Costs

> Interlock programs are managed by private interlock equipment providers. Costs in 2006 averaged about $175 to install an interlock and $2.25 per day while the

> interlock is installed. The offenders usually pay these costs (Marques, 2006). Illinois passed legislation in 2008 that creates a special fund to reimburse interlock providers when they install a device in the vehicle of an indigent offender ([Savage, Teigen, and Farber, 2009]). (UNC Highway Safety Research Center, 2011, p. 1-33)

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" (UNC Highway Safety Research Center, 2011, p. 1-33).

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 long license suspension periods during which offenders are not eligible for any driving, judges who lack confidence in the interlock technology or who fail to enforce "mandatory" interlock requirements, and interlock costs. See Beirness and Marques (2004), Beirness, Clayton, and Vanlaar (2008), Beirness and Robertson (2005), and [McGee and Eccles] (2003, Strategy C2) for discussion. (UNC Highway Safety Research Center, 2011, p. 1-33)

Public Support

> There is strong support for ignition interlocks among the general public. In a national survey, 84 percent of respondents approved of requiring interlocks in the vehicles of convicted DWI offenders ([McCartt, Wells, and Teoh, 2010]). Moreover, almost two-thirds (64 percent) of respondents favored having alcohol detection technology in *all* vehicles. (UNC Highway Safety Research Center, 2011, pp. 1-32–1-33)

Measuring Effectiveness

The effectiveness of alcohol interlocks is generally measured in terms of recidivism, expressed as the percentage of offenders who have alcohol-related traffic violations while the interlocks are installed. As noted above, the existence of state regulations does not necessarily lead to widespread use; this could be an additional metric. Very few studies look at whether the existence of specific provisions of the regulation leads to fewer alcohol-related crashes in the state. A New Mexico study, for example, found that, although crashes decreased during the study period, because other safety programs were implemented at the same time, it was not possible to determine whether the decrease was a result of the interlock law or other factors (Marques, Voas, et al., 2010, p. 4).

Recent Research on Effectiveness

According to a 2010 survey, about 15 studies of interlock effectiveness had been completed. These studies found rates of between 35 and 75 percent effectiveness when they were installed in a vehicle. However, although these rates were statistically significant, offenders were not randomly assigned (Marques and Voas, 2010).

Two large-scale randomly assigned studies in Maryland found different results regarding the length of the effect. The first, with almost 1,400 subjects, found that offenders with interlocks, as opposed to a license-restriction program, were 65 percent less likely than members of the control group to commit a violation while the interlock was installed. But when the year ended, recidivism rates between the two groups were about the same (K. Beck et al., 1999). The second, analyzing about 1,900 drivers, found that offenders randomly assigned to an interlock program for two years were 26 percent less likely to have another DWI offense during the two-year period following the removal of the interlock. However, the difference between the two groups was only 36 percent for the two-year period of the study. The authors attributed this to the reduced monitoring by the state during the study period. They also suggested that the reduced recidivism post–device removal may have been due to the longer period, during which time offenders may have received substantial reinforcement against drinking and driving (Rauch et al., 2011).

Marques, Voas, et al., 2010, conducted eight separate studies to assess the effects of New Mexico's mandatory interlock laws (six laws have been passed since 1999, with progressively more-stringent requirements). They found that recidivism was reduced by 65 percent when offenders whose licenses were revoked installed interlocks; first-time-offender recidivism was 61 percent lower with interlocks than without; offenders with long-term license revocations were not very interested in entering interlock programs; greater interlock usage rates were attained with mandatory programs than voluntary ones; and offenders 20 and younger had higher recidivism rates than older offenders, but rates for young offenders were lower with interlocks than without interlocks.

Other recent research has found that closer monitoring of offenders was found to produce fewer noncompliance issues than standard monitoring (Zador et al., 2011). A study in Florida evaluated a new law that requires an offender to install an interlock before his or her license can be reinstated (most laws require a fixed period of time, so this is a stronger sanction). Only about one-quarter of offenders in the study qualified for reinstatement, but, of those, 93 percent had interlocks installed (Voas, Tippetts, Fisher, et al., 2010).

Table B.2. Alcohol Interlock Laws, as of October 2011

State	Administrative License Suspension for 1st Offense	Restore Driving Privileges During Suspension	Ignition Interlocks Mandatory Under State Law for First-Time Offenders	Ignition Interlocks Mandatory Under State Law for Repeat Offenders
Ala.	90 days	No	High-BAC offenders only	Yes
Alaska	90 days	After 30 days[a]	All offenders	Yes
Ariz.	90 days	After 30 days[a]	All offenders	Yes
Ark.	6 months	Yes[a]	All offenders	Yes
Calif.	4 months	After 30 days[a]	All offenders (in four counties)[b]	No
Colo.	3 months	Yes[a]	All offenders	Yes
Conn.	90 days	Yes[a]	All offenders[c]	Yes
Del.	3 months	No	High-BAC offenders only	Yes
D.C.	2–90 days	Yes[a]	No	No
Fla.	6 months	After 30 days[a]	High-BAC offenders only	Yes
Ga.	1 year	Yes[a]	No	Yes[d, e]
Hawaii	3 months	After 30 days[a]	All offenders	Yes
Idaho	90 days	After 30 days[a]	No	No
Ill.	6 months	After 30 days[a]	All offenders	Yes
Ind.	180 days	After 30 days[a]	No	No
Iowa	180 days	After 90 days[a]	No	No
Kan.	30 days	No	All offenders	Yes
Ky.	No	Not applicable	No	No
La.	90 days	After 30 days[a]	All offenders	Yes
Maine	90 days	Yes[a]	No	No
Md.	45 days	Yes[a]	High-BAC offenders only	Yes
Mass.	90 days	No	No	Yes
Mich.	No	Not applicable	High-BAC offenders only	Yes
Minn.	90 days	After 15 days[a]	High-BAC offenders only	Yes
Miss.	90 days	No	No	No
Mo.	30 days	No	No	Yes
Mont.	No	Not applicable	No	Yes
Neb.	180 days	After 30 days[a]	All offenders	Yes
Nev.	90 days	After 45 days[a]	No	No
N.H.	6 months	No	High-BAC offenders only	Yes
N.J.	No	Not applicable	High-BAC offenders only	Yes
N.M.	90 days	After 30 days[a]	All offenders	Yes
N.Y.	Variable[†]	Yes[a]	All offenders	Yes
N.C.	30 days	After 10 days[a]	High-BAC offenders only	Yes

State	Administrative License Suspension for 1st Offense	Restore Driving Privileges During Suspension	Ignition Interlocks Mandatory Under State Law for First-Time Offenders	Ignition Interlocks Mandatory Under State Law for Repeat Offenders
N.D.	91 days	After 30 days[a]	No	No
Ohio	90 days	After 15 days[a]	No	No
Okla.	180 days	Yes[a]	High-BAC offenders only[g]	Yes
Ore.	90 days	After 30 days[a]	All offenders	Yes
Pa.	No	Not applicable	No	Yes
R.I.	No	Not applicable	No	No
S.C.	No	Not applicable	No	Yes
S.D.	No	Not applicable	No	No
Tenn.	No	Not applicable	High-BAC offenders only	Yes
Texas	90 days	Yes[a]	No	Yes
Utah	120 days	No	All offenders	Yes
Vt.	90 days	No	No	No
Va.	7 days	No	High-BAC offenders only	Yes
Wash.	90 days	Yes[a]	All offenders	Yes
W.Va.	6 months	After 30 days[a]	High-BAC offenders only	Yes
Wis.	6 months	Yes[a]	High-BAC offenders only	Yes
Wyo.	90 days	Yes[a]	High-BAC offenders only	Yes

SOURCE: IIHS, 2011b.
[a] Drivers usually must demonstrate special hardship to justify restoring privileges during suspension, and then privileges often are restricted.
[b] First-time-offender pilot program in four counties—Alameda, Los Angeles, Sacramento, and Tulare.
[c] Effective December 1, 2012.
[d] Interlock is mandatory unless waived because of financial hardship.
[e] Effective January 1, 2012.
[f] In New York, administrative license suspension lasts until prosecution is complete.
[g] Effective November 1, 2011.

Sobriety Checkpoints

A sobriety checkpoint is a predetermined location at which

> 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. Fell, Lacey, and Voas (2004) provide an overview of checkpoint operations, use, effectiveness, and issues. (UNC Highway Safety Research Center, 2011, p. 1-18)

History

Sobriety checkpoints were first introduced in Scandinavia in the 1930s (Elder, Shults, et al., 2002) and became common in the United States in the early 1980s (Hedlund and McCartt, 2002). In 1990, the U.S. Supreme Court ruled in favor of the constitutionality of sobriety checkpoints; however, the debate over checkpoints has continued, and some individual state courts have deemed them illegal for violating state constitutions (IIHS, 2012).

Use

> Sobriety checkpoints are authorized in 38 States and the District of Columbia (NHTSA, [2008g] [see Table B.3]), but few States conduct them often. According to GHSA ([2014b]), 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, et al., 2003]). (UNC Highway Safety Research Center, 2011, p. 1-18)

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 percent ([Elder, Shults, et al., 2002]). Similarly, a meta-analysis found that checkpoints reduce alcohol-related crashes by 17 percent, and all crashes by 10 to 15 percent ([Erke, Goldenbeld, and Vaa, 2009]). In recent years, NHTSA has supported a number of efforts to reduce alcohol-impaired driving using sobriety checkpoints. Evaluations of recent 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, et al., 2007]; [Zwicker, Chaudhary, Solomon, et al., 2007]). In addition, a study examining demonstration programs in 7 States found reductions in alcohol-related fatalities between 11 and 20 percent 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, et al., 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, [2007]; Syner et al., 2008), the *Checkpoint Strikeforce* program ([Lacey, Kelley-Baker, et al., 2008]), and the national Labor Day holiday campaign: *Drunk Driving. Over the Limit. Under Arrest* ([Solomon, Hedlund, et al., 2008]). (UNC Highway Safety Research Center, 2011, p. 1-18)

Recent Research on Effectiveness

Nunn and Newby, 2011, examined the effectiveness of 22 sobriety checkpoints implemented over one year at nine checkpoint locations in Indianapolis, Indiana, using various methodologies (pre/post, difference in differences, and interrupted time series). Impairment rates (impaired-driver collisions per 100 collisions) decreased insignificantly in nondowntown locations and increased significantly in downtown areas. Sobriety checkpoints also resulted in a small significant reduction in the number of alcohol-related crashes when compared with similar control locations, with differences more pronounced in downtown areas. Finally, the time-series analysis found that the number of impaired collisions in postcheckpoint periods was approximately 19 percent less than in the precheckpoint periods.

Measuring Effectiveness

Because sobriety checkpoints are intended to deter impaired driving, an appropriate measure would be the number of impaired drivers deterred, but this is not easily identified. Instead, traffic enforcement agencies track changes in alcohol-related crashes, injuries, and fatalities. Measures can also include the number of stops and the number of DWI arrests per checkpoint or awareness or perceptions of the checkpoints obtained through surveys.

Costs

> The main costs are for law enforcement time and for publicity. A typical checkpoint requires several hours from each law enforcement officer involved. Law enforcement costs can be reduced by operating checkpoints with 3 to 5 officers, perhaps supplemented by volunteers, instead of the 10 to 12 or more officers used in some jurisdictions (NHTSA, 2002; NHTSA, [2006a]; [Stuster and 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 and higher was 70 percent lower in these counties compared to drivers in comparison counties that did not operate additional checkpoints ([Lacey, Ferguson, et al., 2006]). NHTSA has a guidebook available to assist law enforcement agencies in planning, operating and evaluating low-staff sobriety checkpoints (NHTSA, [2006a]). (UNC Highway Safety Research Center, 2011, pp. 1-18–1-19)

"Checkpoint publicity can be costly if paid media are used, although publicity can also include earned media" (e.g., free news coverage of campaign) (UNC Highway Safety Research Center, 2011, p. 1-19).

Time to Implement

"Checkpoints can be implemented very quickly if officers are trained in detecting impaired drivers, SFST [Standardized Field Sobriety Test], and checkpoint operational procedures. See NHTSA, 2002, for implementation information" (UNC Highway Safety Research Center, 2011, p. 1-19).

Other Issues

Legality

> Checkpoints currently are permitted in 38 States and the District of Columbia (NHTSA, [2008g]). Checkpoints are permitted under the United States Constitution but some State courts have held that checkpoints violate their State's

> constitution. Some State legislatures have not authorized checkpoints. States where checkpoints are not permitted may use saturation patrols (see [“Saturation Patrols,” next]). (UNC Highway Safety Research Center, 2011, p. 1-19)

Visibility

According to NHTSA, checkpoints

> must be highly visible and publicized extensively to be effective [(NHTSA, 2011b)]. 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 ([Goodwin, Foss, et al., 2005], Strategy B1). (UNC Highway Safety Research Center, 2011, p. 1-19)

Arrests

The primary purpose of checkpoints is to deter impaired driving, not to increase arrests. Police generally arrest impaired drivers detected at checkpoints and publicize those arrests, but arrests at checkpoints should not be used as a measure of checkpoint effectiveness. The number of drivers evaluated at checkpoints would be a more appropriate measure.

Other Offenses

Checkpoints may also be used to check for valid driver’s 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 impaired-driving enforcement effort.

