Tool

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

## Supplement to Tool Documentation

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# Preface

In December 2015, RAND Corporation researchers produced an online tool called the Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS) for the National Center for Injury Prevention and Control at the Centers for Disease Control and Prevention (CDC). The purpose of this tool, which is available to the public at www.cdc.gov/motorvehiclesafety/calculator/ (CDC, 2015), is 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.

In 2017, the team completed an update to the tool as part of a project led by the National Governors Association, funded by CDC, to work with states and governors' offices to strengthen strategies to reduce highway and traffic injuries and fatalities. The work includes updates to some of the data used, updates to some of the assumptions and methods to derive the data, and a full redesign of the user interface of the tool. This report documents which data, assumptions, and methods we updated. 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 14 motor vehicle injury prevention interventions included in MV PICCS.

The more complete documentation, which includes discussion of how we selected interventions for inclusion in the tool and how we programmed the tool, is available in Ringel et al., 2015.

RAND researchers have also undertaken related work that used the data in the tool to conduct policy analyses of traffic safety spending. This work was sponsored by the Robert Wood Johnson Foundation. The main report is Ecola, Batorsky, and Ringel, 2015.

Four research briefs highlight those analyses:

- Liisa Ecola, Benjamin Saul Batorsky, Jeanne Ringel, Johanna Zmud, Kathryn Connor, David Powell, Brian G. Chow, Christina Panis, and Gregory S. Jones, *Which Behavioral Interventions Are Most Cost-Effective in Reducing Drunk Driving?* Santa Monica, Calif.: RAND Corporation, RB-9826, 2015a
- Liisa Ecola, Benjamin Saul Batorsky, Jeanne Ringel, Johanna Zmud, Kathryn Connor, David Powell, Brian G. Chow, Christina Panis, and Gregory S. Jones, *A New Tool to Help Decisionmakers Select Interventions to Reduce Traffic Crash Deaths and Injuries*, Santa Monica, Calif.: RAND Corporation, RB-9827, 2015b
- Liisa Ecola, Benjamin Saul Batorsky, Jeanne Ringel, Johanna Zmud, Kathryn Connor, David Powell, Brian G. Chow, Christina Panis, and Gregory S. Jones, *How to Get the Biggest Impact from an Increase in Spending on Traffic Safety*, Santa Monica, Calif.: RAND Corporation, RB-9855, 2015c

- Liisa Ecola, Benjamin Saul Batorsky, Jeanne Ringel, Johanna Zmud, Kathryn Connor, David Powell, Brian G. Chow, Christina Panis, Gregory S. Jones, *Should Traffic Crash Interventions Be Selected Nationally or State by State?* Santa Monica, Calif.: RAND Corporation, RB-9860, 2015d.

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

## RAND Health

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For more information about RAND Infrastructure Resilience and Environmental Policy, see www.rand.org/jie/irep or contact the director at irep@rand.org.

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# Summary

Motor vehicle crashes account for a large number of deaths and injuries. In the United States, in 2015, more than 35,000 people were killed and approximately 2.44 million were injured in motor vehicle crashes (National Center for Statistics and Analysis, 2016b). Crash deaths rose yet again in 2016, to more than 37,000 (National Center for Statistics and Analysis, 2017). In 2010, the economic costs associated with motor vehicle crashes in the United States were substantial, estimated to be $242 billion (Blincoe 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.

In 2014, RAND researchers developed, for the Centers for Disease Control and Prevention (CDC), 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 the numbers of injuries and deaths for a given implementation budget. The tool is called Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS) and is available at www.cdc.gov/motorvehiclesafety/calculator/ (CDC, 2015).

Developing MV PICCS required collecting and analyzing data related to the selection of interventions, their effectiveness, and their cost (specific to each state), as well as programming the tool to select interventions based on a specified budget and the cost-effectiveness of interventions in a specific state.

Since 2014, we have updated the tool twice. The first update was released in 2015; it added two new interventions and produced a series of reports about allocating traffic safety funds (listed in the preface). In this report, we refer to this update (the interventions and reports together) as MV PICCS 2.0.

In 2017, we conducted the second update, described in this report, for the National Governors Association (NGA), working with the National Center for Injury Prevention and Control at CDC. NGA commissioned RAND to update the MV PICCS tool, with the following goals:

- Determine whether new interventions should be added, based on the most-recent evidence available.
- Update information on the effectiveness of interventions.
- Update cost data.
- Redesign the tool's user interface to be more user-friendly.

This documentation summarizes the changes made to MV PICCS in these four areas. We refer to this most recent update as MV PICCS 3.0.

## New Interventions

We reviewed seven interventions for potential addition to the tool. We considered adding one new intervention out of those: lowering the legal limit for a driving-while-intoxicated (DWI) charge from a blood alcohol concentration of 0.08 to 0.05 g per deciliter. However, following discussions with NGA and CDC, we opted not to include it, for two main reasons: It would be difficult to (1) develop a specific estimate of how many lives could be saved and (2) incorporate it with similar drunk-driving interventions (sobriety checkpoints and saturation patrols). A more detailed discussion of the findings from our literature review of studies on blood alcohol concentration can be found in Appendix A.

During the research for the 2015 update, we reviewed the literature on cell phone and texting bans to prevent distracted driving. At the time, we determined that the evidence was not strong enough to include these interventions in the tool. We also scanned the literature in 2017 to determine whether the research findings suggested any new understanding of their effectiveness, and we found that the research was still mixed. This review is provided in Appendix A.

## Effectiveness Data Updates

Given the extensive review we conducted during the original research and the 2015 update, we did not update any of the effectiveness data (the percentage by which the number of deaths due to specific crash causes would decline if the intervention were implemented). We did update the state-specific data on the number of deaths in different crash categories by state, as well as our estimates of injuries by state, with the most-recent data available, 2015. These updates provide more-realistic estimates because most states have experienced an increase in traffic crash deaths from 2010 to 2015. We also believe that our current method for estimating injuries provides a more accurate number of injuries per state.

## Cost Data Updates

We made some changes to the data that determine the cost per intervention. These include adjusting all dollar figures to 2017 dollars and using more-recent data for cost elements, such as state employee wages, number of drivers by state, and the value of saving one life. We also made two more-significant changes. First, because of known undercounting in the data, we adjusted figures for the number of people arrested for DWI. The new figures should provide a more realistic estimate of the number of arrests, which leads to more-realistic implementation costs, especially in those states where undercounts were very pronounced. Second, we updated our method for estimating the number of red-light and speed cameras assumed to be deployed in each state. This resulted in reductions in the estimated number of cameras, which translates into lower costs for these two interventions in all states. Both of these updates should lead to more-realistic estimates.

## User Interface Redesign

Finally, we completely redesigned the user interface to streamline it and make it more intuitive to use. This includes the way in which users enter information and the way the tool displays the results. We have also created links within the tool to fact sheets about each intervention and a new feature that allows the user to generate a Portable Document Format version of the MV PICCS results. We believe that the user interface is now more intuitive in terms of inputting data, as well as in providing outputs that are easier to interpret and share.

Table S.1 summarizes the changes made to MV PICCS.

**Table S.1. Summary of Changes to MV PICCS**

| Methods and Data from MV PICCS 2.0 | MV PICCS 3.0 Revisions to Methods and Data |
|---|---|
| Interventions | |
| Identified 14 interventions | No change to the list of interventions |
| | Updated information on which interventions are currently implemented for each state |
| Effectiveness | |
| Informed by the literature, developed an estimate of the percentage of lives saved by each intervention | No change to these estimates |
| Identified the number of people killed in each state, by crash type, using 2010 FARS data | Updated FARS data from 2010 to 2015 |
| Estimated the number of people injured in each state, by crash type | Used a different method to develop injury estimates and applied it using FARS and General Estimates System data from 2015 |
| Estimated the monetary value of lives saved and injuries prevented, by state | Updated state-specific adjustment factors and updated costs to 2017 dollars; no change to underlying injury and fatality dollar estimates |
| Costs | |
| Developed ten cost components | No change to the list of cost components |
| Defined cost components for each intervention | No change to cost components per intervention |
| Developed cost estimates for each intervention | Updated all costs to 2017 dollars |
| | Updated state-specific cost elements (wage rates, population, number of licensed drivers, and number of registered motorcycles) to the most recent year available |
| | Developed a new method to estimate the number of DWI arrests per state, which affects the costs of four DWI-related interventions |
| | Revised the method of estimating the number of red-light and speed cameras per state, resulting in lower costs |
| Online tool | |
| Created a user interface with two types of analysis (cost-effectiveness analysis and portfolio analysis) | Combined both forms of analysis into one model run with one complete set of cost-effectiveness outputs that provides a summary of the portfolio analysis results |
| Updated ways for users to supply data inputs | Streamlined data inputs and changed the order so that users input the desired parameters before model runs; changed defaults to unimplemented interventions and excluded fines and fees; provided a state map |
| Streamlined the sensitivity analysis, allowing users to change some default inputs | Streamlined sensitivity analysis such that users can change only two types of inputs and allowed users to access sensitivity inputs on any model run |
| | Created additional graphics to display information, and provided links to information on each intervention |

NOTE: FARS = Fatality Analysis Reporting System.

# Acknowledgments

Many thanks to our sponsors at the National Governors Association: Jeffrey Locke, who managed the project for the association, and staff members Kalyn Hill and Lauren Dedon. They provided valuable insights based on their work with state users of the tool.

We also thank the Centers for Disease Control and Prevention (CDC) officials and staff who provided technical assistance. Erica Spies, our main contact, kept us on track, answered every question patiently, and provided extremely good advice. Erin K. Sauber-Schatz, our liaison for the previous work on the Motor Vehicle Prioritizing Interventions and Cost Calculator for States, provided important continuity and institutional memory. Jessica Burke, Melvin Crum, Kevin Webb, and Nimeshkumar Patel helped us understand the technical requirements for programming the website to be compatible with CDC infrastructure and transferring it to CDC. Kristin Belcher and Yamile Underwood assisted with thinking through some of the best ways to communicate the information in the tool to its users.

Tonja Lindsey and Ruby Li at the National Highway Traffic Safety Administration walked us through some of the statistical complexities of fatality and injury data.

At RAND, we thank Michael Robbins, who developed a statistical method to assist with our data analysis, as well as Rosanna Smart, Janet M. Hanley, and Sascha Ishikawa for their thoughtful and constructive reviews of the report and the tool. Their input improved the final product significantly.

# Abbreviations

| | |
|---|---|
| BAC | blood alcohol concentration |
| BLS | Bureau of Labor Statistics |
| CDC | Centers for Disease Control and Prevention |
| DMV | department of motor vehicles |
| DOT | U.S. Department of Transportation |
| DWI | driving while intoxicated |
| FARS | Fatality Analysis Reporting System |
| FBI | Federal Bureau of Investigation |
| GES | General Estimates System |
| GHSA | Governors Highway Safety Association |
| HVE | high-visibility enforcement |
| IIHS | Insurance Institute for Highway Safety |
| MV PICCS | Motor Vehicle Prioritizing Interventions and Cost Calculator for States |
| NGA | National Governors Association |
| NHTSA | National Highway Traffic Safety Administration |
| PDF | Portable Document Format |
| RBT | random breath testing |
| WISQARS | Web-Based Injury Statistics Query and Reporting System |

# Chapter One. Introduction

## Project Objectives

Traffic crashes have long been a leading cause of death in the United States, especially among people ages 16 to 25 (National Center for Statistics and Analysis, 2016a). After years of declining, traffic fatalities began to rise in 2015, when 35,092 people were killed and 2.44 million were injured on the nation's roadways (National Highway Traffic Safety Administration [NHTSA], 2017). Crash deaths rose yet again in 2016, to more than 37,000 (National Center for Statistics and Analysis, 2017).[1] In 2010, the economic costs associated with motor vehicle crashes were substantial, estimated to be $242 billion (Blincoe 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.

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[2]—cannot fully assess the costs and effects of different interventions and select the most cost-effective ones.

The purpose of the original project was to support states and local communities across the United States in making evidence-based resource allocation decisions related to the implementation of effective interventions to prevent motor vehicle–related injuries and deaths. We achieved this by building an interactive online tool called the Motor Vehicle Prioritizing Interventions and Cost Calculator for States (MV PICCS), available at www.cdc.gov/motorvehiclesafety/calculator/ (Centers for Disease Control and Prevention

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[1] This document does not include data on injuries for 2016.

[2] The full list of potential decisionmakers could include governors, state legislators, state public safety secretaries, state public health commissioners, state transportation secretaries, governors advisers (criminal justice, health, transportation), and state highway safety officials.

[CDC], 2015). Since the most recent update in December 2015,[3] states have been able 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.

We conducted the original 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 Report 622 (Preusser 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 could 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.