Table B.3. State Laws on Sobriety Checkpoints, as of December 2011

State	Checkpoints Conducted	Frequency	Legality
Ala.	Yes	Throughout the year	Upheld under U.S. Constitution
Alaska	No	Not applicable	No state authority
Ariz.	Yes	At least once per month	Upheld under U.S. Constitution
Ark.	Yes	Weekly	Upheld under state and U.S. Constitutions
Calif.	Yes	2,500+ annually	Upheld under state and U.S. Constitutions
Colo.	Yes	Once or twice per month	Upheld under state and U.S. Constitutions
Conn.	Yes	Not applicable	Upheld under state constitution
Del.	Yes	Once or twice per month	Upheld under U.S. Constitution

State	Checkpoints Conducted	Frequency	Legality
D.C.	Yes	Monthly January to June; weekly July through December	Upheld under state law and U.S. Constitution
Fla.	Yes	Between 15 and 20 per month	Upheld under U.S. Constitution
Ga.	Yes	Weekly	Upheld under state and U.S. Constitutions
Hawaii	Yes	Weekly	Authorized by statute
Idaho	No	Not applicable	Illegal under state law
Ill.	Yes	Several hundred per year	Upheld under U.S. Constitution
Ind.	Yes	Not applicable	Upheld under state constitution
Iowa	No	Not applicable	Not permitted; statute authorizing roadblock controls does not authorize sobriety checkpoints
Kan.	Yes	Once or twice per month	Upheld under state law and U.S. Constitution
Ky.	Yes	Weekly	Upheld under U.S. Constitution
La.	Yes	Not applicable	Upheld under state constitution
Maine	Yes	Not applicable	Upheld under U.S. Constitution
Md.	Yes	Weekly	Upheld under state and U.S. Constitutions
Mass.	Yes	Year round	Upheld under state and U.S. Constitutions
Mich.	No	Not applicable	Illegal under state constitution
Minn.	No	Not applicable	Illegal under state constitution
Miss.	Yes	Weekly	Upheld under U.S. Constitution
Mo.	Yes	Once or twice per month	Upheld under state and U.S. Constitution
Mont.	No	Not applicable	Statute permits only safety spot checks
Neb.	Yes	6 to 10 per month	Upheld under state law
Nev.	Yes	Once or twice per month	Authorized by statute
N.H.	Yes	Weekly, weather permitting	Authorized by statute (must be judicially approved)
N.J.	Yes	Once or twice per month	Upheld under state and U.S. Constitutions
N.M.	Yes	Not applicable	Upheld under state and U.S. Constitutions (law enforcement must follow guidelines)
N.Y.	Yes	Weekly	Upheld under U.S. Constitution
N.C.	Yes	Weekly	Authorized by statute
N.D.	Yes	Not applicable	Upheld under state and U.S. Constitutions
Ohio	Yes	Year round	Upheld under state and U.S. Constitutions
Okla.	Yes	Once or twice per month	Upheld under state and U.S. Constitutions
Ore.	No	Not applicable	Illegal under state constitution
Pa.	Yes	Several hundred per year	Upheld under state and U.S. Constitutions
R.I.	No	Not applicable	Illegal under state constitution
S.C.	Yes	Not applicable	No state authority
S.D.	Yes	Weekly	Upheld under state and U.S. Constitutions
Tenn.	Yes	Once or twice per month	Upheld under state and U.S. Constitutions

State	Checkpoints Conducted	Frequency	Legality
Texas	No	Not applicable	Illegal under Texas' interpretation of U.S. Constitution
Utah	Yes	About every other month	Authorized by statute
Vt.	Yes	Weekly	Upheld under state and U.S. Constitutions
Va.	Yes	Weekly	Upheld under state and U.S. Constitutions
Wash.	No	Not applicable	Illegal under state constitution
W.Va.	Yes	Weekly	Upheld under state and U.S. Constitutions
Wis.	No	Not applicable	Prohibited by statute
Wyo.	No	Not applicable	Prohibited by interpretation of roadblock statute

SOURCE: GHSA, 2014b.

Saturation Patrols

> 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. (UNC Highway Safety Research Center, 2011, p. 1-20)

Saturation patrols look for impaired-driving behaviors, such as reckless or aggressive driving, speeding, and following too closely. "Like sobriety checkpoints, the primary purpose of saturation patrols 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" (UNC Highway Safety Research Center, 2011, p. 1-20). Saturation patrols can have advantages over sobriety checkpoints, including increased effectiveness, reduced staffing, and comparative ease of operation (Greene, 2003).

> 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). (UNC Highway Safety Research Center, 2011, p. 1-20)

History

Saturation patrols have been used by law enforcement agencies longer than sobriety checkpoints (Greene, 2003). The first high-profile saturation patrol, Project Zero Patrol, was developed as New York State's Zone Enforcement Reduction Operation in the late 1990s (National Hardcore Drunk Driver Project, 1998). The Project Zero Patrol, a statewide saturation patrol initiative that combined resources across state and local police and sheriff departments, proved effective at deterring impaired driving. Other states have since adopted similar saturation patrol programs, such as Minnesota's Operation Nighttime Concentrated Alcohol Patrol

(NightCAP) program, which has doubled the annual number of stops and citations since its implementation in 2003.

Use

"A survey conducted by The Century Council (2008) reported that 44 States used saturation patrols"; however, it did not report which states. They are legal in all states (National Hardcore Drunk Driver Project, 1998). We were unable to identify a list of states that actively use saturation patrols.

Effectiveness

> A demonstration program in Michigan revealed that saturation patrols can be effective in reducing alcohol-related fatal crashes when accompanied by intensive publicity ([Fell, Langston, et al., 2008]). Michigan is prohibited by State law from conducting sobriety checkpoints. In addition, saturation patrols can be very effective in arresting impaired drivers. For example, in 2006 Minnesota's 290 saturation patrols stopped 33,923 vehicles and arrested 2,796 impaired drivers ([National Hardcore Drunk Driver Project, 1998]). (UNC Highway Safety Research Center, 2011, p. 1-20)

Saturation patrols have also been found to promote other safe driving behavior, such as seat belt usage (Hedlund, Gilbert, et al., 2008).

Recent Research on Effectiveness

None.

Measuring Effectiveness

Effectiveness can be measured in DWI arrests per working hour. Other measures can include the number of drivers evaluated and the number of DWI arrests per patrol. Because saturation points are intended to deter impaired driving, an appropriate measure would be the number of impaired drivers deterred, but this is not easily identified. Instead, traffic enforcement agencies can track changes in annual arrest rates and alcohol-related crashes before and after the introduction of saturation patrols.

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. (UNC Highway Safety Research Center, 2011, p. 1-20)

In order to be most effective, saturation patrols need to be frequent and heavily advertised.

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. (UNC Highway Safety Research Center, 2011, p. 1-20)

Other Issues

Legality

"Saturation patrols are legal in all jurisdictions" (UNC Highway Safety Research Center, 2011, p. 1-20).

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 ([Goodwin, Foss, et al., 2005], Strategy B1). (UNC Highway Safety Research Center, 2011, p. 1-20)

Other Offenses

"Saturation patrols are effective in detecting other driving and criminal offenses" (UNC Highway Safety Research Center, 2011, p. 1-20).

Bicycle Helmet Laws for Children

> The purpose of bicycle helmet laws for children is to reduce the number of severe and fatal head injuries to children involved in bicycle crashes. Bicycle helmets, when used properly, reduce head injuries and fatalities. Attewell, Glase, and McFadden (2001) examined all research studies published between 1987 and 1998. They found that helmets reduced overall head injuries by about 60 percent and reduced fatalities by about 73 percent. A Cochrane review and meta-analysis reported a reduction in injury rates between 63 and 88 percent ([Thompson, Rivara, and Thompson, 1999]). (UNC Highway Safety Research Center, 2011, p. 9-9)

"A helmet use law is a significant tool in increasing helmet use, but as with all laws effectiveness is related to implementation" (UNC Highway Safety Research Center, 2011, p. 9-9).

> Legislation effectiveness is enhanced when combined with supportive publicity and education campaigns. See, for example, [Rivara et al., 1998], [Kanny et al. (2001)], and [G. 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). (UNC Highway Safety Research Center, 2011, p. 9-9)

> 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. (UNC Highway Safety Research Center, 2011, p. 9-9)

History

States and cities started passing bicycle helmet legislation in the late 1980s (Dunlap, 2011). California and New York were among the first, mandating helmets for bicycle passengers age 5 and younger.

Use

As of December 2011, "21 States, the District of Columbia, and at least 201 municipalities or counties [had] child helmet laws ([Bicycle Helmet Safety Institute (BHSI), 2014] [and [IIHS, 2011a]]). Most laws cover all bicyclists under age 16. Only 13 States have no State or local bicycle helmet laws" (UNC Highway Safety Research Center, 2011, p. 9-9).

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 et al., 2006]; [Macpherson and Spinks, 2008]). 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 and Spinks, 2008]). 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. (UNC Highway Safety Research Center, 2011, p. 9-9)
>
> 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 and Spinks, 2008]). (UNC Highway Safety Research Center, 2011, pp. 9-9–9-10)
>
> Earlier crash-trend analyses using FARS data suggested that State helmet-use laws for children reduce child bicycle fatalities by about 15 percent in the long run ([Grant and 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 of age. 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. (UNC Highway Safety Research Center, 2011, p. 9-10)

Recent Research on Effectiveness

Researchers looked at bicycle-related injuries in Los Angeles County before and after California enacted a statewide helmet law for minors and found no difference in the rate of helmet use or injury patterns, although lack of a concurrent control group prevented the authors from concluding that the legislation had no effect (Castle et al., 2012).

The comprehensiveness of helmet legislation may play a critical role in effectiveness by creating a culture of bicycle safety. One cross-sectional study of three provinces in Canada showed that self-reported helmet use was lowest in the province without a helmet regulation (26.9 percent) and lower among youth in Ontario, where a helmet law for minors was in effect, than in Nova Scotia, where a universal helmet law had been in effect for approximately the same amount of time (46.7 percent versus 77.5 percent) (Dennis, Potter, et al., 2010). Another cross-sectional study using nationally representative data found that more children ages 5 to 14 years who lived in places with statewide helmet laws always wore helmets while riding bicycles (59.3 percent) than children living in places with local laws (44.9 percent) or no law (25.5 percent) (Dellinger and Kresnow, 2010).

Measuring Effectiveness

There are several ways to measure the effectiveness of bicycle helmet laws. Rates of helmet use can be estimated through parental self-reporting, self-reporting by adolescents, or observation. Additionally, hospitals and surveillance systems can track the number of bicycle-related fatalities, head injuries, and traumatic brain injuries (TBIs).

Costs

To be effective,

> [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, 2008c]). (UNC Highway Safety Research Center, 2011, p. 9-10)

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. (UNC Highway Safety Research Center, 2011, p. 9-10)

Universal Motorcycle Helmet Laws

> Motorcycle helmets are highly effective in protecting motorcycle riders' heads in a crash. The latest research indicates that helmets reduce motorcycle rider fatalities by 22 to 42 percent and brain injuries by 41 to 69 percent ([Coben, Steiner, and Miller, 2007]; [Cummings et al., 2006]; [Deutermann, 2004]; [Liu et al., 2008]; [NHTSA, 2003c]; [NHTSA, 2006c]). 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 percent reduction in risk of death in a crash and 69 percent 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 [Federal Motor Vehicle Safety Standard] 218 compliant helmets on injury outcomes (Liu et al., 2008). Others have found no evidence that helmets increase the risk of neck injuries ([I. Potts, Garets, et al., 2008], Strategy E1; [NHTSA and Motorcycle Safety Foundation, 2000]; [Ulmer and Preusser, 2003]). (UNC Highway Safety Research Center, 2011, p. 5-7)

State universal motorcycle helmet–use laws are effective at increasing helmet use. DOT-compliant helmet use increased nationally from 63 percent in 2008 to 67 percent in 2009, and use of noncompliant helmets decreased for the second year in a row (from 11 percent to 9 percent; NHTSA, 2009). Although "DOT-compliant helmet use increased in States with and without universal helmet laws" (UNC Highway Safety Research Center, 2011, p. 5-7), helmet use remains much higher in states with universal laws. "In 2009, compliant helmet use was 86 percent across States with a universal helmet law that covers all riders, and 55 percent across States with no law or a law covering only young riders ([NHTSA, 2009])" (UNC Highway Safety Research Center, 2011, p. 5-7).

> Studies in States that enacted universal helmet laws observed use rates of 90 percent or higher immediately after the law became effective, compared to 50 percent or lower before the law ([Ulmer and Preusser, 2003], Section II). States that repealed universal helmet laws saw the opposite effect, as use rates dropped from above 90 percent to about 50 percent ([Kyrychenko and McCartt, 2006]; [Preusser, Hedlund, and Ulmer, 2000], Section V; [Ulmer and Preusser, 2003], Sections IV and V [and Mertz and Weiss, 2008]). Reenactment of a universal law in Louisiana (after a cycle of repeals and reenactments since 1968) resulted in an increase in [helmet] use among riders involved in crashes, from 42 percent before reenactment to 87 percent following ([Gilbert et al., 2008]). (UNC Highway Safety Research Center, 2011, p. 5-7)

History

"The first universal motorcycle helmet law was enacted in 1966" (UNC Highway Safety Research Center, 2011, p. 5-7). As a way to increase helmet use, the federal government offered an incentive—certain federal safety programs and highway construction funds—for states that enacted helmet use laws (IIHS, 2011a).

> 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 Insurance Institute for Highway Safety [IIHS] ([2008, 2010c]) summarizes the helmet law history in each State [see Table B.4]. (UNC Highway Safety Research Center, 2011, p. 5-7)

Use

As of August 2010,

> 20 States, the District of Columbia, and Puerto Rico had helmet laws covering all riders. Three States (Illinois, Iowa, and New Hampshire) did not have a motorcycle helmet law ([GHSA, 2014a]; [IIHS, 2011a]). Most other States had laws covering only riders under a specified age, typically 18 or 21 ([IIHS, 2011a]). (UNC Highway Safety Research Center, 2011, p. 5-7)

Effectiveness

> The U.S. General [Accounting] 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 percent lower with universal helmet laws (GAO, 1991; [Ulmer and Preusser, 2003], Section II). Studies since 1990 confirm these results (Cummings et al., 2006; [D. Houston and Richardson, 2008]; [Kyrychenko and McCartt, 2006]; Morris, 2006; [Ulmer and Northrup, 2005]; [Ulmer and Preusser, 2003], Section II). (UNC Highway Safety Research Center, 2011, p. 5-8)
>
> 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 ([D. Houston, 2007]). A reduction in fatality rates among all ages was estimated for partial coverage laws compared to no law by [D. Houston & Richardson, 2008], but the effect was much smaller (7 percent to 8 percent) than that for universal coverage (22 to 33 percent). Moreover, when Florida eliminated the requirement that all motorcycle riders 21 and older wear helmets, there was an 81 percent increase in motorcyclist fatalities ([Ulmer and Northrup, 2005]). Fatalities even increased among riders under age 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). (UNC Highway Safety Research Center, 2011, p. 5-8)

However, another analysis of Florida found that the increase in fatalities was associated with the increase in registered motorcycles; the adjusted fatality rate per 10,000 motorcycles did not change following repeal (O'Keeffe et al., 2007).