In 2017, the National Governors Association (NGA), working with the National Center for Injury Prevention and Control at CDC, commissioned RAND to update the MV PICCS tool, with the following goals:

- Determine whether new interventions should be added, based on the most-recent evidence available.
- Update annual or regularly updated data sources to reflect more-recent circumstances.
- Update other data sources as needed.
- Redesign the tool's user interface to be more user-friendly.

The revision provided an opportunity to revisit some of our earlier methods and assumptions and make changes as needed to make the tool as useful as possible. Table 1.1 summarizes the changes made to MV PICCS.

[3] The first version of MV PICCS was publicly released in October 2014. The December 2015 update added two new interventions and updated some data but did not change the underlying methods or the user interface of the tool. We refer to the 2015 update as MV PICCS 2.0 and this most recent update as MV PICCS 3.0.

**Table 1.1. Summary of Changes to MV PICCS**

| Methods and Data from MV PICCS 2.0 | MV PICCS 3.0 Revisions to Methods and Data |
|---|---|
| Interventions | |
| Identified 14 interventions | No change to the list of interventions |
| | Updated information on which interventions are currently implemented for each state |
| Effectiveness | |
| Informed by the literature, developed an estimate of the percentage of lives saved by each intervention | No change to these estimates |
| Identified the number of people killed in each state, by crash type, using 2010 FARS data | Updated FARS data from 2010 to 2015 |
| Estimated the number of people injured in each state, by crash type | Used a different method to develop injury estimates and applied using FARS and GES data from 2015 |
| Estimated the monetary value of lives saved and injuries prevented, by state | Updated state-specific adjustment factors and updated costs to 2017 dollars; no change to underlying injury and fatality dollar estimates |
| Costs | |
| Developed ten cost components | No change to the list of cost components |
| Defined the cost components for each intervention | No change to cost components per intervention |
| Developed cost estimates for each intervention | Updated all costs to 2017 dollars |
| | Updated state-specific cost elements (wage rates, population, number of licensed drivers, and number of registered motorcycles) to the most recent year available |
| | Developed a new method to estimate the number of DWI arrests per state, which affects the costs of four DWI-related interventions |
| | Revised the method of estimating number of red-light and speed cameras per state, resulting in lower costs |
| Online tool | |
| Created a user interface with two types of analysis (cost-effectiveness analysis and portfolio analysis) | Combined both forms of analysis into one model run with one complete set of cost-effectiveness outputs that provides a summary of the portfolio analysis results |
| Updated ways for users to supply data inputs | Streamlined data inputs and changed the order so that users input the desired parameters before model runs; changed defaults to unimplemented interventions and excluded fines and fees; provided a state map |
| Streamlined sensitivity analysis allowing users to change some default inputs | Streamlined sensitivity analysis such that users can change only two types of inputs, and allowed users to access sensitivity inputs on any model run |
| | Created additional graphics to display information and provided links to information on each intervention |

NOTE: FARS = Fatality Analysis Reporting System. GES = General Estimates System. DWI = driving while intoxicated.

The remaining chapters discuss the changes made to MV PICCS. Chapter Two discusses why we chose not to add any new interventions and explains how we updated the information about which interventions are implemented in which states. Chapter Three discusses our updates to the data on effectiveness and their overall effect on the model output. Chapter Four discusses updates to the cost estimates and their overall effect on the model output. Chapter Five explains our updates to the user interface. Chapter Six reviews the tool's limitations and potential future refinements. Appendix A provides more information about the interventions we reviewed. Appendix B lists the values we assigned to prevented injuries and deaths.

# Chapter Two. Selecting Interventions

We selected 14 interventions for MV PICCS 2.0, as shown in Table 2.1.

**Table 2.1. Interventions for Analysis**

| Intervention | Short Name | Description |
|---|---|---|
| Automated red light–camera enforcement | Red-light camera | This camera captures an image of a vehicle whose driver fails to stop for a red light. Tickets are generally sent to offenders by mail. |
| Automated speed-camera enforcement | Speed camera | This camera 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. |
| Alcohol interlocks | Alcohol interlocks | This device prevents a vehicle from starting until the driver has blown into a tube and the device determines that the driver's BAC is below the state-allowed level (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. |
| Sobriety checkpoints | Sobriety checkpoints | Here, 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). |
| Saturation patrols | Saturation patrols | This consists of an increased police presence in selected locations where police patrol the area looking for suspicious driving behavior. In contrast to sobriety checkpoints, they do not stop every vehicle. |
| Bicycle helmet law for children | Bicycle helmet | To reduce the likelihood of trauma to the head and its related consequences, this mandates the use of helmets by children while they are riding bicycles. |
| Universal motorcycle helmet law | Motorcycle helmet | This law requires all motorcyclists, regardless of age or experience level, to wear a helmet that meets safety standards set by DOT. It contrasts with partial helmet laws, which typically apply only to riders below a certain age. |
| Primary enforcement seat belt law | Primary enforcement seat belt law | 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. |
| High-visibility enforcement for seat belts and child restraint law | 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 child restraints.[a] |
| License plate impoundment | 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, the officer places a sticker on the license plate to indicate that it is invalid. The stickers are designed so that, if someone tries to remove one, it leaves a visible pattern on the plate. Because it is relatively easy for police to observe whether a vehicle has a license plate or the sticker, this intervention deters convicted DWI offenders from driving that vehicle. |

| Intervention | Short Name | Description |
|---|---|---|
| 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 most often target 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. |
| Vehicle impoundment | 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. The offender can either reclaim or surrender the vehicle when the impoundment period ends. |
| In-person license renewal | In-person renewal | This intervention requires all drivers over age 70 to renew their drivers' licenses in person at DMVs, instead of using mail-in or online renewal. |
| Increased seat belt fines | Increased 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. |

NOTE: BAC = blood alcohol concentration. DOT = U.S. Department of Transportation. DMV = department of motor vehicles.
[a] *Child restraint* includes both child car seats and booster seats. For simplicity, we refer generally to *child restraint*.

Informed by our knowledge of the literature and in consultation with NGA and CDC, we reviewed seven potential new interventions for inclusion in the tool: DWI courts, vision testing at DMVs, cognitive screening at DMVs, referring older drivers to licensing agencies, 24/7 sobriety programs, lowering BAC limits for repeat offenders only, and lowering the legal BAC limit from 0.08 to 0.05 for all DWI charges. With the exception of lower BAC limits for all DWI charges, our review of existing literature could not establish a strong enough evidence base to justify including any of these additional interventions.

After the initial literature review, we intended to include lowering BAC limits from 0.05 to 0.08 as a new intervention because several countries have adopted this level, and the National Transportation Safety Board has formally recommended its adoption (National Transportation Safety Board, 2013). However, following discussions with NGA and CDC, we opted not to include it, for two main reasons:

- First, it is difficult to distill the existing evidence about its effectiveness into a single point estimate of the proportion of lives that would be saved with its implementation. Although there have been studies of lowering the BAC limit, many of them have been undertaken for different changes (for example, from 0.1 to 0.08) or the change in BAC has been accompanied by extensive enforcement efforts that make it difficult to separate out the effect of the actual lowered limit from that of the intensity of enforcement.
- Second, our list of interventions already includes two that focus on identifying drunk drivers on the road: sobriety checkpoints and saturation patrols.[4] Given that any assumptions about lowering the BAC would include a similar type of enhanced enforcement, it would be difficult to integrate this with our existing assumptions about

[4] We include both because some states forbid sobriety checkpoints.

> the effectiveness of sobriety checkpoints and saturation patrols. We use two different estimates of fatality reduction: 18 percent for saturation patrols and 8.1 percent for sobriety checkpoints. If the model selects both, the sum is 26.1 percent. Because of the adjustment, the adjusted total reduction in fatalities is 24.8 percent, to account for the overlap between the two. This combination is already among the most-effective interventions and higher than almost all estimates of the effectiveness of lowering the BAC on its own.

Appendix A provides a more detailed discussion of the findings from our literature review of BAC studies.

During previous work on MV PICCS, we also looked at whether bans on cell phones and texting were effective. Informed by that review, we determined that the evidence of effectiveness was not strong enough to support inclusion in MV PICCS. Appendix A provides a fuller discussion of that evidence, updated with more-recent studies.

The one change we made to the data about the interventions themselves was to update the list of which interventions are in use in which states, as shown in Table 2.2. We use an asterisk to indicate those that changed from the previous status. The data are current as of 2017 for all interventions except in-person license renewal (2016), license plate impoundment (2008), limits on diversion (2013), and vehicle impoundment (2008). For license plate impoundment and vehicle impoundment, we found no data updated since MV PICCS 2.0. We could not locate any information on the status of saturation patrols and seat belt enforcement campaigns. As in the prior version of the tool, users can change the default information about which interventions are currently implemented in the state, recognizing that these laws can change over time.

**Table 2.2. Intervention Status, by State**

| State | Red-Light Camera | Speed Camera | Alcohol Interlock | Sobriety Checkpoint | Saturation Patrol | Bicycle Helmet | Motorcycle Helmet | Primary Enforcement 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 | 1 | 1 | 1 | 9 | 1 | 1 | 1 | 9 | 0 | 0 | 1 | 0 | 0 |
| Alaska | 0 | 0 | 1 | 0 | 9 | 0 | 0 | 1 | 9 | 0 | 0 | 1 | 0 | 0 |
| Ariz. | 1 | 1 | 1 | 1 | 9 | 0 | 0 | 0 | 9 | 0 | 1 | 1 | 0 | 0 |
| Ark. | 0 | 0 | 1 | 1 | 9 | 0 | 0 | 1 | 9 | 1 | 1 | 0 | 1 | 0 |
| Calif. | 1 | 0 | 0[a] | 1 | 9 | 1 | 1 | 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 | 1[a] | 1 | 9 | 1 | 1 | 1 | 9 | 0 | 0 | 0 | 0 | 0 |
| Fla. | 1 | 0 | 0[a] | 1 | 9 | 1 | 0 | 1 | 9 | 0 | 1 | 1 | 0 | 0 |
| Ga. | 1 | 0 | 0[a] | 1 | 9 | 1 | 1 | 1 | 9 | 1 | 0 | 0 | 0 | 0 |
| Hawaii | 0 | 0 | 1 | 1 | 9 | 1 | 0 | 1 | 9 | 1 | 0 | 0 | 0 | 0 |
| Idaho | 0 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 9 | 0 | 0 | 0 | 1 | 0 |
| Ill. | 1 | 1 | 1 | 1 | 9 | 0 | 0 | 1 | 9 | 1 | 0 | 1 | 0 | 0 |
| Ind. | 0 | 0 | 0 | 1 | 9 | 0 | 0 | 1 | 9 | 0 | 0 | 0 | 0 | 0 |
| Iowa | 1[a] | 1[a] | 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 | 0 | 0 |
| Maine | 0 | 0 | 1[a] | 1 | 9 | 1 | 0 | 1 | 9 | 1 | 0 | 1 | 1 | 0 |
| Md. | 1 | 1 | 1 | 1 | 9 | 1 | 1 | 1 | 9 | 1 | 0 | 1 | 0 | 0 |
| Mass. | 0 | 0 | 0[a] | 1 | 9 | 1 | 1 | 0 | 9 | 1 | 0[a] | 0 | 0 | 0 |

| State | Red-Light Camera | Speed Camera | Alcohol Interlock | Sobriety Checkpoint | Saturation Patrol | Bicycle Helmet | Motorcycle Helmet | Primary Enforcement Seat Belt Laws | Seat Belt Enforcement Campaign | License Plate Impoundment | Limits on Diversion | Vehicle Impoundment | In-Person License Renewal | Higher Seat Belt Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mich. | 0 | 0 | 0[a] | 0 | 9 | 0 | 0[a] | 1 | 9 | 1 | 1 | 0 | 0 | 0 |
| Minn. | 0 | 0 | 0[a] | 0 | 9 | 0 | 0 | 1 | 9 | 1 | 0 | 1 | 1 | 0 |
| Miss. | 0 | 0 | 1[a] | 1 | 9 | 0 | 1 | 1 | 9 | 0 | 1 | 1 | 0 | 0 |
| Mo. | 1[a] | 1[a] | 1 | 0[a] | 9 | 0 | 1 | 0 | 9 | 0 | 0 | 1 | 1 | 0 |
| Mont. | 0 | 0 | 0[a] | 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 | 1[a] | 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. | 0[a] | 0 | 0[a] | 1 | 9 | 1 | 1 | 1 | 9 | 0 | 0 | 1 | 1 | 0 |
| N.M. | 1[a] | 1[a] | 1 | 1 | 9 | 1 | 0 | 1 | 9 | 0 | 1 | 1 | 1 | 0 |
| N.Y. | 1 | 1[a] | 1 | 1 | 9 | 1 | 1 | 1 | 9 | 0 | 1 | 0 | 0 | 0 |
| N.C. | 1 | 0 | 0[a] | 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 | 1[a] | 1[a] | 0 | 1 | 9 | 0 | 0 | 0 | 9 | 1 | 0 | 0 | 1 | 0 |
| Okla. | 0 | 0 | 0[a] | 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 | 1 |
| Pa. | 1 | 0 | 0[a] | 1 | 9 | 1 | 0 | 0[a] | 9 | 0 | 0 | 0 | 0 | 0 |
| R.I. | 1 | 0 | 1[a] | 0 | 9 | 1 | 0 | 1 | 9 | 0 | 0[a] | 0 | 0 | 0 |
| S.C. | 0 | 0 | 0[a] | 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 | 1[a] | 1 | 1 | 9 | 1 | 1 | 1 | 9 | 0 | 0[a] | 0 | 0 | 0 |
| Texas | 1 | 0 | 1 | 0 | 9 | 0 | 0 | 1 | 9 | 0 | 0 | 0 | 0 | 1 |
| Utah | 0 | 0[a] | 1 | 1 | 9 | 0 | 0 | 1 | 9 | 0 | 1[a] | 0 | 0 | 0 |
| Vt. | 0 | 0 | 1[a] | 1 | 9 | 0 | 1 | 0 | 9 | 0 | 0 | 0 | 0 | 0 |

| State | Red-Light Camera | Speed Camera | Alcohol Interlock | Sobriety Checkpoint | Saturation Patrol | Bicycle Helmet | Motorcycle Helmet | Primary Enforcement Seat Belt Laws | Seat Belt Enforcement Campaign | License Plate Impoundment | Limits on Diversion | Vehicle Impoundment | In-Person License Renewal | Higher Seat Belt Fines |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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 | 1[a] | 9 | 0 | 0 | 0 | 0 | 0 |
| Wis. | 0[a] | 0 | 0[a] | 0 | 9 | 0 | 0 | 1 | 9 | 0 | 0 | 1 | 0 | 0 |
| Wyo. | 0 | 0 | 0[a] | 0 | 9 | 0 | 0 | 0 | 9 | 0 | 1 | 1 | 0 | 0 |

SOURCES: Red-light and speed cameras, Insurance Institute for Highway Safety (IIHS), 2017d; alcohol interlocks, IIHS, 2017b; motorcycle helmets, IIHS, 2017c; primary enforcement seat belt laws and higher seat belt fines, IIHS, 2017e; bicycle helmets, Bicycle Helmet Safety Institute, 2017; sobriety checkpoints, Governors Highway Safety Association (GHSA), undated (c); license plate and vehicle impoundment, McKnight et al., 2008; limits on diversion and plea agreements, NHTSA, 2017; in-person license renewal, AAA Foundation for Traffic Safety, 2016.
NOTE: 1 = in force. 9 = unknown. 0 = not in force.
[a] A change in implementation status since the documentation report for MV PICCS 2.0.

# Chapter Three. Changes to Effectiveness Data and Analysis

*Effectiveness data* refers to all of the data that help determine the numbers of lives saved and injuries prevented for a specific intervention in a specific state. Our estimates of effectiveness include four elements:

- the calculation of the number of lives lost and injuries sustained in each state
- for each intervention, the estimated effect on lives saved and injuries prevented
- for each intervention, the estimated number of lives saved and injuries prevented for each state
- the monetary value of saving a life or preventing an injury.

To reach an overall estimate of the benefit of a particular intervention in a specific state, we multiply the estimated numbers of lives saved and injuries prevented by the monetary value.

We did not change the second of these elements because we estimated them for MV PICCS 2.0 based on an extensive literature review. The details of how we arrived at the proportions of lives saved and injuries prevented are provided in Chapter Four of Ringel et al., 2015. These are assumed to be consistent across states (that is, implementing a universal motorcycle helmet law will reduce deaths in motorcycle crashes by the same percentage in every state).

We made changes to the other three effectiveness elements, as detailed in this chapter.

## Numbers of Deaths and Injuries per State

### *New Methods for Counting Total Deaths*

In MV PICCS 2.0, we relied on two data sources to estimate the numbers of lives saved and injuries prevented. The number of lives saved is based on the number of fatalities that occurred because of various crash types (e.g., alcohol-related crashes) taken from FARS. FARS provides an actual count of all fatalities on public roads in the United States each year. The previous MV PICCS made calculations based on 2010 FARS data; we updated to 2015 data, the most recent available at the time of this work. We calculate the number of lives that a particular intervention saves based on the number of deaths in the relevant crash type and the estimated effectiveness of the intervention. For example, for sobriety checkpoints, the number of lives saved is based on the number of alcohol-related deaths in a particular state and the estimated effectiveness that sobriety checkpoints have in reducing deaths.

We made minor changes to the way we calculate the number of deaths for two categories:

- **bicyclist deaths.** In the 2015 MV PICCS, we counted all bicyclist fatalities, even though the intervention is a law designed to require children to wear helmets. We updated our methods to count only deaths of bicyclists who were 15 or younger, and we also updated this for estimating injuries to include only bicyclists age 15 or younger.

- **deaths at signalized intersections.** Our current definition of a *crash occurring at a signalized intersection* requires that the crash occur at an intersection and that a traffic control signal of some sort be present at that intersection.[5] We used this definition for creating injury estimates as well.

### *New Methods for Estimating Total Injuries*

We updated our method for estimating the total number of injuries in each state to address limitations of the injury data. There is no equivalent data source to FARS for counting all traffic crash injuries. Most estimates of the number of people injured in traffic crashes are based on GES. This database is a sample of all injury crashes,[6] representing approximately 1 percent of all police crash reports in each year that occur around the country. GES classifies injuries by severity on a scale that includes death as the most serious outcome.

Before we can estimate the number of injuries that an intervention prevents, we need a total number of injuries by state and by type. Lacking an actual count of all injuries, we instead rely on ratios of fatalities to injuries. For example, using GES data, we determined that, nationwide, for every fatality due to speeding, there are 36 injuries due to speeding. We then multiply by 36 the actual number of fatalities in a state, as reported in FARS, to estimate the total number of injuries. Although this assumes that these ratios are consistent across states, which might or might not be the case, without state-specific information, we believe that this is the most reasonable assumption under the circumstances.

For the previous MV PICCS, we used the weighted estimates of fatalities and injuries for each crash type to develop this ratio. However, we found that GES was undercounting fatalities compared with the counts in FARS. This meant that, when we multiplied our total ratio of fatalities to injuries by the number of fatalities in FARS, the estimated total number of injuries was around 3.7 million. NHTSA's published figures estimate 2.4 million injuries in 2015 (National Center for Statistics and Analysis, 2016b), meaning that our ratios would provide overly high numbers of injuries.

Instead, we used the weights for each crash type in GES to develop a total number of injuries, then divided that number by the number of fatalities in FARS to determine the ratio. We also excluded from GES injury counts any fatal injuries because otherwise the ratio would be skewed. Table 3.1 compares these ratios with the ratios we used in MV PICCS 2.0.

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[5] In MV PICCS 2.0, we considered *only* whether the crash occurred at an intersection, not the presence of any sort of traffic signal.

[6] Generally, crashes are classified into three types: fatal crashes (those that cause deaths), injury crashes (those that cause injuries but no deaths), and property damage crashes (those that damage the vehicles or other property but do not result in any injuries or deaths). GES data include both fatal and injury crashes, but we excluded fatal crashes from our calculations because we relied instead on FARS data.

**Table 3.1. Injury-to-Fatality Ratios for MV PICCS 2.0 and 3.0**

| Category | Ratio Developed with 2010 GES Data Used in MV PICCS 2.0 | Ratio Developed with 2010 GES Data Calculated with the Updated Method | MV PICCS 3.0 Ratio |
|---|---|---|---|
| Total | 106.54 | 68.21 | 70.02 |
| Alcohol-related | 36.18 | 16.63 | 14.10 |
| Motorcycle | 264.54 | 18.77 | 18.18 |
| Bicycle | 171.54 | 158.48 | 145.08 |
| Occurred at an intersection with a light | 85.86 | 228.62 | 223.31 |
| Vehicle occupants | 105.55 | 87.53 | 94.65 |
| Driver over age 70 | 90.83 | 56.33 | 61.03 |
| Speed-related | 82.60 | 44.09 | 36.43 |

NOTE: The MV PICCS 2.0 ratio is based on FARS and GES data for 2010. The MV PICCS 3.0 ratio is based on FARS and GES data for 2015. The middle column is shown for comparison; these would have been the ratios used in the 2015 tool had we used the method described in this section. We have not used these figures in either version of MV PICCS.

As the table shows, some of these estimates changed quite dramatically, and all but one decreased. As shown in the "Calculated with the Updated Method" column of Table 3.1, the majority of this difference can be attributed to using the FARS count of fatalities, rather than the GES estimate of fatalities, in our ratio. The largest decrease is in the ratio of motorcycle fatalities to injuries. Previously, our ratio was more than 250, and now it is 18. This difference is largely due to a coding error in MV PICCS 2.0 that we recently discovered and corrected in the current version. Updating the data from 2010 to 2015 affects the ratios as well (comparing the "Calculated with the Updated Method" and "MV PICCS 3.0 Ratio" columns of Table 3.1), but the change is small in comparison to the change in methods.

## The Effect on Estimates of Lives Saved and Injuries Prevented

The total number of motor vehicle–related fatalities in the United States increased from 32,999 in 2010 to 35,092 in 2015 (NHTSA, 2017). These increases were not uniform across the country, or across crash types, so the effects of implementing any given intervention in any state include slight changes to the number of lives saved, lower in some cases and higher in others.

The lower injury-to-fatality ratios for all but one category means that the number of injuries estimated for each state is lower in the updated model, so, in turn, the number of injuries that each intervention prevents is also lower.

## The Monetary Value of Saving a Life or Preventing an Injury

### *Estimates of Monetary Value*

For MV PICCS 2.0, we estimated the value of a life saved or injury prevented based on national-level estimates provided in Blincoe et al., 2015. We relied on these same estimates for MV PICCS 3.0 because this detailed work on the costs of traffic crashes is widely cited. We incorporated three important changes to these costs:

- First, we adjusted the unit costs for inflation to generate estimates in 2017 dollars (we used 2012 dollars for MV PICCS 2.0).
- Second, we adjusted some of the costs to account for state-level variation using updated state-specific adjusters.
- Third, we aggregated the costs by injury severity into one metric (we made no change to this part of the method).

The Blincoe et al., 2015, estimates include nine cost components: medical, emergency services, market productivity, household productivity, insurance administration, workplace costs, legal costs, travel delay, and property damage. We made state-specific adjustments for market productivity, household productivity, and medical costs. We used updated state-specific price adjustments employed by CDC's Web-Based Injury Statistics Query and Reporting System (WISQARS) cost-of-injury reports computed using ACCRA Cost of Living Index data and population data.[7] We modified the market and household productivity estimates using the WISQARS work-loss adjustments and modified the medical estimates using the WISQARS medical adjustments.

As Table 3.2 shows, for the majority of states, the productivity factor increased, while states were roughly split on whether the medical factor increased or decreased. Table B.1 in Appendix B shows these data for all states.

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[7] *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 what is now called the Cost of Living Index.

**Table 3.2. Average, Low, and High Values of State-Specific Price Multipliers, of Saving a Life, and of Preventing an Injury**

| Value | MV PICCS 2.0 Multiplier: Productivity (Market and Household) | MV PICCS 2.0 Multiplier: Medical | MV PICCS 3.0 Multiplier: Productivity (Market and Household) | MV PICCS 3.0 Multiplier: Medical | MV PICCS 2.0 Value of Preventing an Injury, in Dollars | MV PICCS 2.0 Value of Saving a Life, in Dollars | MV PICCS 3.0 Value of Preventing an Injury, in Dollars | MV PICCS 3.0 Value of Saving a Life, in Dollars |
|---|---|---|---|---|---|---|---|---|
| Average | 0.97 | 1.00 | 1.03 | 0.99 | 22,052 | 1,282,982 | 22,073 | 1,603,394 |
| Lowest | 0.75 | 0.89 | 0.87 | 0.77 | 19,897 | 1,042,033 | 20,480 | 1,385,639 |
| Highest | 1.58 | 1.28 | 1.41 | 1.69 | 27,281 | 1,924,863 | 24,924 | 2,124,519 |

SOURCES: Multipliers, CDC, 2014, § 4.4. Others, calculations by the authors.