> 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. (UNC Highway Safety Research Center, 2011, p. 5-8)

Recent Research on Effectiveness

Recent research has generally supported the effectiveness of helmets and universal helmet laws.

One study using the National Trauma Data Bank, a large national database with trauma registry data, confirmed that helmet users in motorcycle collisions had lower injury-severity scores, mortality, and resource utilization than nonusers. The researchers predicted that helmet use could have saved approximately $32.5 million (or $1,750 per patient) over the seven-year study duration by reducing costs associated with intensive care unit (ICU) hospitalizations (Croce et al., 2009).

Bavon and Standerfer, 2010, examined the effect that repealing Texas' universal helmet law in 1997 had on motorcyclist fatalities and found decreases in helmet use and significant increases in fatalities, as well as increases in the fatality rate per 100 billion vehicle-miles traveled.

Weiss, Agimi, and Steiner, 2010, used data from the 2005 to 2007 State Inpatient Databases of the Healthcare Cost and Utilization Project and found 38 percent more TBIs among young motorcycle riders in states with a partial helmet use law for only riders under age 21 than young motorcycle riders in states with a universal law. A comparison of three states with no motorcycle laws (New Hampshire, Iowa, and Illinois) and three states with partial helmet use laws for those age 17 or younger (Connecticut, Indiana, and Wisconsin) found no significant difference in average fatality rate per 10,000 registered motorcycles or helmet use in youth motorcycle-related fatalities, indicating that a partial law has no public health benefit over no law at all (Brooks, Naud, and Shapiro, 2010). In another study, the partial helmet use law in Connecticut was also associated with low helmet use (44.2 percent) in all-age motorcycle-related crashes (Landman et al., 2011).

Measuring Effectiveness

The effectiveness of helmet use laws is typically measured by changes in different motorcycle-related fatality metrics. Studies may examine the total number of motorcycle rider deaths, motorcycle rider deaths per billion miles traveled, or motorcycle rider deaths per 10,000 registered motorcycles. Different medical measures, such as severity of injury outcomes, specifically head and brain trauma, hospitalizations, and medical costs (including hospital and treatment costs), are also sometimes reported.

Helmet use is another common measure that can be collected through self-reporting, observation, or police records, although DOT-compliant helmet use may be more difficult to ascertain. The proportion of crashes or fatalities involving riders wearing helmets is also sometimes used to measure effectiveness.

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. (UNC Highway Safety Research Center, 2011, p. 5-8)

Time to Implement

"A universal helmet use law can be implemented as soon as the law is enacted" (UNC Highway Safety Research Center, 2011, p. 5-8).

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, 2003c]). 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). (UNC Highway Safety Research Center, 2011, p. 5-8)

States continue to debate helmet use laws. In 2009, legislation was introduced in 19 of the 20 states with a universal helmet law to repeal that law; however, none of the bills was passed (Ecola, Collins, and Eiseman, 2010). D. Houston, 2010, commented that some states have not adopted universal laws, despite the proven public health effectiveness.

> See [M. 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. (UNC Highway Safety Research Center, 2011, p. 5-8)

Noncompliant Helmets

> Some riders in States with universal helmet laws wear helmets that do not comply with FMVSS 218 in order to avoid a helmet law citation ([Glassbrenner and Ye, 2006]). See the discussion in Chapter 5, Section 1.3. (UNC Highway Safety Research Center, 2011, p. 5-8)

Table B.4. Motorcycle and Bicycle Helmet Laws, as of December 2011

State	Motorcycle Helmet Requirement Governs	Motorcycle Helmet Law Covers All Low-Power Cycles	Bicycle Helmet Requirement Governs
Ala.	All riders	Yes	15 and younger
Alaska	17 and younger[a]	Yes	No law
Ariz.	17 and younger	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 1.5, or ability to attain speeds greater than 25 mph are covered by the motorcycle helmet law.	No law
Ark.	20 and younger	Yes	No law
Calif.	All riders	Yes	17 and younger
Colo.	17 and younger and passengers 17 and younger	Yes	No law
Conn.	17 and younger	Yes	15 and younger
Del.	18 and younger[b]	All low-power cycles except motorized scooters are covered by the motorcycle helmet law; bicycle helmet is acceptable for a motorized scooter.	17 and younger
D.C.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 1.5, or ability to attain speeds greater than 35 mph are covered by the motorcycle helmet law.	15 and younger
Fla.	20 and younger[c]	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph and all low-power cycles operated by those 15 and younger are covered by the motorcycle helmet law.	15 and younger
Ga.	All riders	All low-power cycles are covered by the motorcycle helmet law except that bicycle helmets are acceptable for electric-assisted bicycles.	15 and younger
Hawaii	17 and younger	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	15 and younger
Idaho	17 and younger	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 5, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
Ill.	No law	No law	No law
Ind.	17 and younger	Yes	No law
Iowa	No law	No law	No law

State	Motorcycle Helmet Requirement Governs	Motorcycle Helmet Law Covers All Low-Power Cycles	Bicycle Helmet Requirement Governs
Kan.	17 and younger	All low-power cycles except electric-assisted bicycles are covered by the motorcycle helmet law.	No law
Ky.	20 and younger[d]	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
La.	All riders	Yes	11 and younger
Maine	17 and younger[e]	All low-power cycles with an engine displacement greater than 50 cc or more than 1,500 watts are covered by the motorcycle helmet law.	15 and younger
Md.	All riders	All low-power cycles designed to travel at speeds exceeding 35 mph, scooters with engine displacement greater than 50 cc or brake horsepower greater than 2.7, and mopeds with an engine displacement greater than 50 cc or brake horsepower greater than 1.5 are covered by the motorcycle helmet law.	15 and younger
Mass.	All riders	Yes	1–16 (riding with children younger than 1 prohibited)
Mich.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph and all low-power cycles operated by those 18 and younger are covered by the motorcycle helmet law.	No law
Minn.	17 and younger[f]	Yes	No law
Miss.	All riders	Yes	No law
Mo.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 3, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
Mont.	17 and younger	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
Neb.	All riders	Yes	No law
Nev.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
N.H.	No law	No law	15 and younger
N.J.	All riders	Yes	16 and younger

State	Motorcycle Helmet Requirement Governs	Motorcycle Helmet Law Covers All Low-Power Cycles	Bicycle Helmet Requirement Governs
N.M.	17 and younger	All low-power cycles with an engine displacement greater than 50 cc or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	17 and younger
N.Y.	All riders	All low-power cycles designed to travel at speeds of 20 mph or greater are covered by the motorcycle helmet law.	1–13 (riding with children younger than 1 prohibited)
N.C.	All riders	Yes	15 and younger
N.D.	17 and younger[g]	Yes	No law
Ohio	17 and younger[h]	Yes	No law
Okla.	17 and younger	All low-power cycles are covered by the motorcycle helmet law except that bicycle helmets are acceptable for electric-assisted bicycles operated by those 18 and younger.	No law
Ore.	All riders	Yes	15 and younger
Pa.	20 and younger[i]	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 1.5, or ability to attain speeds greater than 25 mph are covered by the motorcycle helmet law.	11 and younger
R.I.	20 and younger[j]	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 4.9, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	15 and younger
S.C.	20 and younger	Yes	No law
S.D.	17 and younger	Yes	No law
Tenn.	All riders	Yes	15 and younger
Texas	20 and younger[k]	Yes	No law
Utah	17 and younger	Yes	No law
Vt.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law
Va.	All riders	All low-power cycles operated at speeds greater than 35 mph or with an engine displacement greater than 50 cc are covered by the motorcycle helmet law.	No law
Wash.	All riders	Yes	No law
W.Va.	All riders	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	14 and younger

State	Motorcycle Helmet Requirement Governs	Motorcycle Helmet Law Covers All Low-Power Cycles	Bicycle Helmet Requirement Governs
Wis.	17 and younger[l]	All low-power cycles designed to travel at speeds exceeding 30 mph and type 1 motorcycles with automatic transmission with an engine displacement greater than 50 cc are covered by the motorcycle helmet law.	No law
Wyo.	17 and younger	All low-power cycles with an engine displacement greater than 50 cc, brake horsepower greater than 2, or ability to attain speeds greater than 30 mph are covered by the motorcycle helmet law.	No law

SOURCE: IIHS, 2011a.
[a] Alaska's motorcycle helmet use law covers passengers of all ages, operators younger than 18, and operators with instructional permits.
[b] In Delaware, every motorcycle operator or rider age 19 and older shall have in his or her possession a safety helmet approved by the secretary.
[c] In Florida, the law requires that all riders younger than 21 years wear helmets, without exception. Someone 21 years or older may ride without a helmet only if he or she can show proof that he or she is covered by a medical insurance policy.
[d] In Kentucky, the law requires that all riders younger than 21 years wear helmets, without exception. Someone 21 years or older may ride without a helmet only if he or she can show proof that he or she is covered by a medical insurance policy. Motorcycle helmet laws in Kentucky also cover operators with instructional or learner's permits.
[e] Motorcycle helmet laws in Maine cover operators with instructional learner's permits and any operator in his or her first year of licensure. Maine's motorcycle helmet use law also covers passengers 17 years and younger and passengers if their operators are required to wear helmets.
[f] Motorcycle helmet laws in Minnesota cover operators with instructional or learner's permits.
[g] North Dakota's motorcycle helmet use law covers all passengers traveling with operators who are covered by the law.
[h] Ohio's motorcycle helmet use law covers any operators during the first year of licensure and all passengers of operators who are covered by the law.
[i] Pennsylvania's motorcycle helmet use law covers all operators during the first two years of licensure unless the operator has completed the safety course approved by the Pennsylvania Department of Transportation (PennDOT) or the Motorcycle Safety Foundation.
[j] Rhode Island's motorcycle helmet use law covers all passengers (regardless of age) and any operator during the first year of licensure (regardless of age).
[k] Texas exempts a rider 21 years or older if he or she can either show proof of successfully completing a motorcycle operator training and safety course or can show proof of having a medical insurance policy. A peace officer may not stop or detain a person who is the operator of or a passenger on a motorcycle for the sole purpose of determining whether the person has successfully completed the motorcycle operator training and safety course or is covered by a health insurance plan.
[l] Motorcycle helmet laws in Wisconsin cover operators with instructional or learner's permits.

Primary Enforcement of Seat Belt Laws

> Primary enforcement [of seat] belt use laws permit seat belt use law violators to be stopped and cited independently of any other traffic behavior. Secondary enforcement laws allow violators to be cited only after they first have been stopped for some other traffic violation. (UNC Highway Safety Research Center, 2011, p. 2-13)

History

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 ([Automotive Coalition for Traffic Safety (ACTS)], 2001). Few occupants wore the belts: surveys in various locations recorded belt use of about 10 percent. The first

> widespread survey, taken in 19 cities in 1982, observed 11 percent belt use for drivers and front-seat passengers ([Williams and Wells, 2004]). (UNC Highway Safety Research Center, 2011, p. 2-4)

"New York enacted the first belt use law in 1984. Other States soon followed. In a typical State, belt use rose quickly to about 50 percent shortly after the State's belt law went into effect" (UNC Highway Safety Research Center, 2011, p. 2-4). By 1996, every state, with the exception of New Hampshire, had a mandatory seat belt use law covering drivers and front-seat occupants.

Use

"As of July 2010, 31 States and the District of Columbia had primary belt use laws, 18 States had secondary enforcement laws, and New Hampshire had no belt use law applicable to adults (IIHS, [undated])" (UNC Highway Safety Research Center, 2011, p. 2-13). Seat belt laws vary by whether they cover front-seat occupants only or include rear-seat occupants as well. In a few states, seat belt use is a secondary law for drivers and passengers older than a specified age (varies by state) but a primary law for younger passengers.

Effectiveness

> In 2009, belt use averaged 88 percent in the 30 States with primary seat belt laws at that time and the District of Columbia and averaged 77 percent in those with weaker enforcement laws ([Chen and Ye, 2010]). Studies of 5 States that changed their belt use laws from secondary to primary enforcement found that belt use increased from 12 to 18 percentage points where all passenger vehicles were covered by the law and 8 percentage points in one State where pickup trucks were excluded (Nichols, 2002). The [Centers] for Disease Control and Prevention's systematic review of 13 high-quality studies ([Shults et al., 2004]) found that primary laws increase belt use by about 14 percentage points and reduce occupant fatalities by about 8 percent compared to secondary laws. In another study, Farmer and Williams (2005) found that passenger vehicle driver death rates dropped by 7 percent 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 eight percentage points. Depending on the level of high-visibility enforcement that they employ, however, far greater results are possible. (UNC Highway Safety Research Center, 2011, p. 2-13)
>
> Recent research (Masten, 2007) has provided strong support that changing from secondary to primary enforcement [of] seat belt laws increases occupant seat belt use during the nighttime hours as well as the daytime hours when most observational surveys of seat belt use are conducted. (UNC Highway Safety Research Center, 2011, p. 2-13)
>
> [Hedlund, Gilbert, 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 in the FARS data for all 6 States 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. (UNC Highway Safety Research Center, 2011, p. 2-13)

Chaudhary, Tison, and Casanova (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 in 2007, measured increases in seat belt use from 77 to 84 percent during the daytime and from 69 percent to 81 percent at night. (UNC Highway Safety Research Center, 2011, p. 2-14)

Recent Research on Effectiveness

L. Beck and West, 2011, used data from the nationally representative Behavioral Risk Factor Surveillance System (BRFSS) survey in 2008 to compare seat belt use. They found that 88.2 percent of adults living in states with primary enforcement of seat belt laws reported always wearing a seat belt, compared with 79.2 percent in states with secondary laws. Differences in seat belt use existed in certain sociodemographic categories, but usage rates were higher for each group in states with primary enforcement of seat belt laws.