### *The Effect of These Adjustments on Estimates of Monetary Value of Lives Saved and Injuries Prevented*

For almost every state, the value of preventing an injury changed only slightly, while the value of saving a life increased. This is because, although we include the same nine components (e.g., medical, emergency services, market productivity) in both injury and fatality calculations, the market productivity component makes up a larger portion of the fatality estimate. As a result, the value of saving one life increased in all but one state (Connecticut) and the District of Columbia. A few other states had decreases in productivity but increases in the medical adjustment factor, so they had small increases in the value of a life saved.

How this changes the overall monetary benefit within a state depends also on the injury-to-fatality ratio for a particular intervention and the numbers of lives saved and injuries prevented. For example, in Georgia (a typical state in terms of the magnitude of the changes from MV PICCS 2.0 to MV PICCS 3.0), MV PICCS 2.0 calculated a benefit of $1.449 billion if all 14 interventions were implemented. The updated MV PICCS 3.0 estimates a total benefit of $1.442 billion. The difference is the result of three contributing factors:

- The total number of injuries prevented declined. The total number of injuries decreased for most crash types because the estimated ratios of injuries per fatality went down. Injuries prevented by red-light cameras increased because the estimated ratios of injuries per fatality went up. Injuries prevented by seat belt laws increased because of the large increase in the number of people who died in passenger vehicle crashes (from 907 in 2010 to 1,034 in 2015).
- Fatalities increased in all crash types (for example, the number of people who were killed because of alcohol-involved driving increased from 299 in 2010 to 366 in 2015). Therefore, a greater number of lives is saved with the same interventions.
- The value of saving one life increased from $1.3 million to $1.5 million, and the value of preventing one injury increased from $19,740 to $21,411.

Table 3.3 shows the effects of these three types of changes. Table 3.3 shows the effects of these three types of changes. The column “Total Benefit in MV PICCS 2.0, in Thousands” displays the total benefit per intervention as calculated for MV PICCS 2.0. The next pair of columns shows what the benefit would have been had we used the updated injury-to-fatality ratios. In most cases, this declines because the ratios are lower. The second pair of columns updates the first pair with fatalities from 2015 instead of 2010. Finally, the third pair of columns shows the current tool values, with both of these updates as well as the new value of life.

**Table 3.3. Comparison of Benefits Between MV PICCS 2.0 and 3.0 for Georgia, Based on Changes to Three Inputs**

| | Total Benefit in MV PICCS 2.0, in Thousands | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 |
|---|---|---|---|---|---|---|---|
| **Injury-to-Fatality Ratios:** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | |
| **Number of Fatalities:** | | **No Change from MV PICCS 2.0** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | |
| **Value of Life:** | | **No Change from MV PICCS 2.0** | | **No Change from MV PICCS 2.0** | | **Updated to MV PICCS 3.0** | |
| **Intervention** | | | | | | | |
| Alcohol interlock | 42,013 | 32,914 | –22 | 40,102 | –5 | 46,936 | 12 |
| Bicycle helmet | 12,647 | 11,236 | –11 | 429 | –97 | 471 | –96 |
| Higher seat belt fines | 220,834 | 206,782 | –6 | 235,735 | 7 | 267,062 | 21 |
| In-person license renewal | 53,970 | 43,698 | –19 | 42,571 | –21 | 48,914 | –9 |
| License plate impoundment | 47,264 | 37,028 | –22 | 45,114 | –5 | 54,180 | 15 |
| Limits on diversion | 19,256 | 15,085 | –22 | 18,380 | –5 | 22,351 | 16 |
| Motorcycle helmet | 239,298 | 60,810 | –75 | 72,783 | –70 | 86,187 | –64 |
| Primary enforcement seat belt law | 214,700 | 201,038 | –6 | 229,187 | 7 | 259,726 | 21 |
| Red-light camera | 129,736 | 247,361 | 91 | 114,465 | –12 | 127,321 | –2 |
| Saturation patrol | 104,448 | 81,830 | –22 | 103,275 | –1 | 123,403 | 18 |
| Seat belt enforcement campaign | 165,626 | 155,086 | –6 | 176,801 | 7 | 201,076 | 21 |
| Sobriety checkpoint | 71,911 | 46,639 | –35 | 58,862 | –18 | 69,217 | –4 |
| Speed camera | 74,504 | 51,318 | –31 | 64,872 | –13 | 75,333 | 1 |

| | Total Benefit in MV PICCS 2.0, in Thousands | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 | Total Benefit, in Thousands of Dollars, with | Percentage Change from Total Benefit in MV PICCS 2.0 |
|---|---|---|---|---|---|---|---|
| **Injury-to-Fatality Ratios:** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | |
| **Number of Fatalities:** | | **No Change from MV PICCS 2.0** | | **Updated to MV PICCS 3.0** | | **Updated to MV PICCS 3.0** | |
| **Value of Life:** | | **No Change from MV PICCS 2.0** | | **No Change from MV PICCS 2.0** | | **Updated to MV PICCS 3.0** | |
| **Intervention** | | | | | | | |
| Vehicle impoundment | 53,216 | 41,690 | –22 | 50,795 | –5 | 59,982 | 13 |
| Total | 1,449,423 | 1,232,515 | –15 | 1,253,371 | –14 | 1,442,145 | –1 |

SOURCE: All values calculated by the authors.
NOTE: The “Total Benefit in MV PICCS 2.0” column displays the total benefit per intervention as calculated for MV PICCS 2.0. The next “Total Benefit” column shows what the benefit would have been had we used the updated injury-to-fatality ratios, accompanied by the corresponding percentage changes in the next column. The pair after that has that update plus the number of fatalities updated, and the final pair has those updates plus the value of life updated. In most cases, these values and percentages decline because the ratios are lower.

The changes that occur to benefits in Georgia are similar to those in other states. The changes to the ratios affect all states in the same direction. If the number of fatalities in a particular category changes by a large percentage, this would change the benefit in the same direction (the higher the number of fatalities, the higher the number of lives we estimated to be saved). Finally, most states saw large increases in their values of saving a life and very minor changes in the values of preventing an injury.

# Chapter Four. Cost Data, Estimates, and Analysis

Much of the work on developing the cost side of MV PICCS was related to developing a cost structure with ten cost components:

- publicity
- police or highway patrol time
- court system
- DMV
- equipment
- fines and fees
- probation
- education programs
- vehicle impoundment
- program management.

Because we did not add any new interventions that might have necessitated a review of the cost-estimating structure, we did not make changes to the list of components, to which components were associated with which intervention, or to the assumptions about the percentage of people violating a law. Our previous work developing these cost estimates is provided in Chapter Three of Ringel et al., 2015.

However, we did make some important changes to the cost inputs and calculations. The most basic is that we updated most costs in MV PICCS from 2012 dollars to 2017 dollars.[8] We also updated some data sources to the most-recent figures available (in most cases, this was 2015 data; if we updated it to a different year, we note that in the discussion about that source).

In reviewing our previous data sources and assumptions, we determined that two changes would provide better overall estimates: adjustments to DWI arrest data and changes to our assumptions regarding automated enforcement.[9]

## Updated Cost Inputs and Assumptions

### *Inflation*

We used the Bureau of Labor Statistics (BLS) Consumer Price Index inflation calculator to change cost data in the tool to 2017 dollars (BLS, undated [a]).

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[8] Because states rarely update the amount of a fine because of inflation, we did not update any of the fines or fees, even to inflate them to 2017 dollars.

[9] State terminology varies; a DWI charge against a drunk driver is the same as a charge of driving under the influence (generally referred to as *DUI*). For the sake of consistency, this report uses *DWI*.

### *Wages*

We used BLS data to determine the average wage in each state for three groups of workers:

- probation officers and correctional treatment specialists
- police officers
- office and administrative support workers employed by state governments.

For the first two groups, we obtained data through the BLS Occupational Employment Statistics query system, searching by the appropriate occupation code.[10] Data for probation officers and correctional treatment specialists were missing for Connecticut, Delaware, and Rhode Island, so we used the average pay of all states as a proxy for the real cost for these states.

For the third group, office and administrative support workers employed by state governments, we used a different BLS data source, Occupational Employment Statistics research estimates by state and industry (BLS, undated, 2016). (Although BLS produces estimates of wage and employment by state and industry, these have small samples and have potential for systematic error.[11]) All BLS wage data were retrieved for 2016 and inflated to 2017 dollars.

## Updated Data on Populations

We also updated the number of individuals, drivers, and registered vehicles.

### *Population*

We updated two sets of population data because they are used in two different areas of MV PICCS:

- state population: We updated state population by age for 2015 (U.S. Census Bureau, 2016). This affects the cost estimates for sobriety checkpoints and higher seat belt fines.
- population by metropolitan area: We updated metropolitan area population, which is used in calculating costs for the red-light camera intervention (U.S. Census Bureau, 2017).

### *The Number of Licensed Drivers*

We updated the number of licensed drivers per state (Office of Highway Policy Information, 2016, Table DL-22). The number of licensed drivers affects the costs of all interventions with publicity costs because we assume that costs fluctuate with the number of drivers to be reached by the publicity campaign. This includes red-light and speed cameras, saturation patrols and

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[10] BLS occupation 21-1092 for probation officers and correctional treatment specialists and BLS occupation 33-3051 for police and sheriff's patrol officers.

[11] From this data set, we used May 2016 data for the relevant industry 4 sector according to the North American Industry Classification System, 999200, state government (excluding schools and hospitals). From the employment data for state governments, we selected the occupation category 43-0000, office and administrative support occupations.

sobriety checkpoints, motorcycle and bicycle helmet laws, and primary enforcement seat belt laws and seat belt enforcement campaigns. The number of drivers over age 70 also factors into the cost of in-person license renewal.

### *The Number of Registered Motorcycles*

We updated the number of registered motorcycles, which affects the costs of implementing motorcycle helmet laws, in each state to 2015 data (Office of Highway Policy Information, 2016, Table MV-1).

## Driving-While-Intoxicated Arrest Data

### *A New Method of Calculating Driving-While-Intoxicated Arrests*

The most comprehensive set of arrest data for DWI is the one compiled by the Federal Bureau of Investigation (FBI).[12] The FBI does not collect these data directly; it compiles data provided by police agencies into a consistent data set. The FBI acknowledges the limitations of these data with a disclaimer that states, "Because the number of agencies submitting arrest data varies from year to year, users are cautioned about making direct comparisons between 2015 arrest totals and those published in previous years' editions of *Crime in the United States*" (FBI, 2015, Table 69 footnote).

Errors in DWI arrest data are due to incomplete submittals by jurisdictions, meaning that some states are undercounting the number of arrests. The data set includes the number of jurisdictions that report arrest numbers, as well as the population represented across those jurisdictions. This allows us to adjust the number of arrests systematically. We calculated adjusted arrest counts for each state by multiplying the number of reported DWI arrests by the ratio of the total population of the state (as reported in U.S. Census Bureau, 2016) with the population of those jurisdictions that reported arrest data.

This straightforward extrapolation still might not reflect actual arrests because it is not necessarily the case that the rate of arrests across reporting jurisdictions will equal the corresponding rate across jurisdictions that do not report. However, we deemed this method to be preferable to using the reported numbers without adjustment.[13] Table 4.1 presents our resulting data.

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[12] We believe that these arrest figures include exclusively arrests for driving while intoxicated with alcohol because laws about drugged driving vary widely from state to state (GHSA, undated [b]). However, the FBI does not comment on this point in the data declaration for the relevant table.

[13] We tried two other methods to determine whether there were better methods to adjust DWI arrests to be more accurate. First, we cross-checked our estimates with those that Casanova-Powell et al., 2015, obtained directly from the states, and there were still over- and undercounts. Second, we considered using DWI per capita fatalities but did not find a clear relationship between arrest rates and fatalities that might have led to more-reliable arrest figures.

**Table 4.1. Federal Bureau of Investigation–Reported and –Estimated Driving-While-Intoxicated Arrests, by State, 2015**

| State | FBI-Reported DWI Arrests | Ratio of Reporting Jurisdictions to State Population, as a Percentage | Estimated DWI Arrests |
|---|---|---|---|
| Alabama | 7,863 | 75 | 10,428 |
| Alaska | 3,163 | 100 | 3,179 |
| Arizona | 22,367 | 75 | 29,896 |
| Arkansas | 6,919 | 90 | 7,669 |
| California | 141,458 | 99 | 142,316 |
| Colorado | 25,562 | 94 | 27,320 |
| Connecticut | 8,148 | 92 | 8,863 |
| Delaware | 386 | 100 | 386 |
| District of Columbia[a] | 1,346 | 100 | 1,346 |
| Florida | 31,783 | 100 | 31,859 |
| Georgia | 19,217 | 76 | 25,278 |
| Hawaii | 5,250 | 81 | 6,456 |
| Idaho | 5,844 | 92 | 6,382 |
| Illinois | 3,659 | 22 | 16,356 |
| Indiana | 14,428 | 71 | 20,306 |
| Iowa | 9,028 | 80 | 11,269 |
| Kansas | 7,186 | 65 | 11,107 |
| Kentucky | 17,825 | 99 | 18,001 |
| Louisiana | 5,339 | 53 | 10,105 |
| Maine[b] | 5,756 | 100 | 5,766 |
| Maryland | 17,100 | 76 | 22,597 |
| Massachusetts | 8,258 | 91 | 9,058 |
| Michigan | 26,845 | 93 | 28,718 |
| Minnesota | 20,830 | 96 | 21,706 |
| Mississippi | 6,889 | 40 | 17,163 |
| Missouri | 19,449 | 88 | 22,054 |
| Montana | 3,674 | 86 | 4,253 |
| Nebraska | 5,348 | 62 | 8,652 |
| Nevada | 7,612 | 100 | 7,612 |
| New Hampshire | 4,746 | 92 | 5,162 |
| New Jersey | 22,201 | 91 | 24,502 |
| New Mexico | 8,542 | 76 | 11,290 |

Ultimately, we determined that our population-based adjustment method was the most objective way to adjust for undercounted arrest figures without introducing other statistical uncertainty.

| State | FBI-Reported DWI Arrests | Ratio of Reporting Jurisdictions to State Population, as a Percentage | Estimated DWI Arrests |
|---|---|---|---|
| New York | 28,988 | 53 | 54,760 |
| North Carolina | 35,967 | 69 | 51,932 |
| North Dakota | 6,351 | 98 | 6,458 |
| Ohio | 34,254 | 71 | 48,049 |
| Oklahoma | 11,101 | 91 | 12,151 |
| Oregon | 9,019 | 48 | 18,932 |
| Pennsylvania | 44,615 | 94 | 47,677 |
| Rhode Island | 2,591 | 100 | 2,591 |
| South Carolina | 16,272 | 83 | 19,499 |
| South Dakota | 7,305 | 92 | 7,934 |
| Tennessee | 23,150 | 96 | 24,101 |
| Texas | 64,971 | 98 | 66,116 |
| Utah | 8,813 | 95 | 9,322 |
| Vermont | 2,144 | 93 | 2,300 |
| Virginia | 20,477 | 95 | 21,659 |
| Washington | 24,627 | 91 | 26,985 |
| West Virginia | 4,543 | 58 | 7,815 |
| Wisconsin | 24,588 | 95 | 25,789 |
| Wyoming | 3,157 | 89 | 3,532 |
| Total | 865,616 | | 1,033,310 |

SOURCE: FBI-reported arrests, FBI, 2015, Table 69. Estimated arrests, author calculations.
[a] FBI, 2015, does not include any arrest data from the District of Columbia's municipal police force. For this one jurisdiction, we have substituted arrest figures from the city's own reporting (Metropolitan Police Department, 2016).
[b] The percentages are rounded, but the actual ratio is 99.8 percent, which is why there was an adjustment of ten arrests.

### *The Method's Effect on Cost Estimates*

The fact that some states underreported DWI arrest data meant that previous MV PICCS estimates for certain states were underestimating the cost of implementing four alcohol-related interventions because we used the number of arrests to estimate the cost of state police time.[14] The cost-effectiveness ratios in states with undercounted DWI arrests were far higher than those in states with more-complete arrest data. For example, in Arkansas, a typical state, the cost-effectiveness ratio of license plate impoundment was previously 163, when most other states were in the double digits. The cost of implementation was only $181,000. After this revision, the cost is $205,000 and the ratio is 146 ($30 million in benefits divided by the cost).

[14] Costs for sobriety checkpoints and saturation patrols are not based on existing arrest rates for DWI, so this new calculation does not affect their costs.

## Automated Enforcement

### *New Assumptions About the Number of Cameras*

Creating cost estimates for the number of red-light and speed cameras in the previous MV PICCS was challenging because there is no reliable data source on how many red-light or speed cameras are typically used to implement this intervention. In addition, we expect red-light cameras to be used largely in urban areas, so it is difficult to develop statewide estimates. Ultimately, we used 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. In actual implementations, decisionmakers would probably select areas that studies identified with sufficient traffic or red light–running behavior to have an impact, but, at the state level, these data are not readily available and therefore are not included in the simplified regression model.

Using road network–miles meant that we were underestimating the number of cameras in some states (such as the District of Columbia and Delaware) and overestimating them in large rural states. The overestimation in large states created very large dollar figures for implementation (because of the number of cameras) and high fine revenue (due to our assumption about the number of speeding drivers who would be ticketed, per camera).

When we first developed these estimates, we created high, medium, and low estimates for each state, based on the intensity of implementation (high implementation assumed that the state would deploy a higher number of cameras than those at medium or low implementation levels). Although, at one point, we had considered the idea that a user might be able to select an implementation level to analyze, this proved too complex, and we programmed the tool with the medium-level estimate for all states. To address this issue and reflect many states' shift away from camera usage, we have now changed these estimates to the low level of deployment.

### *The Assumptions' Effect on Cost Estimates*

This change means that the number of cameras is now estimated to be lower and that fewer drivers receive tickets.[15] For example, the cost in North Dakota to implement speed cameras was previously estimated at $18.7 million, with fines of $70 million; in the revised tool, the cost is $6.9 million and the fines are $3.3 million. Red-light camera costs decreased by proportionally

[15] It is certainly possible that a change in the number of cameras deployed would result in different driver behavior. If people grew accustomed to a high number of cameras, over time, one might expect to see a lower number of violations as people drive more slowly and stop more often at red lights. We could not, however, find estimates in the literature of these long-term changes, so we programmed the tool with estimates we identified of the number of violations per camera regardless of long-term behavioral changes. Across all interventions, it was too complex to attempt to model longer-term changes in behavior.

similar amounts. All states have decreased cost estimates and lower fines collected, but the decreases are of lower magnitude in smaller states.

Table 4.2 summarizes the changes in cost estimates and how the final costs for exact interventions changed. Like in Table 3.3 in Chapter Three, we selected a typical state, Georgia, to demonstrate. Because the cost formulas are more complex than the effectiveness formulas, we did not calculate all of the interim potential costs.

**Table 4.2. Comparison of Costs Between MV PICCS 2.0 and 3.0 for Georgia, Based on Changes to Inputs and Assumptions**

| Intervention | Total Cost in MV PICCS 2.0, in Thousands of Dollars | Cost Updates That Affect This Intervention | Changes to Noncost Inputs That Affect This Intervention | Total Cost in MV PICCS 3.0, in Thousands of Dollars | Percentage Change from 2015 Costs |
|---|---|---|---|---|---|
| Alcohol interlock | 124 | Increase in state employee wages | Update and adjustments to the number of DWI arrests | 114 | –8 |
| Bicycle helmet | 519 | Increase in state employee wages; publicity costs adjusted for inflation | Update to the state population | 619 | 19 |
| Higher seat belt fines | 0 | None; we assume this intervention to have no cost | None | 0 | Not applicable |
| In-person license renewal | 520 | Increase in state employee wages | Update to the number of licensed drivers | 631 | 21 |
| License plate impoundment | 453 | Increase in state employee wages | Update and adjustments to the number of DWI arrests | 369 | –19 |
| Limits on diversion | 17,885 | Increase in state employee wages; court, probation, and education costs adjusted for inflation | Update and adjustments to the number of DWI arrests | 15,132 | –15 |
| Motorcycle helmet | 1,858 | Increase in police and state employee wages; publicity costs adjusted for inflation | Update to the numbers of licensed drivers and motorcycle registrations | 2,081 | 12 |
| Primary enforcement seat belt law | 6,756 | Publicity costs adjusted for inflation | Update to the state population | 7,292 | 8 |
| Red-light camera | 22,075 | Increase in police and state employee wages; equipment and publicity costs adjusted for inflation | Decrease in the number of cameras deployed; update to the number of licensed drivers | 5,422 | –75 |

| Intervention | Total Cost in MV PICCS 2.0, in Thousands of Dollars | Cost Updates That Affect This Intervention | Changes to Noncost Inputs That Affect This Intervention | Total Cost in MV PICCS 3.0, in Thousands of Dollars | Percentage Change from 2015 Costs |
|---|---|---|---|---|---|
| Saturation patrol | 8,146 | Increase in police and state employee wages; court, equipment, publicity, probation, and education costs adjusted for inflation | Update to the number of licensed drivers | 8,709 | 7 |
| Seat belt enforcement campaign | 2,638 | Publicity costs adjusted for inflation | Update to state population | 2,769 | 5 |
| Sobriety checkpoint | 6,066 | Increase in police and state employee wages; court, equipment, publicity, probation, and education costs adjusted for inflation | Update to the numbers of licensed drivers and state population | 6,717 | 11 |
| Speed camera | 27,378 | Increase in police and state employee wages; equipment costs adjusted for inflation | Decrease in the number of cameras deployed; update to the number of licensed drivers | 11,049 | –60 |
| Vehicle impoundment | 19,985 | Increase in state employee wages; towing cost adjusted for inflation | Update and adjustments to the number of DWI arrests | 16,902 | –15 |
| Total | 114,403 | | | 77,806 | –32 |

Certain costs, such as inflation, increase uniformly across states, and all states experienced some increase in their total populations and numbers of licensed drivers, which affect all interventions that we assumed would contain a publicity component (red-light and speed cameras, saturation patrols and sobriety checkpoints, and motorcycle and bicycle helmet laws). Most states experience a substantial decline in the costs of red light– and speed-camera enforcement because of the change in the assumed number of deployed cameras from medium to low. The four interventions whose costs are partially based on the number of DWI arrests (alcohol interlocks, license plate impoundment, limits on diversion, and vehicle impoundment) could see increases or decreases in costs, depending on whether the adjusted number is higher or lower than the number of DWI arrests in 2011. (In Georgia, arrests declined from 31,176 in 2011 to 25,278 in the 2015 adjustment, so all four of these costs went down.)

# Chapter Five. Tool Redesign

A major portion of this effort was redesigning the MV PICCS tool interface to make it more intuitive for users to request an analysis and more easily interpret the results. Both NGA and CDC had discussed the tool with officials from individual states who suggested that it could be made more intuitive for users, in terms of both inputting information and understanding the model results. To address these concerns, we made seven changes:

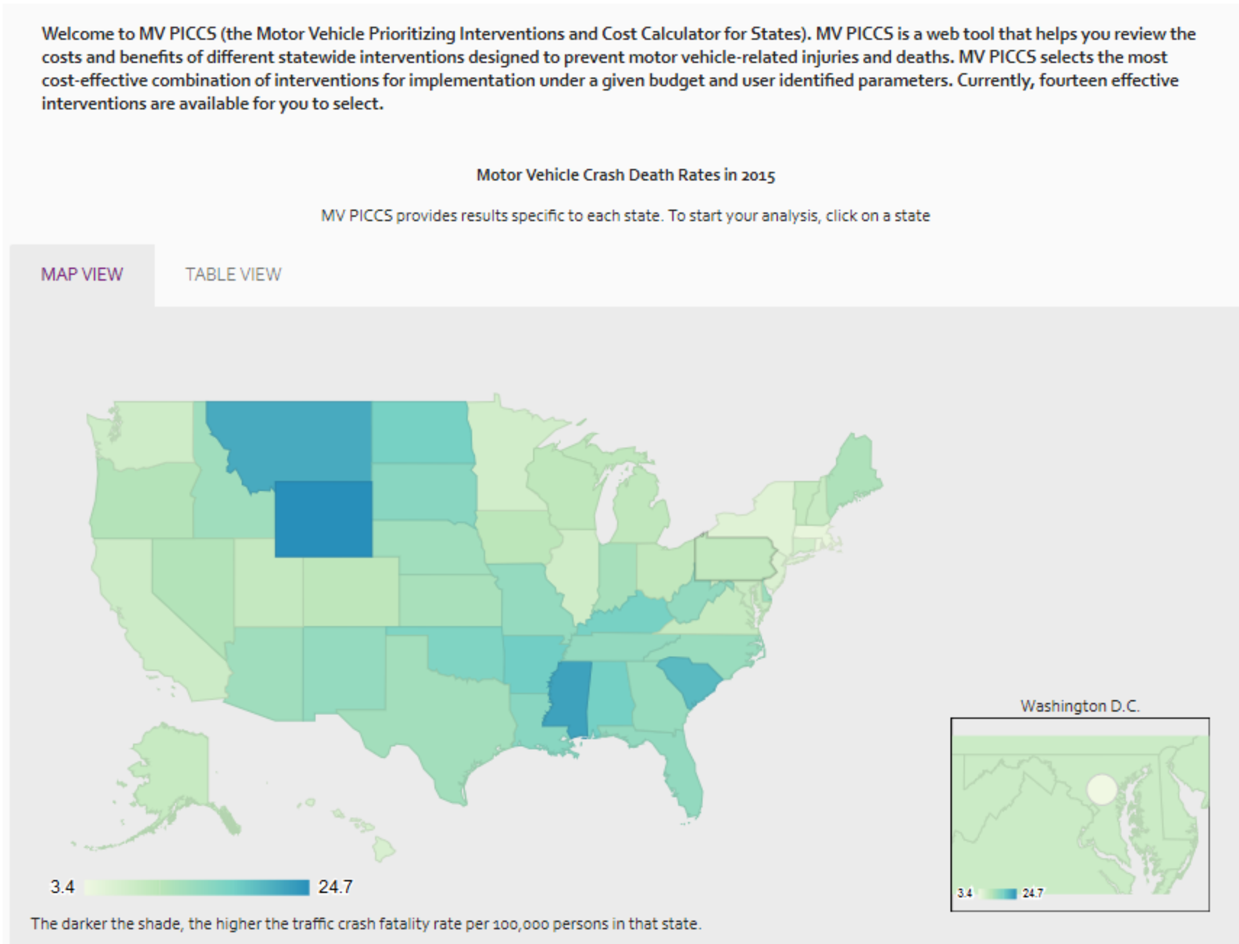
- created a new map showing states' current traffic safety profiles
- redesigned the way in which users input interventions for analysis
- combined cost-effectiveness and portfolio analysis into one set of model outputs
- changed the way in which fine and fee information is provided
- streamlined the sensitivity analysis
- displayed the key results in boxes and provided graphics of some results
- incorporated additional information about interventions.