L. Beck and West, 2011, also examined 2001–2009 motor vehicle occupant injury data from the National Electronic Injury Surveillance System—All Injury Program (NEISS-AIP). The data are at the national level and do not allow for comparisons between states with and without primary enforcement of seat belt laws but demonstrate a 15.6-percent decline in the injury rate from 1,193.8 injuries per 100,000 population in 2001 to 1,007.5 in 2009. During this time, 14 additional states passed primary seat belt laws. In addition to the lack of state-specific data, no information is available on other factors related to injury, such as seat belt use or seat position, and only injuries reported in hospital emergency departments are included, which would likely underestimate the number of injuries.

Traynor, 2009, examined correlations between recent changes in teen driving regulations, DWI laws, seat belt laws, and differences in traffic fatalities using 1999–2003 data from the 48 contiguous states. After controlling for numerous factors affecting crash fatality risk, such as weather conditions, law enforcement spending, and speed limits, he found that the per-mile fatality rate insignificantly decreased with increasing strictness of seat belt laws where a primary law for all occupants was most strict. The author suggested that this may be due to the model design, which accounts for the interaction between seat belt laws and driver alcohol restrictions.

Another recent study used data from the Ohio Crash Outcome Data Evaluation System (CODES) program to predict annual medical cost savings to Medicaid if Ohio were to experience a 10-percentage-point increase in seat belt usage by switching to a primary seat belt law (Conner, Xiang, and Smith, 2010). Using 2003 crash records and hospital data, the authors estimated the ten-year cumulative savings to Medicaid as approximately $91 million (in 2007 dollars, after inflation of health care costs). In this study, only Medicaid costs (which accounted for 20.6 percent of the medical costs due to hospitalizations from motor vehicle crashes) were considered, so total medical cost savings across all payer sources would be even greater.

Measuring Effectiveness

The effectiveness of primary seat belt laws is measured in various ways. Seat belt use is the most common measure and can be captured through observational studies or self-reporting. The annual National Occupant Protection Use Survey (NOPUS) conducted annually by NHTSA estimates daytime seat belt use through direct observation at probabilistically sampled intersections during one month of the year. Other observational studies have examined front-seat occupants only and distinguished between nighttime and daytime use. Self-reported seat belt use is often defined as "always" using a seat belt in a motor vehicle, regardless of seat position. Occupant injuries, fatalities, and death rates from passenger-vehicle and light-truck crashes have also been used to measure seat belt law effectiveness. One study used regression analysis to estimate the effect of the severity of seat belt laws (least severe [no law or fines] to most severe [primary enforcement for all occupants]) on per-mile fatality rate, expressed as the ratio of total annual traffic fatalities to annual millions of vehicle-miles traveled (Traynor, 2009). Medical cost savings have also been used to calculate the effectiveness of primary enforcement of seat belt laws (Conner, Xiang, and Smith, 2010).

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. (UNC Highway Safety Research Center, 2011, p. 2-14)

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" (UNC Highway Safety Research Center, 2011, p. 2-14).

Other Issues

Opposition to Primary Enforcement of Seat 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). 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, et al., 2004]). (UNC Highway Safety Research Center, 2011, p. 2-14)

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 drinking drivers, than for all occupants (Shults et al., 2004). (UNC Highway Safety Research Center, 2011, p. 2-14)

Table B.5. State Laws on Primary Enforcement of Seat Belt Use and Fines, as of May 2014

State	Initial Effective Date	Primary Enforcement	Who Is Covered and in What Seats	Maximum Fine for First Offense
Ala.	July 18, 1991	Yes; effective December 9, 1999	15+ years in front seat	$25
Alaska	September 12, 1990	Yes; effective May 1, 2006	16+ years in all seats	$15
Ariz.	January 1, 1991	No	8+ years in front seat; 5 through 15 in all seats	$10
Ark.	July 15, 1991	Yes, effective June 30, 2009	15+ years in front seat	$25[a]
Calif.	January 1, 1986	Yes; effective January 1, 1993	16+ years in all seats	$20
Colo.	July 1, 1987	No	16+ years in front seat	$71
Conn.	January 1, 1986	Yes; effective January 1, 1986	7+ years in front seat	$15
Del.	December 12, 1985	Yes; effective October 1, 1997	16+ years in all seats	$50[b]
D.C.	January 1, 1992	Yes; effective June 30, 2003	16+ years in all seats	$25
Fla.	July 1, 1986	Yes; effective June 30, 2009	6+ years in front seat; 6 through 17 years in all seats	$30
Ga.	September 1, 1988	Yes; effective July 1, 1996	8 through 17 years in all seats; 18+ years in front seat	$15[c]
Hawaii	December 16, 1985	Yes; effective December 16, 1985	8 through 17 years in all seats; 18+ years in front seat	$45
Idaho	July 1, 1986	No	7+ years in all seats	$10
Ill.	January 1, 1988	Yes; effective July 3, 2003	16+ years in all seats (effective January 1, 2012)	$25
Ind.	July 1, 1987	Yes; effective July 1, 1998	16+ years in all seats	$25
Iowa	July 1, 1986	Yes; effective July 1, 1986	18+ years in front seat	$25

State	Initial Effective Date	Primary Enforcement	Who Is Covered and in What Seats	Maximum Fine for First Offense
Kan.	July 1, 1986	Yes; effective 6/10/10 (secondary for rear-seat occupants >18)	14+ years in all seats	$60; no court costs: 14–17 years; $10/no court costs: 18+ years
Ky.	July 15, 1994	Yes; effective July 20, 2006	6 and younger and more than 50 inches in all seats; 7+ in all seats	$25
La.	July 1, 1986	Yes; effective September 1, 1995	13+ years in all seats	$25; $45 Orleans Parish
Maine	December 26, 1995	Yes; effective September 20, 2007	18+ years in all seats	$50
Md.	July 1, 1986	Yes; effective October 1, 1997 (secondary for rear-seat occupants; effective October 1, 2013)	16+ years in front seat	$25
Mass.	February 1, 1994	No	13+ years in all seats	$25[d]
Mich.	July 1, 1985	Yes; effective April 1, 2000	16+ years in front seat	$25
Minn.	August 1, 1986	Yes; effective June 9, 2009	7 and younger and more than 57 inches in all seats; 8+ in all seats	$25
Miss.	July 1, 1994	Yes; effective May 27, 2006	7+ years in front seat	$25
Mo.	September 28, 1985	No (yes for children <16)	16+ years in front seat	$10
Mont.	October 1, 1987	No	6+ years in all seats	$20
Neb.	January 1, 1993	No	18+ years in front seat	$25
Nev.	July 1, 1987	No	6+ years in all seats	$25
N.H.	Not applicable	No law	No law	No law
N.J.	March 1, 1985	Yes; effective May 1, 2000 (secondary for rear-seat occupants; effective January 20, 2011)	7 years and younger and more than 80 pounds; 8+ in all seats	$20
N.M.	January 1, 1986	Yes; effective January 1, 1986	18+ years in all seats	$25[b]
N.Y.	December 1, 1984	Yes; effective December 1, 1984	16+ years in front seat	$50[e]
N.C.	October 1, 1985	Yes; effective December 1, 2006 (secondary for rear-seat occupants)	16+ years in all seats	$25
N.D.	July 14, 1994	No	18+ years in front seat	$20
Ohio	May 6, 1986	No	8 through 14 in all seats; 15+ years in front seat	$30 driver/ $20 passenger
Okla.	February 1, 1987	Yes; effective November 1, 1997	13+ years in front seat	$20
Ore.	December 7, 1990	Yes; effective December 7, 1990	16+ years in all seats	$110
Pa.	November 23, 1987	No (yes for children <18 years) (effective December 24, 2011)	8 through 17 years in all seats; 18+ years in front seat	$10

State	Initial Effective Date	Primary Enforcement	Who Is Covered and in What Seats	Maximum Fine for First Offense
R.I.	June 18, 1991	Yes; effective June 30, 2011	18+ years in all seats	$40
S.C.	July 1, 1989	Yes; effective December 9, 2005[f]	6+ years in all seats	$25
S.D.	January 1, 1995	No	18+ years in front seat	$20
Tenn.	April 21, 1986	Yes; effective July 1, 2004	16+ years in front seat	$50[g]
Texas	September 1, 1985	Yes; effective September 1, 1985	7 years and younger who are 57 inches or taller; 8+ years in all seats	$200
Utah	April 28, 1986	No (yes for children <19 years)	16+ years in all seats	$45
Vt.	January 1, 1994	No	18+ years in all seats	$25
Va.	January 1, 1988	No	18+ years in front seat	$25
Wash.	June 11, 1986	Yes; effective July 1, 2002	16+ years in all seats	$124
W.Va.	September 1, 1993	Yes; effective July 1, 2013	8+ years in front seat; 8 through 17 years in all seats	$25
Wis.	December 1, 1987	Yes; effective June 30, 2009	8+ years in all seats	$10
Wyo.	June 8, 1989	No	9+ years in all seats	$25 driver[h]/ $10 passenger

SOURCE: IIHS, 2014d.
[a] Arkansas rewards belt use by reducing the fine for the primary violation by $10.
[b] This state assesses points for this violation.
[c] In Georgia, the maximum fine is $25 if the child is 6 to 18 years old.
[d] Drivers in Massachusetts may be fined $25 for violating the belt law themselves and $25 for each unrestrained passenger 12 to 16 years old.
[e] New York assesses points only if the passenger is under 16.
[f] Police are prohibited in South Carolina from enforcing seat belt laws at checkpoints designed for that purpose. However, seat belt violations may be issued at license and registration checkpoints to drivers cited for other offenses.
[g] Drivers 18 and older in Tennessee who choose not to contest the citation pay a $10 fine by mail or $20 for drivers who are 16 and 17 years old.
[h] Wyoming rewards belt use by reducing the fine for the primary violation by $10.

High-Visibility Enforcement for Seat Belts and Child Restraint and Booster Laws

> [T]he 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 but are now primarily conducted under NHTSA's Click It or Ticket high-visibility enforcement program. NHTSA typically includes child restraint and booster seat use and enforcement as a part of their Click It or Ticket campaigns. (UNC Highway Safety Research Center, 2011, p. 2-36)
>
> Effective, high-visibility communications and outreach are an essential part of successful seat belt law high-visibility enforcement programs ([Solomon, Chaudhary, and Cosgrove, 2004]) [and typically accompany CIOT enforcement efforts]. 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, McInturff, and Nichols, 2004]). (UNC Highway Safety Research Center, 2011, p. 2-25)

History

This method of highly publicized enforcement programs has been used in conjunction with mandatory restraint laws starting in Canada in the 1980s (Boase, Jonah, and Dawson, 2004; UNC Highway Safety Research Center, 2011, p. 2-19). After a conference sponsored by NHTSA in 1996, the National Safety Council (NSC) and the National Transportation Safety Board (NTSB) suggested using high-visibility enforcement of existing occupant-protection laws as a strategy to immediately increase seat belt and child restraint use (Milano, McInturff, and Nichols, 2004). North Carolina implemented a statewide program in 1993 using the CIOT slogan (Reinfurt, 2004; UNC Highway Safety Research Center, 2011, p. 2-19), which was "subsequently adopted in other States under different names and sponsors ([Solomon, Compton, and Preusser, 2004])" (UNC Highway Safety Research Center, 2011, p. 2-19). In 2000, South Carolina became the first state to use paid media to publicize a CIOT program, which increased seat belt use statewide (Milano, McInturff, and Nichols, 2004). NHTSA coordinated CIOT messaging in an eight-state region the following year, and the national program adopted the CIOT slogan by 2003 (Milano, McInturff, and Nichols, 2004). "NHTSA's Click It or Ticket high-visibility enforcement model is described in detail in [Solomon, Chaudhary, and Cosgrove, 2004] and Solomon, Chaffe, and Cosgrove (2007)" (UNC Highway Safety Research Center, 2011, p. 2-19).

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 [supported by NHTSA] ([Solomon, Compton, and Preusser, 2004]; [Solomon, Chaffe, and Cosgrove, 2007]). In previous years, two mobilizations were conducted each year, in May and November [around the Memorial Day and Thanksgiving holiday weekends]. (UNC Highway Safety Research Center, 2011, p. 2-19)

These enforcement programs apply to both adult seat belt use and child restraint use, although proper child restraint use may be more difficult for enforcing officers to assess.

> Approximately 10,000 law enforcement agencies took part in the national May 2007 campaign ([Solomon, Preusser, et al., 2009]) [the most recent year for which such data are available]. . . . 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. . . . See [Milano, McInturff, and Nichols, 2004] for a detailed account of the history and evolution of the national campaigns. (UNC Highway Safety Research Center, 2011, p. 2-19, 2-25)

Effectiveness

The majority of studies have assessed the effect that high-visibility enforcement programs have on seat belt use.

> 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. CDC noted that many of the studies were conducted when belt use rates were considerably lower than at present, so that new programs likely will not have as large an effect. Belt use often dropped by about 6 percentage points after the enforcement program ended. Short-term, high-visibility enforcement programs thus typically have a ratchet effect: 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. (UNC Highway Safety Research Center, 2011, p. 2-19)
>
> Between 2002 and 2005, NHTSA evaluated the effects Click It or Ticket campaigns [had] on belt use in the 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, and Preusser, 2002]). (UNC Highway Safety Research Center, 2011, p. 2-19)

Year-by-year results are summarized below.

As discussed in the discussion of the high-visibility seat belt enforcement intervention in the *Countermeasures That Work* report, NHTSA's May 2002 CIOT campaign evaluation included observed seat belt use, motorist attitudes, and program knowledge and recall in 18 states at various stages of implementation of the CIOT program. In addition to a small amount of free and earned media, most states (14 of 18) bought advertisement placement—radio advertisement during rush-hour commutes and television ads during prime viewership times—that ran the week before and the first week of enforcement.