This chapter explains the changes that we made to streamline the tool and provides screenshots of the new user interface.

## Map

Instead of selecting a state from a drop-down list, we provided a color-coded map for users to select a state. The color-coding is based on the number of people killed in 2015 traffic crashes per 100,000 people. The underlying data are accessible in a sortable table on a separate tab. See Figure 5.1.

**Figure 5.1. The Input Screen with Map**



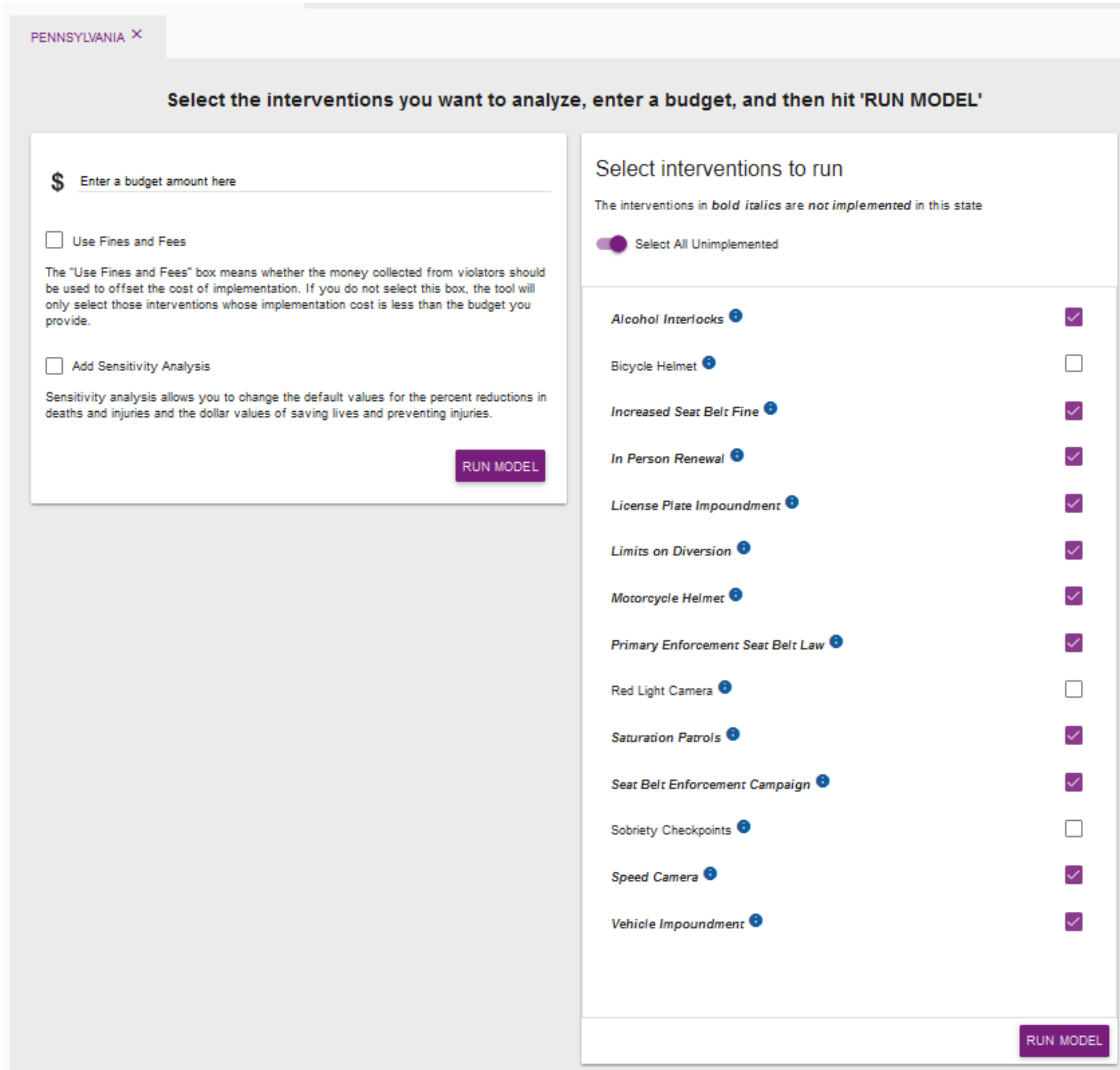

When the user clicks on a state, the tool provides an input screen for that state. Underneath the map, a tab shows which state is currently being analyzed. The user can have more than one state open at a time and easily switch between them by clicking on the name of the state.

## Selecting Interventions

After the user selects a state (this example uses Pennsylvania), the tool displays a list of 14 interventions. As a default, the interventions with a check mark are those that are *not* already implemented in that state. (The tool also indicates these interventions using bold italics.) The user can check or uncheck boxes as desired, but our goal was that the default would allow the user to see the results that would occur if the selected state implemented all interventions that are not already in place. A toggle allows the user to return to the selection of only unimplemented interventions.

The user must enter a budget for analysis. If desired, the user can also check the **Use Fines and Fees** box, but the default is that it is unchecked. This screen also allows the user to select the sensitivity analysis. This screen is shown in Figure 5.2.

**Figure 5.2. Intervention Selection**




## Model Outputs

The tool runs when the user selects **Run Model**. One major difference from MV PICCS 2.0 is that there are no longer separate model runs for cost-effectiveness and portfolio analysis. The difference between these two types of runs was that the cost-effectiveness model analyzed each intervention separately, while portfolio analysis accounted for the fact that some interventions were related to each other and might double-count some of the benefits. For example, if both saturation patrols and sobriety checkpoints were implemented, one would not expect the full benefits from each because some people who would have been deterred from driving with saturation patrols would also have been deterred from driving in the presence of sobriety checkpoints.

Given that some users reported that it was difficult to understand the differences between the two model runs and the fact that they could not be compared side-by-side within the tool, we now include all results in one model run.[16] An intervention table (see Figure 5.3) shows the individual cost and effectiveness results for each intervention that the user selected. If the model selected the intervention, the row is shaded in blue. At the bottom of the table are two rows of totals, **TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS** and **ADJUSTED TOTAL OF SELECTED INTERVENTIONS**.

The **TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS** row sums all of the costs of the model-selected interventions (the equivalent of the cost-effectiveness analysis). If two or more interventions are related, the **ADJUSTED TOTAL OF SELECTED INTERVENTIONS** row shows the total value but adjusted to account for potential double-counting. The values in the **ADJUSTED TOTAL OF SELECTED INTERVENTIONS** row should always be equal to or lower than those in the **TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS** row. If they are equal, it means that none of the interventions are related, so selecting them at the same time does not lead to any adjustments. If two or more related interventions are selected by the tool, the **ADJUSTED TOTAL OF SELECTED INTERVENTIONS** row will show that fewer lives are saved, fewer injuries prevented, and overall benefits are lower.[17]

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[16] In MV PICCS 2.0, the model could select different interventions for the same state budget depending on whether it was running in the cost-effectiveness mode or the portfolio analysis mode. In practice, this seldom occurred. The current configuration does not allow the model to select different sets of interventions but rather runs the cost adjustments on the interventions selected in the cost-effectiveness mode.

[17] Only the primary enforcement seat belt law and seat belt enforcement campaign interventions are programmed to adjust the cost to implement if both are selected, because the increased seat belt fine intervention always has a cost of 0. If one or more seat belt interventions is selected, the net cost will be higher because the fines and fees are lower. We did not adjust for cost to implement and fines and fees for the other sets of related interventions because the ways in which they are implemented differ, while the seat belt interventions are more similar to each other.

**Figure 5.3. The Intervention Details Table**

### Intervention Details

denotes selected by model

| Intervention | Lives Saved | Injuries Prevented | Cost to Implement | Fines and Fees | Net Cost | Benefits |
|---|---|---|---|---|---|---|
| **Alcohol Interlocks* | 12 | 173 | $164,000 | $0 | $164,000 | $22,004,000 |
| **Increased Seat Belt Fine* | 59 | 5548 | $0 | $7,774,000 | -$7,774,000 | $210,449,000 |
| **In Person Renewal* | 16 | 1005 | $1,942,000 | $0 | $1,942,000 | $46,196,000 |
| **License Plate Impoundment* | 14 | 194 | $851,000 | $8,497,000 | -$7,646,000 | $25,501,000 |
| **Limits on Diversion* | 6 | 79 | $32,765,000 | $16,116,000 | $16,649,000 | $10,839,000 |
| **Motorcycle Helmet* | 51 | 935 | $3,786,000 | $203,000 | $3,583,000 | $97,865,000 |
| **Primary Enforcement Seat Belt Law* | 57 | 5394 | $14,617,000 | $5,071,000 | $9,546,000 | $204,057,000 |
| **Saturation Patrols* | 65 | 919 | $14,433,000 | $6,204,000 | $8,229,000 | $118,794,000 |
| **Seat Belt Enforcement Campaign* | 44 | 4161 | $4,544,000 | $1,031,000 | $3,513,000 | $157,457,000 |
| **Speed Camera* | 65 | 2361 | $11,607,000 | $4,727,000 | $6,880,000 | $150,186,000 |
| **Vehicle Impoundment* | 16 | 219 | $31,828,000 | $26,328,000 | $5,500,000 | $29,084,000 |
| *TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS* | ***326*** | ***15296*** | ***$37,327,000*** | ***$28,436,000*** | ***$8,891,000*** | ***$828,452,000*** |
| *ADJUSTED TOTAL OF SELECTED INTERVENTIONS* | ***320*** | ***14950*** | ***$37,327,000*** | ***$27,809,000*** | ***$9,528,000*** | ***$811,082,000*** |

This table shows only the interventions that were selected for analysis. The interventions in ***bold italics*** and marked with an asterisk are not currently implemented in Pennsylvania. The shaded rows are the ones selected by MV PICCS based on two criteria. First, only interventions whose net cost is less than the budget provided were selected. Second, interventions are prioritized based on their cost-effectiveness ratio, which is the benefit divided by the net cost.

The row 'TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS' sums all of the shaded rows.

The row 'ADJUSTED TOTAL OF SELECTED INTERVENTIONS' makes some adjustments based on the selection or related interventions. This is a more realistic assessment because some interventions target the same groups of drivers (e.g., alcohol im drivers).

Five previous model outputs are no longer displayed. One is the cost, by cost component (publicity, police costs, and so forth). This was previously displayed only in the aggregate, so it was not helpful to users who were interested in specific cost components for specific interventions. In consultation with NGA and CDC, we determined that the space needed to display this could be better used for graphical display of other results.

The second is the cost–effectiveness ratio. Although this is the basis for the model's selection of specific interventions, discussions with NGA and CDC indicated that reducing the number of outputs displayed to the user would increase the utility of the tool. Some users also found it difficult to interpret a negative cost–effectiveness ratio, which was the case when the net costs were negative. Third, we deleted cumulative cost, which users can derive on their own, if desired. Finally, we deleted two lines that showed other types of costs: offender costs (costs that an offender bears other than fines and fees, such as installing an alcohol interlock) and compliance costs (costs that an individual bears to comply with a new law, such as purchasing a motorcycle helmet). These costs were not part of the implementation costs, so no calculations have changed as a result.