> The 2003 campaign used extensive paid advertising: about $8 million nationally and $16 million in individual States ([Solomon, Chaudhary, and Cosgrove, 2004], Technical Summary). The advertising strongly supported the campaign with clear enforcement images and messages. Nationally, belt use following the 2003 campaign was 79 percent compared to 75 percent at the same time in 2002 (Glassbrenner, 2005). Twenty-eight States conducted small belt use surveys immediately before the May 2003 campaign. Across these States, belt use was 75.2 percent in 2002, 72.8 percent before the 2003 campaign and 78.5 percent 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 higher level than after the previous campaign ([Solomon, Chaudhary, and Cosgrove, 2004], Chapter IV). (UNC Highway Safety Research Center, 2011, pp. 2-20)

"[Milano, McInturff, and Nichols, 2004] summarize an extensive amount of information from national telephone surveys conducted in conjunction with each national campaign from

1997 through 2003" (UNC Highway Safety Research Center, 2011, p. 2-25). These findings included an increase of 21 percentage points in the number of people who saw, read, or heard about the enforcement efforts (from 43 percent to 64 percent) and a five-fold increase in recall of the CIOT message (from 3 percent to 15 percent).

> The 2004 campaign increased paid advertising to about $12 million nationally and $20 million in the States ([Solomon, Chaffe, and Cosgrove, 2007]). As in 2003, the advertising strongly supported enforcement activities. Belt use nationally reached 80 percent following the campaign (Glassbrenner, 2005). 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, and Cosgrove, 2007]). (UNC Highway Safety Research Center, 2011, p. 2-20)
>
> For the 2005 campaign, paid media valued at $9.7 million nationally and $22 million in States delivered a strong enforcement related message. Overall, seat belt use rates improved in 2005 in a majority of States (35 of 47). The level of improvement was slightly higher among primary law States compared to secondary law States (+2.0 versus +1.2, median point change). Among 22 primary law States, 18 showed an increase while among 25 secondary enforcement States, 17 showed an increase (Solomon, Gilbert, et al., 2007). Nationally, the seat belt use increased to 82 percent in 2005. Activities were similar in 2006, with approximately $12 million in national paid advertising and $20 million in the States that year ([Tison, Solomon, et al., 2008]). National Click It or Ticket activities in 2007 were again similar and observed seat belt use remained at 82 percent through 2007. As of 2007, 12 States had achieved seat belt use rates of 90 percent or higher (Solomon, Preusser, et al., 2009). (UNC Highway Safety Research Center, 2011, p. 2-20)

Hedlund, Gilbert, et al., 2008, compared 16 states with high seat belt use rates and 15 states with low seat belt use rates. The single most important difference between the two groups was the level of enforcement, not demographic characteristics or the amount spent on media. Higher enforcement in high-use states resulted in those states issuing "twice as many citations per capita during their Click It or Ticket campaigns" as low-use states (UNC Highway Safety Research Center, 2011, p. 2-20). This was credited to more-vigorous law enforcement and the presence of primary enforcement of seat belt laws in the high-use states.

Few studies have examined the effectiveness of high-visibility enforcement programs on child passenger safety.

> Pilot programs conducted in 1989 in eight communities demonstrated the potential effectiveness of child passenger safety law enforcement ([NHTSA, undated (b)]). The enforcement efforts increased the correct use of child restraints in the demonstration sites; 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. One study evaluated the effects of Tennessee's "booster" provisions that added new requirements for 4- to 8-year-olds in 2005 ([Gunn, Phillippi, and Cooper, 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 percent. [Decina, Lococo, 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 [from 48.6 percent to 57.7 percent] for children age 4 to 8 following enactment of an enhanced child restraint law (booster seat law) in Wisconsin. (UNC Highway Safety Research Center, 2011, p. 2-36)

Recent Research on Effectiveness

Vasudevan et al., 2009, examined the effectiveness of three CIOT enforcement campaigns in Nevada, a secondary seat belt state, and found a significant increase of observed seat belt use for drivers and passengers in the period following each campaign. These increases ranged from 3 to 8 percentage points. Another CIOT intervention in Utah increased observed seat belt use by 8.3 percentage points, from 76.5 percent one week before enhanced enforcement to 84.8 percent one week after enhanced enforcement (Thomas, Cook, and Olson, 2011).

In Nevada, a media campaign around the state's 2004 CIOT intervention resulted in 58 percent of respondents in a telephone survey being aware of the enhanced enforcement efforts. The majority (63 percent) indicated that they knew about the campaign because of a television message (Vasudevan et al., 2009).

Measuring Effectiveness

The effectiveness of short-term, high-visibility seat belt law enforcement is typically measured through changes in the percentage of people using proper restraints. Both observational and self-report measures can be used. Because evaluations of these campaigns are so time-sensitive and use typically drops following the campaign, effectiveness of this intervention cannot always be captured through annual surveys of seat belt use, such as NOPUS or BRFSS.

Other measures can be used to assess the effectiveness of high-visibility campaigns, although these typically focus on seat belt use and do not include measures for child restraints. Changes in seat belt use can also be measured by comparing the proportion of fatally injured front-seat occupants wearing seat belts before and after a campaign; however, such a measure is confounded because seat belts can prevent fatal injuries. Time-series analyses have been used to project the number of fatalities and injuries prevented with CIOT programs, although this is less common in the literature (Solomon, Preusser, et al., 2009; Tison and Willams, 2010).

In addition, the number of citations for seat belt and child restraint use during the campaign is easily calculated through police records. Media penetration or awareness of the campaign, captured through telephone surveys or street surveys, can also measure the effectiveness of the campaign.

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. (UNC Highway Safety Research Center, 2011, p. 2-20)

In Nevada, overtime funding for enforcement costs approximately $213,000 to $321,000 for each statewide campaign during the years 2003–2005 (Vasudevan et al., 2009). Paid advertising, which increases a campaign's effectiveness, costs for CIOT campaigns targeted at seat belt use for the general population "were about $125,000 per State for the 2002 campaign and over $400,000 in 2004 ([Solomon, Chaffe, and Cosgrove, 2007])" (UNC Highway Safety Research Center, 2011, p. 2-20).

Time to Implement

"A high-visibility enforcement program [and accompanying media campaign] require 4 to 6 months to plan and implement" (UNC Highway Safety Research Center, 2011, p. 2-20).

Other Issues

Effects in States with Primary and Secondary Enforcement of Seat Belt Laws

> 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; the primary law States had higher use rates before the campaigns ([Solomon, Chaudhary, and Cosgrove, 2004]; see also Nichols, 2002). The 2004 evaluation 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, Chaffe, and Cosgrove, 2007]). (UNC Highway Safety Research Center, 2011, pp. 2-20–2-21)

Effects on Low-Belt-Use Groups

> CDC's systematic review observed that short-term, high-visibility enforcement campaigns increased seat 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). NHTSA's Region 5 implemented a Rural Demonstration Program (RDP) prior to the May 2005 Click It or Ticket (CIOT) mobilization. The goal of the RDP 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 three of the six Region 5 States (Illinois, Indiana, Ohio), but only the paid media component was implemented in the remaining three States (Minnesota, Michigan, Wisconsin). During the RDP phase, States that had intensified enforcement had significant increases in usage

in their rural targeted areas. All six Region 5 States intensified enforcement during the CIOT mobilization, but States that had intensified enforcement during RDP showed substantially greater overall statewide gains during the CIOT phase than did the States that had not intensified enforcement during the Rural Demonstration Program ([Nichols, Ledingham, and Preusser, 2007]). (UNC Highway Safety Research Center, 2011, p. 2-21)

Barriers to Enhanced Enforcement Programs for Child Restraints

[Decina, Lococo, et al., 2008] concluded that barriers to enhanced enforcement programs, especially as related to booster seats, include: parent/caregiver ignorance of child restraint laws; 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. (UNC Highway Safety Research Center, 2011, p. 2-36)

Strategies to Enhance Enforcement Programs for Child Restraints

[NHTSA (undated [b])] 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 targeted to target audiences; information activities coinciding with community events; child restraint distribution programs; and public service announcements and other media coverage. [Decina, Hall, and Lococo, 2010] found that 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. (UNC Highway Safety Research Center, 2011, p. 2-37)

State Use

There is no definitive source of information regarding the use of CIOT on a state-by-state basis. According to NHTSA, all states have participated in the annual mobilization since 2004 (NHTSA, undated [a]). However, the number of states conducting additional mobilizations is unavailable without state-by-state research.

License Plate Impoundment

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. . . . License plate impoundment [allows an officer to] seize and impound or destroy the license plate [of a DWI offender's vehicle]. (UNC Highway Safety Research Center, 2011, p. 1-34)

The impoundment period varies by state, with many states imposing a 90-day penalty (Voas, 2008). Impoundment periods are sometimes equivalent to the duration of license suspension for a DWI offense.

> [NHTSA, 2008h] and [Voas, Fell, et al., 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 [Neuman et al., 2003], Strategies B1, B2, and C1. (UNC Highway Safety Research Center, 2011, p. 1-34)

History

Since the early 1980s, convicted DWI offenders have been subject to administrative license revocation (ALR) laws that suspend the offender's driving privileges for a period of time. However, offenders may continue to endanger others by driving illegally, an offense known as driving while suspended (DWS). Vehicle and plate sanctions evolved as a way to deter offenders from committing further DWS and DWI violations (Voas and DeYoung, 2002).

Use

As of 2004, 16 states were impounding license plates (McKnight et al., 2008). More-recent updates were not available.

Effectiveness

"In Minnesota, license plate impoundment was shown to reduce recidivism when administered by the arresting officer ([A. Rodgers, 1995])" (UNC Highway Safety Research Center, 2011, p. 1-34). Rodgers used survival analysis and found that third-time DWI violators with impounded plates had significantly fewer DWI convictions after two years than similar offenders whose plates were not impounded.

Another study in Minnesota reviewed administrative data and interviewed police officers and repeat offenders (Ross, Simon, and Cleary, 1996). Although this study did not examine the effectiveness of the sanction on recidivism, the researchers reported several findings relevant to understanding license impoundment legislation. For example, switching to police-based procedures for license confiscation from court-based procedures increased the number of confiscations more than ten-fold. However, the reach of the law was limited because offenders' impoundment orders could be lost during the many steps in the procedure (an order is issued, later reviewed in an administrative office, and then a notification is sent by mail to the offender). In addition, an offender may also adopt coping behaviors to avoid DWS penalties, such as registering a car in another person's name.

When "plate impoundment does not involve the courts, it occurs quickly, consistently, and efficiently ([Neuman et al., 2003], Strategy B2; [NHTSA, 2008h]; [NTSB, 2000])" (UNC Highway Safety Research Center, 2011, p. 1-34).

Recent Research on Effectiveness

Leaf and Preusser, 2011, examined the effect that Minnesota's license plate impoundment had on first-offense drivers whose BACs were between 0.20 and 0.22. Both DWI recidivism and DWS violations were lower for the plate impoundment group than for a similar group (first-offense drivers with BACs of 0.17 to 0.19) at all points in time, ranging from 30 days to one year. Using administrative data from previous years, they also determined that drivers whose license plates were not impounded under lax enforcement of the policy were 2.5 times as likely as drivers whose plates were impounded to reoffend in the next month; this effect lessened over time, although some effects persisted for up to three years.

Costs

Unknown.

Measuring Effectiveness

The effectiveness of license plate impoundment programs is generally measured in terms of recidivism expressed as the percentage of offenders who have alcohol-related traffic violations after being sanctioned. Another common measure is the percentage of offenders driving while suspended.

Time to Implement

"All vehicle and license plate sanctions require at least several months to implement" (UNC Highway Safety Research Center, 2011, p. 1-34).

Other Issues

To Whom License Plate Sanctions Are Applied

License plate impoundment varies by state, but most sanctions "have been applied to repeat [DWI] offenders" or those with DWS convictions following a DWI offense (UNC Highway Safety Research Center, 2011, p. 1-35). "[S]ome States also apply vehicle sanctions to high-BAC first offenders (e.g., a BAC of .15 or higher)" or first offenders but with a shorter penalty period (UNC Highway Safety Research Center, 2011, p. 1-35). "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, 2008h])" (UNC Highway Safety Research Center, 2011, p. 1-35). In Ohio and Minnesota, offenders can apply for "family plates," which allow nonoffending family members to operate the vehicle and police officers to stop and check the vehicle for proper licensure (Voas and DeYoung, 2002).

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 license plates at the time of arrest so offenders do not have the opportunity to transfer vehicle ownership ([NHTSA, 2008h])" (UNC Highway Safety Research Center, 2011, p. 1-35).

Table B.6. State Laws on License Plate Impoundment, as of December 2004

State	License Plate Impoundment
Ala.	No
Alaska	No
Ariz.	No
Ark.	Arkansas has a license plate impoundment and confiscation law. License plates are impounded for 90 days for a DWS conviction, and the plates are revoked if the offender has a prior DWI conviction. At the discretion of the court, a temporary license plate may be issued if it is in the best interest of the offender's dependents.
Calif.	No
Colo.	No
Conn.	No
Del.	Delaware has a license plate confiscation law for a first-time DWI offense (90 days) and subsequent DWI offenses (one year). This law applies if the vehicle operator is driving while suspended or revoked for a DWI offense or for an implied-consent refusal of a chemical test or other situations that require mandatory license revocation.
D.C.	No
Fla.	No
Ga.	Georgia has a license plate confiscation law. Under the habitual-traffic-offender law, an offender who commits a second or subsequent DWI offense (within five years) may have the license plates of all the vehicles he or she owns confiscated by the courts.
Hawaii	Hawaii has vehicle-registration revocation and license plate–suspension laws. The registration of all vehicles owned by an offender must be revoked for the same period as his or her license for a second or subsequent DWI offense or for refusing to submit to a chemical breath test under the implied-consent law. Special registrations with special license plates may be issued in hardship situations for household members or co-owners.
Idaho	No
Ill.	Illinois has a license plate–confiscation law. If an offender is convicted of a fourth DWI offense, the offender's vehicle is subject to license plate seizure. Driving while suspended for a DWI also can result in license plate confiscation.
Ind.	No
Iowa	Iowa has vehicle impoundment and immobilization laws. For a second or subsequent DWI offense, the vehicle owned and used by the offender can be impounded or immobilized and the license plate seized (and registration confiscated if the vehicle is in custody) by law enforcement authorities. New registration plates are issued only at the end of the driver's license–revocation period or 180 days, whichever is longer. A vehicle also is subject to license plate impoundment if the vehicle was driven by the offender while still under suspension for a prior DWI offense. Another law prohibits second and subsequent DWI offenders from buying, selling, or transferring vehicles. If there is a hardship to a family member, then this action may be replaced by having an ignition interlock installed on the vehicle.
Kan.	Kansas has a license plate–revocation law under which, on a fourth or subsequent DWI offense, the license plates of the vehicle used in the offense may be revoked for one year.

State	License Plate Impoundment
Ky.	Kentucky has a license plate–confiscation law. For second or subsequent DWI offenses, the court must either order the use of ignition interlocks on all vehicles owned by the offender or impound the license plates of all vehicles owned by the offender for a period not to exceed the license action. A hardship exemption is available to allow family members to use the vehicles.
La.	No
Maine	State officials are given broad authority for any cause considered sufficient to suspend a vehicle owner's registration or certificate of title. For a second or subsequent DWI offense, the offender's vehicle registration and license plates must be suspended for the same length of time as the license is suspended. Hardship exemptions may be made for a family member concerning the use of the vehicle.
Md.	Maryland also has vehicle impoundment– and license plate–suspension laws. In addition to suspending the vehicle's registration, authorities can impound or immobilize the vehicle by suspending license plates for not more than 180 days if the driver's license is currently suspended for a prior alcohol offense.
Mass.	The state has a law concerning license plate and registration revocation (Chapter 90, Section 23, in statute). An offender who drives while revoked is considered an immediate threat; therefore, the police will seize the license plate and notify the registry. If an offender is caught driving while revoked but the vehicle is registered to someone else, the owner must come in for a hearing. The registrar may suspend the owner's registration (but not seize the plates) if it appears that the owner knew the vehicle was being driven by someone with a suspended license. A more general law (Chapter 90, Section 22A) states that the registrar can revoke the license and registration of a driver who is believed to be a threat to safety.
Mich.	For a first or second offense, the registration and license plates of the vehicle involved in the offense shall be cancelled. For a third or subsequent offense or for a fourth or subsequent offense with a DWS conviction, the offender shall be denied the right to register, purchase, or lease a vehicle.
Minn.	Minnesota's license plate–impoundment law requires that a vehicle's tags be impounded if the offender, within the previous ten years, (1) has been convicted of a DWI or has had a license suspended for a prior DWI and has a BAC of 0.10 or greater, (2) has a BAC of 0.20 or greater, or (3) has been convicted of any DWI or implied-consent offense while transporting a child younger than 16 and at least 36 months younger than the offender.
Miss.	No
Mo.	No
Mont.	No
Neb.	Nebraska's vehicle-immobilization law will be considered to be a license plate–suspension or –confiscation and vehicle registration–suspension law. For a second or subsequent DWI or an implied-consent refusal offense within 12 years, all vehicles owned by the offender must be electronically immobilized for not less than five days and not longer than eight months. A co-owner may have the vehicle released if there is a hardship.
Nev.	No
N.H.	No
N.J.	No
N.M.	No
N.Y.	No
N.C.	No
N.D.	North Dakota has a license plate–impoundment law. Following conviction for DWI, an offender may have his or her license plate impounded for the same length of time as the license suspension. License plates also may be impounded for driving while suspended because of a DWI.
Ohio	Ohio also has license plate–impoundment and –immobilization laws. For a second DWI offense within six years, the vehicle used may be immobilized or its license plates may be impoundment for 90 days. License plates also may be impounded for offenders who have had their licenses revoked or suspended for any vehicle-related death.
Okla.	No

State	License Plate Impoundment
Ore.	No
Pa.	No
R.I.	No
S.C.	No
S.D.	No
Tenn.	No
Texas	No
Utah	No
Vt.	No
Va.	No
Wash.	No
W.Va.	No
Wis.	No
Wyo.	No

SOURCE: McKnight et al., 2008.

Limits on Diversion and Plea Agreements

> 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. (UNC Highway Safety Research Center, 2011, p. 1-26)

A plea agreement allows a DWI offender to negotiate the charges against him or her or the terms of his or her sentence.

> 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. (UNC Highway Safety Research Center, 2011, p. 1-26)

Both diversion programs and plea agreements reduce the time to punishment. In addition, they typically also result in less-severe punishment for DWI offenses and negatively affect deterrence. Diversion programs guarantee a minimum action (e.g., education or treatment) to change an offender's behavior, while plea agreements may result in no corrective action. In both cases, the dismissal of charges and lack of permanent record means that a repeat offender may be tried or dealt with as a first-time offender because the record does not show the previous arrests.

> 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 and McCartt, 2002]; [Goodwin, Foss, et al., 2005]; [NTSB, 2000]; [Robertson and Simpson, 2002]). (UNC Highway Safety Research Center, 2011, p. 1-26)

History

Millions of traffic violations are processed through the court system in the United States each year. Plea-bargaining and diversion programs are two ways to reduce the burden on the state and local court systems. In 1984, the NTSB (NTSB, 2000) first recommended eliminating the option of plea-bargaining down DWI offenses, although it is not clear how quickly states adopted this policy. Some studies since then have demonstrated that diversion programs, particularly ones with short sentences, do not reduce recidivism (NTSB, 2000). However, they continue to be favored for their efficiency in dealing with first-time offenders (Wiliszowski et al., 2011).

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, 2006b])" (UNC Highway Safety Research Center, 2011, p. 1-26). A slightly more recent count (2007) identified 15 states with either an anti–plea-bargaining statute or a mandatory-adjudication law (NHTSA, 2011b). (Because NHTSA [2006b] references a personal communication, it is difficult to know whether this intervention declined in use or whether the earlier count used other definitions.) "The [National Hardcore Drunk Driver Project, 1998] documented diversion programs and plea agreement restrictions in several States" (UNC Highway Safety Research Center, 2011, p. 1-26).

Effectiveness

> There are no studies that demonstrate that diversion programs reduce recidivism (NTSB, 2000) and 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 and McCartt, 2002]). Eliminating or establishing limits on diversion programs should remove a major loophole in the DWI control system. (UNC Highway Safety Research Center, 2011, p. 1-26)
>
> Wagenaar et al. (2000) reviewed 52 studies of plea agreement restrictions applied in combination with other DWI control policies and found that they reduced various outcome measures by an average of 11 percent. 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 ([Surla and Koons, 1989]; [NTSB, 2000]). It found that plea agreement restrictions reduced recidivism in all three study communities. (UNC Highway Safety Research Center, 2011, p. 1-26)

In Michigan, lesser offenses, such as operating a vehicle while impaired, still count toward the state's three-strikes policy for repeat offenders. This effectively limits plea-bargaining because offenders who plea-bargain to the lesser offense will still face consequences for repeat offenses. An evaluation of a package of Michigan laws aimed at reducing drunk driving, including limits on plea-bargaining, found a 30-percent decrease in the rate of crashes involving drivers with suspended or revoked licenses, although it is not possible to ascribe causality to only one specific policy (Eby, Kostyniuk, Spradlin, et al., 2002).

Recent Research on Effectiveness

One study in New Jersey examined the impact of removing a prohibition on plea-bargaining (Carnegie, Ozbay, and Mudigonda, 2009). After allowing plea-bargaining from point-carrying moving violations (e.g., reckless driving, failure to stop) to zero-point offenses, there was no difference in the number or composition of moving violations. Although this study did not include DWI offenders, the researchers demonstrated a 36-percent decrease from 1999 to 2006 in the number of negligent drivers subjected to the New Jersey Motor Vehicle Commission's monitoring and control system, which includes countermeasures, such as re-education classes or license suspension. This implies that the previous limits on plea-bargaining had channeled unsafe drivers toward corrective programs, and lifting the limits meant fewer unsafe drivers enrolled in such programs.

Measuring Effectiveness

The effectiveness of diversion programs is generally measured in terms of recidivism, expressed as the percentage of offenders who have another alcohol-related traffic violation within some amount of time.

Costs

> Costs for eliminating [or] 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 [or diversion programs eliminated], some charges may be dismissed or some offenders may request a full trial, resulting in significant costs. (UNC Highway Safety Research Center, 2011, p. 1-26)

Time to Implement

> Eliminating [or] limiting diversion programs and restricting plea agreements statewide may require changes to a State's DWI laws. Once legislation is enacted, policies and practices [that the legal system uses] can be changed within three months. Individual prosecutor offices and courts also can change local policies and practices without statewide legislation. (UNC Highway Safety Research Center, 2011, p. 1-26)

Other Issues

Judicial Factors

Plea-bargaining to a lesser charge is appealing only if the expected outcome of the court proceedings is a harsher punishment. However, this is not always the case. A recent newspaper series reported judge acquittal rates for operating-under-the-influence (OUI) offenses higher than 80 percent in some Massachusetts counties (Farragher, 2011; Saltzman, 2011; Bombardieri, 2011). The high probability of dropped charges through regular proceedings has led lawyers to advise their clients to try their cases instead of plea-bargain. Less-severe punishment or lower risk of conviction due to judge leniency will influence the effect of limits on diversion programs and plea-bargaining.

Table B.7. Limits on Diversion and Plea-Bargaining, as of March, 2010

State	Anti–Plea-Bargaining Statute	Mandatory-Adjudication Law
Ala.	None	None
Alaska	None	None
Ariz.	Ariz. Rev. Stat. Ann. § 28-1387(I), 2014	None
Ark.	Ark. Code Ann. § 5-65-107, 2014	Ark. Code Ann. § 5-65-107, 2014
Calif.	Plea-bargaining is prohibited in serious felony and DWI cases unless (1) there is insufficient evidence of the offense, (2) testimony of a material witness cannot be obtained, or (3) the reduction or dismissal of charges would not result in substantial change in sentence. Cal. Penal § 1192.7(a)(2), 2014; *People v. Arauz*, 5 Cal. App. 4th 663, 1992. In addition, a criminal charge cannot be dismissed without the court's approval. Cal. Penal § 1385, 2014. Under Cal. Veh. § 23635, 2014, the court must give the reasons a DWI charge was reduced to a lesser offense, changed to reckless driving, or dismissed.	None
Colo.	Colo. Rev. Stat. § 42-4-1301(4), 2013.	None
Conn.	None. However, the law does require the state to give to the court, in open session, the reasons a DWI charge was reduced, nolle prossed, or dismissed. Conn. Gen. Stat. § 14-227a(f), 2014.	None
Del.	None	None
D.C.	None	None
Fla.	Applies to DWI where the BAC is 0.15 or more or where there has been physical injury, death, property damage, manslaughter related to the operation of a motor vehicle, or vehicle homicide. Fla. Stat. § 316.656(2), 2014.	Applies to DWI, manslaughter resulting from the operation of a motor vehicle, and vehicle homicide offenses. Fla. Stat. § 316.656, 2014.
Ga.	None	None

State	Anti–Plea-Bargaining Statute	Mandatory-Adjudication Law
Hawaii	None	None
Idaho	None	None
Ill.	None	None
Ind.	None	None
Iowa	None	Deferred judgment may be available for a first offender who has a BAC <0.15 if no bodily injury resulted. Iowa Code § 321J.2, 2013; Iowa Code § 907.3, 2013.
Kan.	Kan. Stat. Ann. § 8-1567(s), 2013. However, certain diversion programs are excepted.	None
Ky.	Plea-bargaining is not allowed if any one of the three following conditions exists: (1) a defendant ≥21 years old has a BAC or BrAC ≥0.08; (2) a defendant <21 years old has a BAC or BrAC ≥ 0.02; or (3) a defendant refused to submit to a chemical test under the implied-consent law. However, this does not apply if the state's witnesses are unavailable for trial or the chemical test results are in error. The court must record the reasons for any change in the original charges. Ky. Rev. Stat. Ann. § 189A.120, 2014.	None
La.	None	None
Maine	None	None
Md.	None	None
Mass.	None	Alcohol screening is required for a first offense. Mass. Ann. Laws ch. 90 § 24(1)(a)(4), 2014.
Mich.	Limited. A person who is charged with driving while under the influence, driving while visibly impaired, or illegal per se offenses cannot enter a plea of either guilty or nolo contendere to driving with "any bodily alcohol content" in exchange for dismissal of the original charge. However, the court, upon the prosecuting attorney's motion, may dismiss the charge. Mich. Comp. Laws Serv. § 257.625(16), 2014.	None
Minn.	None	None
Miss.	A DWI charge cannot be reduced. Miss. Code Ann. § 63-11-39, 2014. For subsequent offenses, mandatory sanctions cannot be suspended or reduced through a plea agreement. Miss. Code Ann. § 63 11-30(2)(b), (c), 2014.	None
Mo.	None	None
Mont.	None, but a DWI offender is not eligible for pretrial diversion. Mont. Code Ann. § 46-16-130(4), 2013.	None
Neb.	None	None, and pretrial diversion of DWI cases is prohibited. Neb. Rev. Stat. Ann. § 29-3604, 2013.