## Fines and Fees

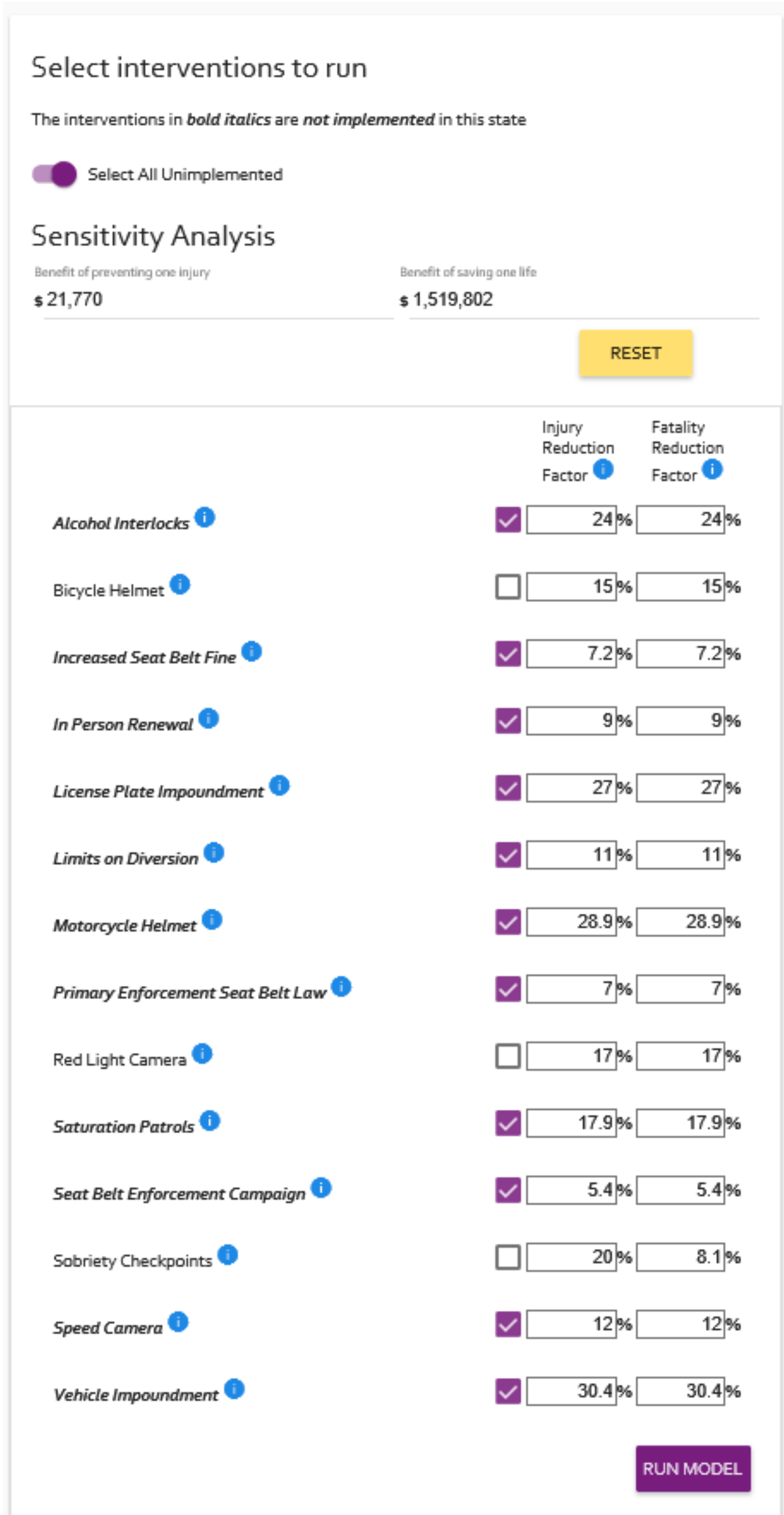
Including the fines and fees as part of the net cost is no longer the default option. When the user checks the box to include fines and fees, these amounts are displayed in the Intervention Details table (Figure 5.3). However, the original cost to the state (**Cost to Implement**) is still displayed separately. User feedback indicated that negative costs were confusing. Although a value in the **Net Cost** column can still be negative when the fines and fees are larger than the implementation cost, now the individual costs and fines and fees are shown separately.

## Sensitivity Analysis

The sensitivity analysis was previously available for only the portfolio analysis run but is now available for the full run. The user can now input user-specified values for two types of inputs: the percentage of fatalities and injuries that a particular intervention would reduce and the value of saving a life or preventing an injury. These values are now displayed in a way that users should find more intuitive (the values for each intervention are side by side and use percentage notation [**17%** rather than **0.17**]). See Figure 5.4.

We eliminated from the sensitivity analysis the ability to change the values for the implementation cost of an intervention and the injury-to-fatality ratio. Because many separate costs are included in the implementation costs (including, in some cases, the fines and fees), we were concerned that users would have difficulty producing alternative credible total costs. (Even with MV PICCS 2.0, the tool's programming grew too complex for us to allow users to change individual cost components.) Also, we were concerned that users might use unrealistic injury-to-fatality reduction ratios and skew the results.

**Figure 5.4. Sensitivity Analysis Inputs**

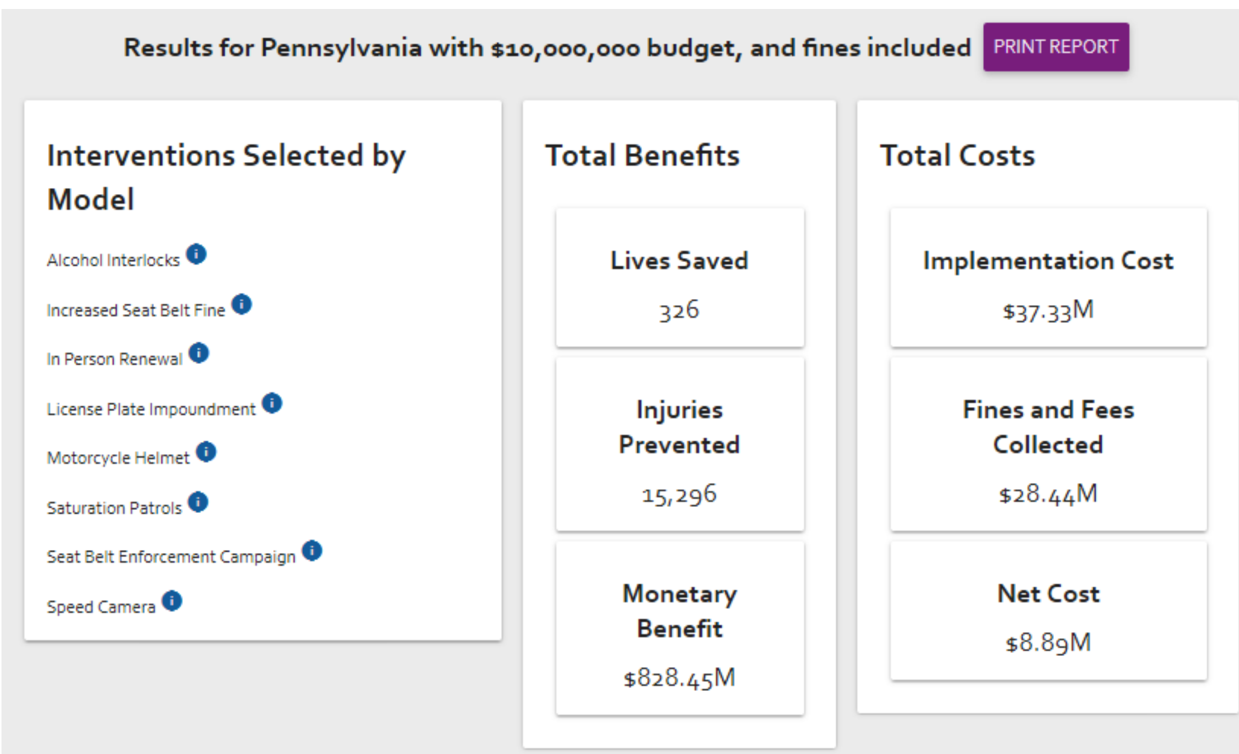


## Key Results and Graphics

Several key pieces of information are now displayed in graphic form, along with being shown in the Intervention Details table. We have added four types of graphics:

- a color-coded map of the United States, which displays fatalities and fatality rates when the user hovers over a state (see Figure 5.1).
- call-out boxes listing the interventions that the model selected and summarizing the total benefits (lives saved, injuries prevented, monetary benefit) and the total costs (implementation cost, fines and fees collected, and net cost) (see Figure 5.5).
- pie charts of lives saved, injuries prevented, and monetary benefits. These show the user how the total breaks down among the interventions that the model selected (see Figure 5.6).
- a bar chart of implementation costs. To reduce possible confusion, this shows the implementation costs on a right-hand bar and the fines and fees on a left-hand bar. The net cost, which is the total implementation cost minus the fines and fees, is shown above the bar chart in text (see Figure 5.7).

**Figure 5.5. Call-Out Box with Model Run Results**




The first two pie charts also display a new piece of information that was not available in the previous MV PICCS: the percentages of all lives saved and injuries reduced for a suite of interventions. This gives the user a sense of the magnitude of the potential reductions. In no state would implementing all of these interventions reduce traffic deaths and injuries to 0, but the user can now easily see whether the potential impact is a 5-percent reduction or a 30-percent one.

**Figure 5.6. Pie Charts of Benefits**

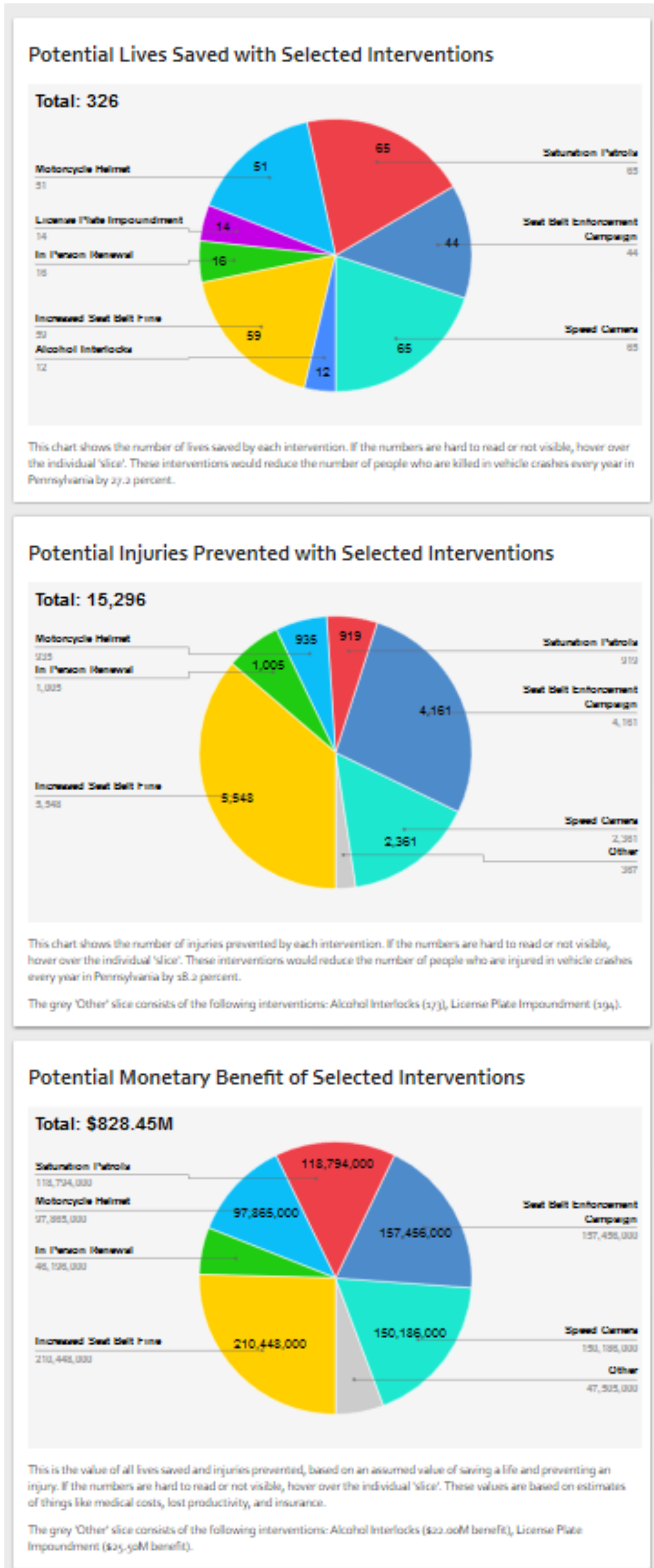
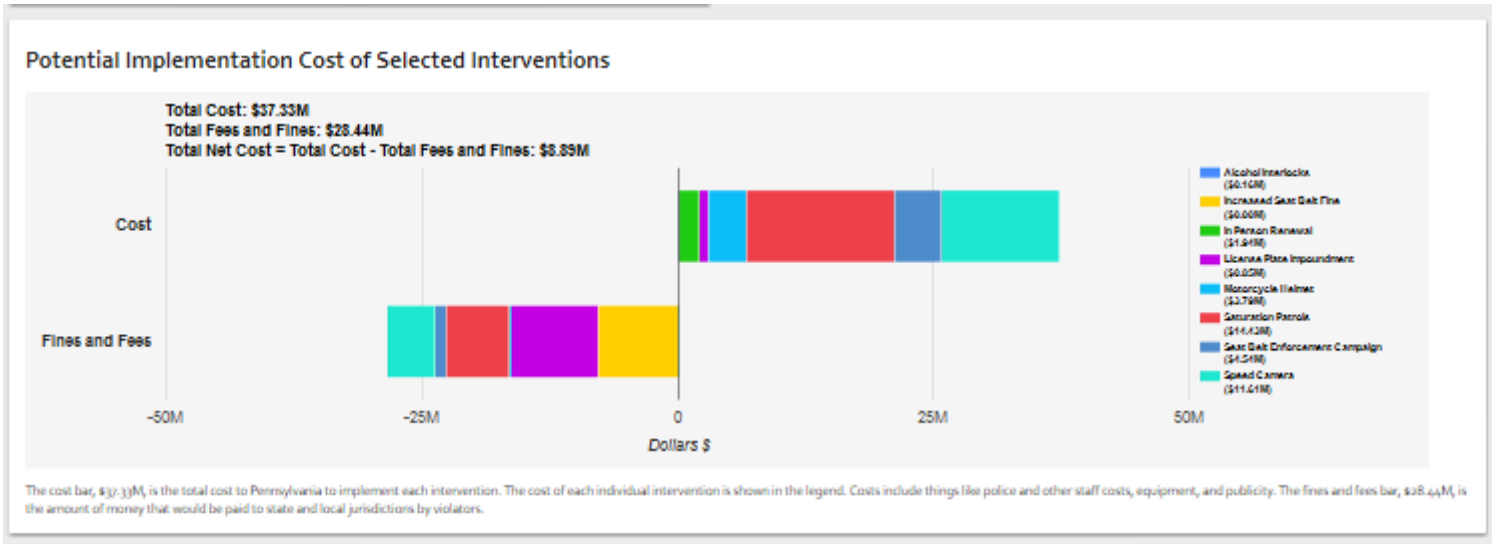