State	Anti–Plea-Bargaining Statute	Mandatory-Adjudication Law
Nev.	A DWI charge cannot be reduced for a lesser charge in exchange for a plea or dismissed unless there is no evidence to support probable cause or such charge cannot be proven at trial. Nev. Rev. Stat. Ann. § 484C.030, 2014.	None
N.H.	None. The law requires the filing of reports on plea-bargaining agreements. Because these reports are public records, they are available for public inspection. N.H. Rev. Stat. Ann. § 265-A:21(II), 2014.	None
N.J.	None. However, a victim who sustains bodily injury or serious bodily injury shall be provided with the opportunity to consult with the prosecutor prior to dismissal of the case or the filing of a proposed plea negotiation with the court. N.J. Rev. Stat. § 39:4-50.12, 2014.	None
N.M.	N.M. Stat. Ann. § 66-8-102.1, 2013. If a guilty plea is entered, it must be to one of the subsections of the DWI statute when alcohol concentration is ≥0.08.	None. However, a driver must be charged with a DWI offense if he or she has an alcohol concentration ≥0.08. N.M. Stat. Ann. § 66-8-110(C), 2013.
N.Y.	Unless available evidence determines otherwise, plea-bargaining is allowed only to another DWI offense. N.Y. Veh. & Traf. Law § 1192(10)(a), 2014.	None, but unconditional discharge for a DWI violation is prohibited. N.Y. Veh. & Traf. Law § 1193(1)(e), 2014.
N.C.	None. However, the law does require the prosecutor to explain a reduction or dismissal of a DWI charge in writing and in open court. N.C. Gen. Stat. § 20-138.4, 2014.	None
N.D.	None	None
Ohio	None	None
Okla.	None	None
Ore.	A person charged with DWI shall not be allowed to plead guilty or no contest to any other offense in exchange for a dismissal of the offense charged. Or. Rev. Stat. § 813.170, 2013.	None
Pa.	None. However the presiding judicial officer at preliminary hearing or arraignment shall not reduce or modify an original DWI charge without the consent of the attorney for the commonwealth. 75 Pa.C.S. § 3812, 2014.	None
R.I.	None	None
S.C.	None	None
S.D.	None. But an illegal per se charge may be reduced or dismissed only when written reasons for such have been filed with the court. S.D. Codified Laws § 32-23-1.3, 2014.	None
Tenn.	None	Tenn. Code Ann. § 55-10-403(b)(1), 2014.
Texas	None	None

State	Anti–Plea-Bargaining Statute	Mandatory-Adjudication Law
Utah	None. However, a court may not accept a plea of guilty or no contest to a DWI charge unless (1) the prosecutor agrees to the plea in open court, in writing or by any other means of adequate communication to record the prosecutor's agreement; (2) the charge is filed by information; or (3) the court receives verification from law enforcement that the defendant's driver's license records shows no conviction of more than one prior violation within ten years, a felony DWI conviction, or automobile homicide. A prosecutor must examine a defendant's criminal and driver's records before entering into a plea. Utah Code Ann. § 41-6a-513, 2014.	None
Vt.	None	None
Va.	None	None
Wash.	None	None
W.Va.	None	None
Wis.	None. However, the court must approve dismissals of or amendments to DWI charges. Wis. Stat. § 967.055, 2014.	None
Wyo.	A DWI charge may not be reduced or dismissed, unless the state in open court moves or files a statement containing supporting facts to indicate that there is insufficient evidence to support the original DWI charge. Wyo. Stat. Ann. § 31-5-233(j), 2014.	No

SOURCE: NHTSA, 2011b.
NOTE: BrAC = breath alcohol concentration.

Vehicle Impoundment

"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" (UNC Highway Safety Research Center, 2011, p. 1-34). Vehicle impoundment allows seizure and storage of a DWI offender's vehicle for a designated period of time. The penalty duration varies by state and can be short term (up to 48 hours) or long term (ranges from ten days up to one year), although long-term impoundment laws are more frequently considered in literature about vehicle sanctions (McKnight et al., 2008).

"[NHTSA, 2008h] and [Voas, Fell, et al., 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 [Neuman et al., 2003], Strategies B1, B2, and C1" (UNC Highway Safety Research Center, 2011, p. 1-34).

History

Since the early 1980s, convicted DWI offenders have been subject to ALR laws that suspend the offender's driving privileges for a period of time. However, offenders may continue to endanger others by driving illegally, an offense known as DWS. Beginning in 1999, the first states began passing vehicle impoundment laws as a way to deter offenders from committing further DWS and DWI violations (Voas and DeYoung, 2002).

Use

As of 2004, vehicle impoundment was used in 22 states (McKnight et al., 2008, Table 1). Of these, 15 states allowed for long-term impoundment. Another seven allowed impoundment on a short-term basis only, to prevent a drunk driver from driving home after an arrest, rather than as a long-term measure (see Table B.8). More-recent updates were not available.

Effectiveness

Six published studies have evaluated vehicle impoundment laws. Of these, three reported positive findings that "[v]ehicle impoundment reduces recidivism while the vehicle is in custody and to a lesser extent after the vehicle has been released" (UNC Highway Safety Research Center, 2011, p. 1-34). Two found relatively little change, and one reported overall reductions in a few traffic safety measures, but these could not be attributed exclusively to vehicle impoundment.

In Ohio, researchers looked at the effect of vehicle impoundment in two counties. One study in Franklin County (Columbus) found a 37.7-percent reduction in DWS recidivism during vehicle impoundment for drivers with previous DWI charges (Voas, Tippetts, and Taylor, 1997). A smaller effect, 27.7 percent, was found in DWI recidivism but was insignificant. The study also found a lasting reduction in recidivism after the vehicle was returned (the length of the penalty period varied from 30 days to 180 days, depending on the number of previous offenses), but this result included the effect of both impoundment and immobilization sanctions. In another study, in Hamilton County (Cincinnati), any driver with any DWS offense or more than one DWI offense is eligible for vehicle impoundment. Voas, Tippetts, and Taylor, 1998, found 40-percent reductions in DWS and DWI offenses for the impounded group during the penalty period and 25-percent reductions approximately one year after impoundment. This postpenalty effect was larger (56 to 58 percent) for the drivers whose cars were impounded due to second and third DWI offenses—possibly because these drivers were not reclaiming their cars.

Similar results were found in California. DeYoung, 1999, studied the specific deterrence effect that California's impoundment law had on drivers with suspended or revoked licenses (S/Rs). This evaluation found that both first-time and repeat S/R drivers whose vehicles were impounded had fewer subsequent DWS convictions, moving-violation convictions, and crashes than those in similar control groups whose violations occurred the year before the law went into effect. The effect of impoundment, relative to the control group, was larger for repeat S/R drivers. This study was not limited to drivers with alcohol offenses, and the reason for drivers' S/R status was not provided; however, it is likely that many of the S/R orders result from repeat DWI convictions.

Researchers also examined the effect that California's impoundment law had on multiple safety outcomes in the city of Upland (Cooper, Chira-Chivala, and Gillen, 2000) using crash and citation data from one year before implementation up to 4.5 years after implementation. This study did not track individual violators over time. Time-series analyses found slight reductions in DWI offenses, driving without a valid license, and traffic crashes (includes fatal and nonfatal injury, hit-and-run, and speed-related crashes). The authors suggest that these outcomes are the result of the continued, long-term, and strict enforcement of the impound law in the city.

Two studies were less conclusive about effectiveness of impoundment laws. In a separate analysis of the California impoundment law, DeYoung, 2000, examined the general deterrent effect by examining crash rates of both S/R drivers and non-S/R drivers using time-series analysis (autoregressive integrated moving average [ARIMA] models). The crash rates for both groups decreased after the vehicle impoundment law went into effect (13.6 percent for the S/R drivers and 8.3 percent for control drivers), but these effects quickly lessened over time and were almost completely gone after one year. The authors found no compelling evidence of a general deterrent impact of the impoundment law.

A study in Manitoba, Canada, by Beirness, Simpson, et al., 1997, as cited in Voas and DeYoung, 2002, found a decline in both fatal crashes and nighttime single-car crashes for DWS drivers after an impoundment law and ALS law went into effect.[41] The authors were unable to attribute causality of their findings because of the simultaneous introduction of the two laws.

Costs

> The strategy is costly, as storage fees can be $20 daily and owners may abandon low-value vehicles rather than pay substantial storage costs, [in which case the locality is responsible for the storage and towing costs] ([Neuman et al., 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. (UNC Highway Safety Research Center, 2011, pp. 1-34–1-35)

Measuring Effectiveness

The effectiveness of vehicle impoundment laws is generally measured in terms of recidivism expressed as the percentage of offenders who drive while unlicensed (DWU) or suspended (DWS) or have alcohol-related traffic violations after being sanctioned. Crash rates are another common outcome of interest in impoundment studies.

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[41] The duration of the study period was not provided.

Time to Implement

Specific information on implementing vehicle impoundment is not available; however, "vehicle and license plate sanctions require at least several months to implement" (UNC Highway Safety Research Center, 2011, p. 1-34).

Other Issues

To Whom Vehicle Sanctions Are Applied

Vehicle impoundment policies vary by state, but "most vehicle sanctions have been applied to repeat [DWI] offenders" or those with DWS convictions following a DWI offense (UNC Highway Safety Research Center, 2011, p. 1-35). "[S]ome States also apply vehicle sanctions to high-BAC first offenders (e.g., a BAC of .15 or higher)" or first offenders but with a shorter penalty period (UNC Highway Safety Research Center, 2011, p. 1-35). "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, 2008h])" (UNC Highway Safety Research Center, 2011, p. 1-35).

Administrative Issues

> All license plate and vehicle sanctions require an administrative structure to process the license plates or vehicles. [If laws] permit officers to impound vehicles . . . at the time of arrest [rather than waiting for a court-issued order, this reduces] the opportunity [for offenders] to . . . transfer vehicle ownership ([NHTSA, 2008h]). (UNC Highway Safety Research Center, 2011, p. 1-35)

Table B.8. Vehicle Impoundment Laws, as of December 2004

State	Vehicle Impoundment or Confiscation Law
Ala.	A vehicle may be impounded if a driver is found to be driving with a revoked license or driving with a license suspended because of a DWI-related offense or refuses a breath test. However, the law provides that the vehicle will be released to the registered owner if the offender is not the owner. Further, police can release the vehicle, rather than impounding it, if it is determined that the driving is due to an emergency. This law does not seem to be aimed at long-term prevention of drinking and driving by separating offenders from their vehicles.
Alaska	The municipalities may enact ordinances to impound or confiscate motor vehicles for violations of local DWI offenses or refusal of chemical test laws for first and subsequent offenses. However, these laws are not mandatory.
Ariz.	Under Arizona's temporary vehicle impoundment law, the offender's vehicle may be immediately impounded for 30 days if the driver is arrested for any of the following offenses: (1) DWR for any reason; (2) DWS where the suspension was based on driving under the influence; (3) DWS where the suspension was based on a drunk-driving offense; or (4) DWS where the suspension was based on the frequency of traffic law violation convictions. The vehicle may be released before 30 days if the offender's driving privileges have been reinstated or if the offender's spouse enters a five-year agreement with the state to not to allow an unlicensed driver to operate the vehicle.
Ark.	None

State	Vehicle Impoundment or Confiscation Law
Calif.	California has two vehicle impoundment laws. The first law states that a vehicle owned and driven by an offender may be impounded up to 30 days for a first or second DWI offense and up to 90 days for third and subsequent offenses, if the offense is committed within five years of a prior offense. This first law prevents the vehicle from being impounded if it is the only vehicle available to the family or if another person has a community-property interest in the vehicle. The second law states that the vehicle owned and driven by the offender may be impounded for up to six months for a first DWI offense and up to 12 months for a subsequent DWI offense. We found no information on reasons one law might be enforced rather than the other. There is no mention of laws concerning chemical test refusals.
Colo.	None
Conn.	Connecticut has a vehicle impoundment law. The vehicle may be impounded for refusing a chemical test, which is a criminal offense and a felony DWI for a third or subsequent DWI offense. An ALR suspension counts as a prior DWI offense. There is also limited vehicle impoundment of 48 hours if a driver is arrested for drinking and driving with a suspended or revoked license. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.
Del.	None
D.C.	The District of Columbia also has a limited vehicle impoundment law, under which impoundment is limited to 24 hours. However, the vehicle may be released to a legally licensed driver.
Fla.	Florida has a vehicle impoundment law, under which the vehicle that is used and owned in a first DWI offense may be impounded for ten days. This action may not be concurrent with probation or imprisonment. For a second DWI offense within five years, the vehicle can be impounded for 30 days and, for a third DWI offense within ten years, for 90 days. This applies to all vehicles owned by the offender and may not be concurrent with probation or imprisonment. However, unlike first DWI offenses, it must be concurrent with the driver's license revocation. For first, second, and third DWI offenses, these actions are conditions of mandatory probation; however, the court may decide not to order vehicle impoundment if the family has no other means of transportation. There also is a limited vehicle impoundment law for a DWI offense if, at the time of the DWI offense, the offender was driving with a license suspended for a prior DWI offense. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.
Ga.	None
Hawaii	None
Idaho	None
Ill.	If the DWI offender is the registered owner, then the vehicle can be impounded for 24 hours for a second DWI offense or 48 hours for a third DWI offense. The vehicle may be released sooner to a competent, licensed driver with the owner's consent. There also is a limited vehicle impoundment law, under which law enforcement can impound a driver's vehicle for not more than 12 hours following a DWI arrest. Limited impoundment may be used if the officer reasonably believes that the arrested offender will commit another DWI offense if released. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.
Ind.	None
Iowa	For a second or subsequent DWI offense, the vehicle owned and used by the offender can be impounded or immobilized and the license plate seized (and registration confiscated if the vehicle is in custody) by law enforcement authorities. New registration plates are issued only at the end of the driver's license revocation period or 180 days, whichever is longer.
Kan.	For DWI violations, judges, at their discretion, may order vehicle impoundment or immobilization of the vehicle used in the offense, for up to one year. The offender pays all costs. Judges must take into account hardship to family. This law went into effect on July 1, 2003.
Ky.	None
La.	None

State	Vehicle Impoundment or Confiscation Law
Maine	Maine also has a temporary vehicle impoundment law. The vehicle used in a DWI offense or for DWS for a prior DWI offense may be seized; however, the vehicle may be released after eight hours. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.
Md.	The vehicle can be impounded or immobilized (by suspending license plates) for not more than 180 days if the driver's license is currently suspended for a prior alcohol offense.
Mass.	None
Mich.	None
Minn.	Under Minnesota's vehicle impoundment law, a vehicle may be impounded after a DWI arrest and released to the vehicle owner with proof of a valid driver's license and insurance. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.
Miss.	For a second or subsequent DWI offenses, all vehicles owned by the offender must be impounded or immobilized at the time of conviction and remain so until the license suspension has expired. If any other person must use the vehicle, an ignition interlock may be required as an alternative to impoundment or immobilization.
Mo.	Missouri has a vehicle impoundment or vehicle forfeiture law; however, under Missouri law, cities with populations higher than 100,000 can make their own vehicle impoundment or forfeiture laws. The state law applies to the vehicle operated by the offender regardless of ownership; consequently, the vehicle is subject to impoundment or forfeiture if the driver has had one or more DWI offenses, including illegal per se. The vehicle also can be impounded or forfeited if the offender is driving with a license suspended for a prior DWI offense or for a DWI and involuntary manslaughter offense. Last, the vehicle can be impounded or forfeited if the driver has had two or more DWI offenses (including illegal per se) and, for either offense, had a BAC of 0.08 or greater (0.02 or greater for those under 21) or if the driver has refused to submit to a chemical test under the implied-consent law.
Mont.	None
Neb.	An offender who is driving with a license suspended for a prior DWI or an implied-consent conviction may have his or her vehicle impounded for not less than ten days and not longer than 30 days. An offender under 21 may have his or her vehicle impounded if he or she has a BAC of 0.02 or greater.
Nev.	None
N.H.	None
N.J.	According to Century Council, 2003, New Jersey has a vehicle impoundment law under which an offender's vehicle must be impounded for 12 hours at the time of arrest. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders. NHTSA, 2003a, does not report any vehicle impoundment laws in New Jersey, which raises a question as to which source is correct.
N.M.	New Mexico also has a vehicle immobilization law, under which a vehicle may be immobilized for 30 days if the offender was driving with a revoked license, unless immobilization poses a hardship to the family.
N.Y.	None
N.C.	None
N.D.	None
Ohio	None
Okla.	None
Ore.	Vehicle impoundment or immobilization is limited to one year for a second or subsequent DWI offense or for driving with a suspended license. This action is at the court's discretion and applies to all vehicles owned and used by the offender, even if not used in the offense. The offender must pay the costs of removing, storing, or immobilizing the vehicle.
Pa.	None
R.I.	None

State	Vehicle Impoundment or Confiscation Law
S.C.	None
S.D.	None
Tenn.	None
Texas	None
Utah	None
Vt.	None
Va.	Any vehicle used in a DWI offense may be impounded or immobilized for 30 days if the offender was driving with a license suspended because of a prior DWI, an administrative per se violation, or chemical test refusal. In addition, vehicles owned by an offender may be impounded or immobilized for up to 90 days even if the vehicles were not used in the offense. There are family hardship exceptions for households with only one vehicle.
Wash.	Washington has a vehicle impoundment law. In addition to impounding the vehicle for other possible penalties for driving with a license suspended for a prior DWI conviction, authorities may also impound the vehicle for not more than 30 days on a first offense. For a second offense, the vehicle may be impounded for not more than 60 days or, for a third offense, not more than 90 days.
W.Va.	None
Wis.	There is a policy in Wisconsin that allows temporary vehicle impoundment, as part of the immobilization process. This is not a law, just a policy, and is used only temporarily and at the discretion of officers in the field.
Wyo.	Wyoming has a policy that allows for temporary vehicle impoundment. An offender's vehicle may be impounded following an arrest if a sober driver is unavailable. This law seems intended to prevent the offender from operating the vehicle immediately after the drinking-and-driving offense, rather than being aimed at long-term prevention of drinking and driving by offenders.

SOURCE: McKnight et al., 2008.

In-Person License Renewal

In Goodwin, Kirley, et al., 2013, this intervention also includes vision testing. The write-up below concentrates on in-person renewal only.

> 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. Some States allow all drivers to renew by mail or electronically. (Goodwin, Kirley, et al., 2013, p. 7-22)
>
> 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. (Goodwin, Kirley, et al., 2013, p. 7-22)
>
> 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 ([I. Potts, Stutts, et al., 2004]). 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 and Lococo, 2003; Stutts et al., 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 and Lococo, 2003) . . . . (Goodwin, Kirley, et al., 2013, p. 7-22)

History

Some states have licensed drivers since the 1900s, although, in many states, there was a considerable gap between the first driver's license law and the requirement that a driver pass a license examination. Several states did not require examinations until the 1950s (FHWA, 1995, Table DL-230).

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 Public Affairs, 2010; [IIHS, 2015]). In 2001, about 12 States met the [AAMVA] recommendations of in-person renewal with a vision test, at least every 4 years for all drivers over some specified age (Staplin and Lococo, 2003). See also the AAA Foundation for Traffic Safety ([undated]) "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. (Goodwin, Kirley, et al., 2013, p. 7-22)

Effectiveness

> License examiners report that in-person renewals and vision tests are effective in identifying people whose driving skills may be impaired ([I. Potts, Stutts, et al., 2004]). 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. (Goodwin, Kirley, et al., 2013, pp. 7-22–7-23)

Grabowski, Campbell, and Morrisey, 2004, compares policies in different states; the authors found that

> [i]n-person license renewal was related to a significantly lower fatality rate among the oldest old drivers [85 and up]. More stringent state licensure policies such as vision tests, road tests, and more frequent license renewal cycles were not independently associated with additional benefits. (p. 2840)

Sharp and Johnson, 2005, compares 15 states based on their licensing procedures as they affect drivers over 70. The authors found that the longer the renewal cycle, the higher the elderly crash rate. Road tests tend to reduce the licensing rate. The effect of requiring in-person testing and administering a written test or a road test (not just a vision test) is twice as large (in terms of lowering crashes) as increasing the amount of time between testing, which tends to increase elderly crashes.

Measuring Effectiveness

Effectiveness of in-person license renewal can be measured by the number of people who decline to renew because one effect of these laws is that they discourage license renewal by people whose driving abilities might have declined. Effectiveness can also be measured in crash or fatality rates, particularly among older drivers.

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 percent of licensed drivers in the State are 65 and older, then the agency's overall workload would increase by about 15 percent 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. (Goodwin, Kirley, et al., 2013, p. 7-23)

Time to Implement

> 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. (Goodwin, Kirley, et al., 2013, p. 7-23)

Other Issues

Age Discrimination

As of 2013, five states explicitly prohibit using age by itself as a justification for reexamining a driver's qualifications (Teigen and Shinkle, 2014). These laws differ slightly from state to state. Some have argued that it would be better to move toward a cognitive-based rather than age-based screening approach for license renewal (Langford, Methorst, and Hakamies-Blomqvist, 2006; Chaudhary, Ledingham, et al., 2013) to improve the effectiveness and fairness of such a policy.

Table B.9. State Laws on In-Person Renewal Requirements and Renewal Cycle, for All Drivers and Older Drivers, 2009

State	Standard In-Person Renewal Requirements	Older-Driver In-Person Renewal Requirements	Age-Based Requirements	Standard Renewal Cycle	Older-Driver Renewal Cycle
Ala.	Every renewal	Same	None	4 years	Same
Alaska	Every other renewal	Every renewal ages 69+	In-person renewal	5 years	Same
Ariz.	Every renewal	Same (every renewal ages 70+)	More-frequent renewal, in-person renewal, vision testing	12 years (photo update only)	5 years starting at age 65
Ark.	Every renewal	Same	None	4 years	Same
Calif.	Every 3rd renewal with good driving record	Every renewal ages 70+	In-person renewal	5 years	Same
Colo.	Every other renewal	Same	Vision testing	5 years	Same
Conn.	Every renewal (includes locations other than DMV)	Same	None	4 or 6 years at driver's option	2-year option available starting at age 65
Del.	Every renewal	Same	None	8 years	Same
D.C.	Every other renewal	Every renewal age 70 and over	Medical report	8 years	Same
Fla.	Every other renewal	Same	More-frequent renewal, vision testing	8 years	6 years starting at age 80
Ga.	Every renewal	Same	More-frequent renewal	5 or 8 years	5 years starting at age 60
Hawaii	Every renewal	Same	More-frequent renewal	8 years	2 years starting at age 72
Idaho	Every 8 years	Every 4 years ages 70+	More-frequent renewal, in-person renewal	4 or 8 years (option of driver)	4 years starting at age 63
Ill.	Every other renewal	Every renewal ages 75+	More-frequent renewal, in-person renewal, road test	4 years	2 years ages 81–86, then 1 year ages 87+
Ind.	Every other renewal	Same	More-frequent renewal	6 years	3 years ages 75–84, then 2 years ages 85+
Iowa	Every renewal	Same	More-frequent renewal	8 years	2 years starting at age 72
Kan.	Every renewal ages 70+	Same	More-frequent renewal	6 years	4 years starting at age 65
Ky.	Every renewal with some exceptions	Same	None	4 years	Same
La.	Every other renewal	Every renewal ages 70+	In-person renewal	4 years	Same

State	Standard In-Person Renewal Requirements	Older-Driver In-Person Renewal Requirements	Age-Based Requirements	Standard Renewal Cycle	Older-Driver Renewal Cycle
Maine	Every other renewal	Every renewal ages 62+	More-frequent renewal, in-person renewal, vision testing	6 years	4 years starting at age 65
Md.	8 years, at least every other has to be in person	Same	None	8 years	Same
Mass.	Every other renewal	Every renewal, ages 75+	More-frequent renewal	5 years	Same
Mich.	Every other renewal	Same	None	4 years	Same
Minn.	Every renewal	Same	None	4 years	Same
Miss.	Every other renewal	Every renewal ages 71+	In-person renewal	4 years	Same
Mo.	Every renewal	Same	More-frequent renewal	6 years	3 years starting at age 70
Mont.	Every other renewal	Every renewal ages 75+	More-frequent renewal, in-person renewal	8 years	4 years starting at age 75
Neb.	Every other renewal	Same	None	5 years	Same
Nev.	Every other renewal	Same	None	4 years	Same
N.H.	Every renewal (every other renewal if eligible for online renewal)	Same	None	5 years	Same
N.J.	Every renewal	Same	None	4 years	Same
N.M.	Every renewal	Same	More-frequent renewal	4 or 8 years (option of the driver)	4 years ages 71–74, then 1 year ages 75+
N.Y.	Optional; if not in person, must submit vision report	Same	None	8 years	Same
N.C.	Every renewal	Same	More-frequent renewal	8 years	5 years starting at age 66
N.D.	Every renewal	Same	None	6 years	4 years starting at age 78
Ohio	Every renewal	Same	None	4 years	Same
Okla.	Every renewal (at tag agencies)	Same	None	4 years	Same
Ore.	Every renewal	Same	Vision testing	8 years	Same
Pa.	Not required	Same	None	4 years	2-year option starting at age 65
R.I.	Every renewal	Same	More-frequent renewal	5 years	2 years starting at age 75
S.C.	Every other renewal if clean record	Same	More-frequent renewal	10 years	5 years starting at age 65
S.D.	Every renewal	Same	None	5 years	Same
Tenn.	Every other renewal	Same	None	5 years	Same

State	Standard In-Person Renewal Requirements	Older-Driver In-Person Renewal Requirements	Age-Based Requirements	Standard Renewal Cycle	Older-Driver Renewal Cycle
Texas	Every other renewal	Every renewal for ages 79+	More-frequent renewal, in-person renewal	6 years	2 years starting at age 85
Utah	Every renewal	Same	Vision testing	5 years	Same
Vt.	Optional (if photo in past 8 years)	Same	None	2 or 4 years (option of driver)	Same
Va.	Every other renewal	Every renewal ages 80+	In-person renewal	8 years	Same
Wash.	Every other renewal	In person every renewal ages 70+	Electronic renewal up to age 70	5 years	Same
W.Va.	Every renewal	Same	None	5 years	Same
Wis.	Every renewal	Same	None	8 years	Same
Wyo.	Every other renewal	Same	None	4 years	Same

SOURCE: AAA Foundation for Traffic Safety, undated.

Population Growth

The population of older drivers is projected to increase significantly over time. Estimates suggest that, by 2030, 70 million people in the United States will be older than 65, which translates into 25 percent of drivers (K. Wilson, 2007). The controversy around requiring in-person renewal based solely on age will likely grow as a result.

Increased Fines for Seat Belt Use

In Goodwin, Kirley, et al., 2013, this intervention includes using a point-based system under which drivers could be assessed demerit points against their license. Because this element of the intervention has not been proven effective, the write-up concentrates on increased fines. The history portion is taken from the general discussion of seat belts for adults—trends and laws.

> Penalties for most belt use law violations are low. As of May 2014, a violation resulted in a typical fine of $25 or less in all but 14 States (IIHS, [2014d]). Low fines may not convince nonusers to buckle up and may also send a message that belt use laws are not taken seriously. (p. 2-15)

History

> 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 percent belt use for drivers and front-seat passengers (Williams and Wells, 2004). This survey became the benchmark for tracking belt use nationwide. (Goodwin, Kirley, et al., 2013, p. 2-4)

> 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 percent to 20 percent to post-law use rates of

> about 50 percent (Nichols and Ledingham, 2008). (Goodwin, Kirley, et al., 2013, p. 2-4)

By 1996, every state, with the exception of New Hampshire, had a mandatory seat belt use law covering drivers and front-seat occupants.

Use

As of May 2014, 11 primary law states and three secondary law states had maximum base fines for first offenses of $30 or more for all adult drivers (IIHS, 2014d). A few states charge higher fines by location (Louisiana), for drivers versus passengers (Ohio), and younger offenders versus adults (Kansas). Three states have fines of more than $100: Oregon, Texas, and Washington.

Effectiveness

> Houston and Richardson ([2005]) 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. (Goodwin, Kirley, et al., 2013, p. 2-15)

For each additional $1 in fines, seat belt use increases by 0.15 percentage points. The model already factors in primary vs. secondary enforcement, so the amount of the fine seems to have an additional effect. They also estimated the effect of different states increasing their fines to $50. Many secondary states would see gains of 12–15 percentage points, based on the level of fines in 2002 (Houston and Richardson, 2005).

> [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. Increased a State's fine from $25 to $60 was associated with an increase of 3 to 4 percent 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 percent. (Goodwin, Kirley, et al., 2013, p. 2-15)

Few states levy fines of more than $100, but fines of this magnitude conferred little improvement.

> In a national survey in 2000, 42 percent 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 percent 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 and Wells, 2004). (Goodwin, Kirley, et al., 2013, p. 2-15)

Measuring Effectiveness

Effectiveness of seat belt penalties is generally measured in the percentage of vehicle occupants wearing seat belts. Percentages can be observed (NHTSA annually conducts an observational survey called the National Occupant Protection Use Survey [NOPUS]) or taken from data in FARS.

Costs

> The direct costs associated with increasing fine levels or assessing driver's license points of minimal. (Goodwin, Kirley, et al., 2013, p. 2-16)

Time to Implement

Fine increases can be implemented as soon as they are publicized and appropriate changes are made to the motor vehicle record 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. (Goodwin, Kirley, et al., 2013, p. 2-16)

In addition, it is possible that, as fines increase, the likelihood of nonpayment because of financial constraints will increase as well.

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. (Goodwin, Kirley, et al., 2013, p. 2-16)

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