**Figure 5.7. Bar Chart of Implementation Costs and Fines and Fees**



## Additional Intervention Information

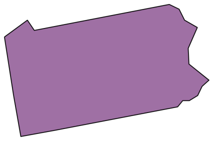
In several places, the user can hover over or click on buttons that provide more details. In the selected intervention box, as well as in the box where the user determines which interventions to analyze, a small "information" button next to the intervention name provides a sentence about the intervention when the user hovers over it. Similar buttons are provided for the injury-to-fatality reduction ratios in the sensitivity analysis. Hovering over individual slices in the pie charts provides the exact number that corresponds to that slice; if many interventions have been selected, the smallest ones appear as **Other**, with details provided directly below.[18] Finally, clicking the icon next to the name of each intervention in the Intervention Details table brings the user to the fact sheet about that intervention, which opens in a separate tab.

Finally, we used the **PRINT REPORT** button to allow the user to generate a Portable Document Format (PDF) report of the main calculations and graphics for any model run.

A sample PDF is provided beginning on the next page.

[18] The program we used to create these pie charts, Google Charts, cannot be modified to display all of the numbers.

# MV PICCS Model Run Results for Pennsylvania with $10,000,000 Budget, and Fines Included



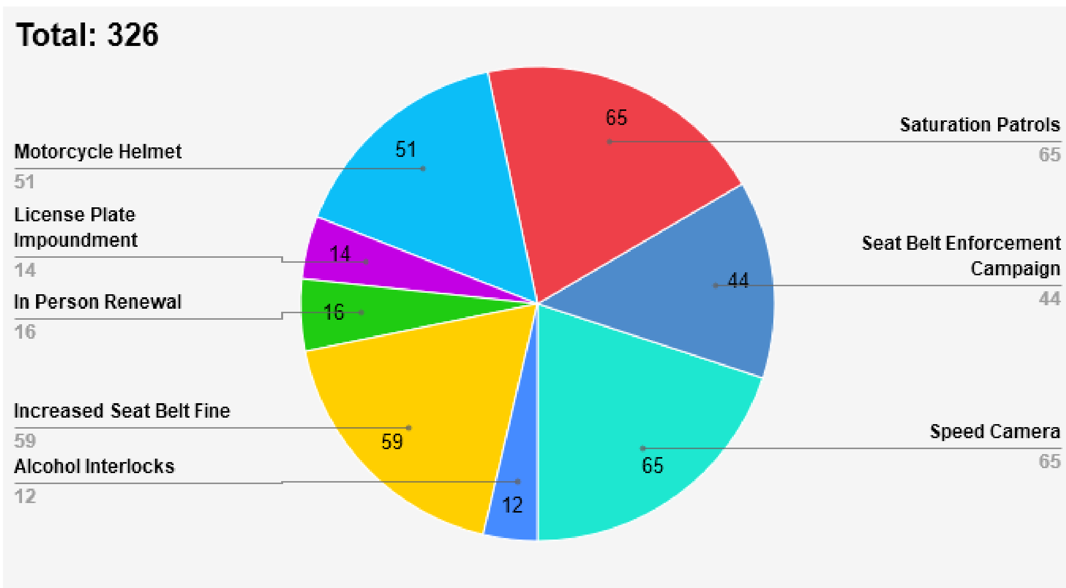
### Pennsylvania Motor Vehicle Crash Deaths and Injuries in 2015

Total number of deaths: 1,200
Total number of injuries: 84,028
Death rate (per 100k people): 9.4

Data Sources: Fatality Analysis Reporting System, General Estimates System, and U.S. Census. See MV PICCS tool for details.

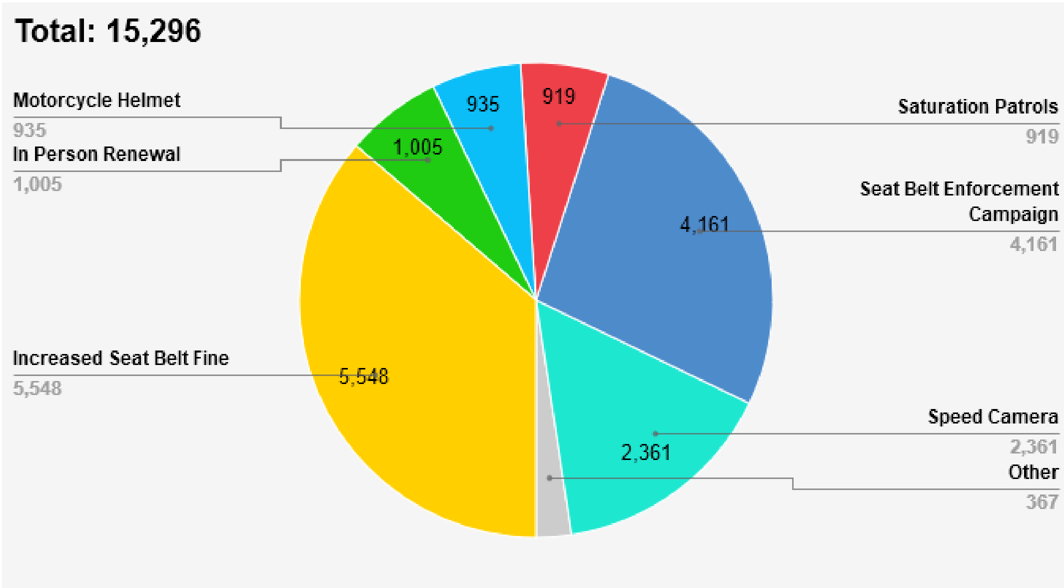
The charts below show the potential number of lives saved, injuries prevented, monetary benefit, and implementation costs of a particular combination of traffic safety interventions. The MV PICCS tool selected this combination of interventions based on which of the 14 available interventions were identified by the user for analysis, as well as the budget provided by the user. The user is responsible for including only those interventions that are not already implemented in Pennsylvania.

## Potential Lives Saved with Selected Interventions



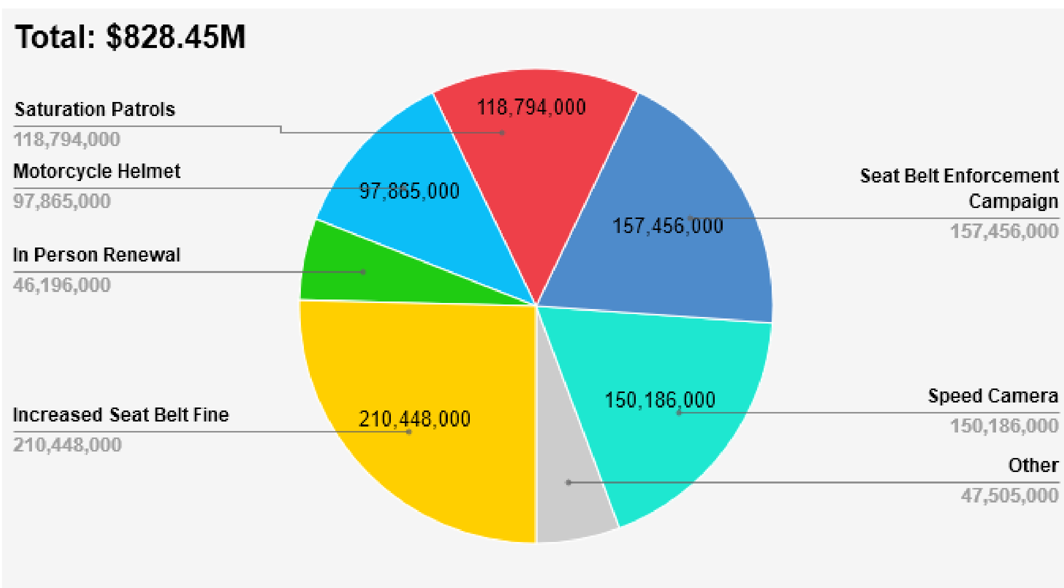

This chart shows the number of lives saved by each intervention. These interventions would reduce the number of people who are killed in vehicle crashes every year in Pennsylvania by 27.2 percent.

## Potential Injuries Prevented with Selected Interventions



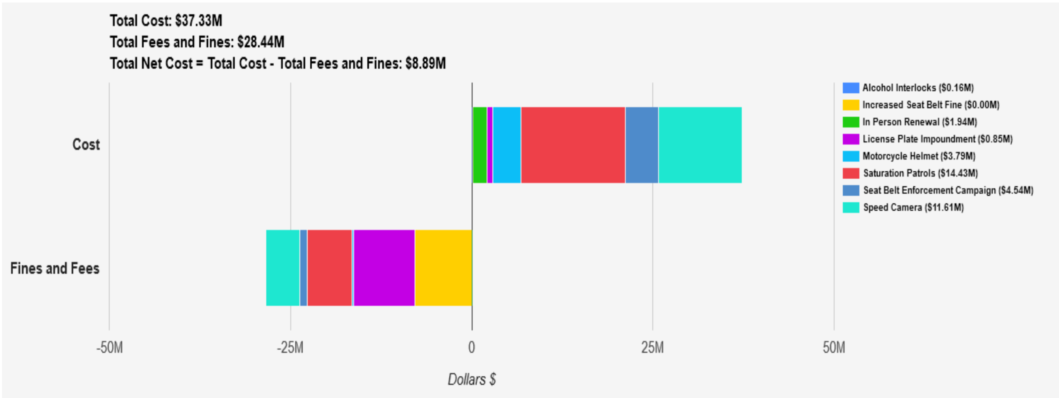

This chart shows the number of injuries prevented by each intervention. These interventions would reduce the number of people who are injured in vehicle crashes every year in Pennsylvania by 18.2 percent. The grey 'Other' slice consists of the following interventions: Alcohol Interlocks (173), License Plate Impoundment (194).

## Potential Monetary Benefit of Selected Interventions




This is the value of all lives saved and injuries prevented, based on an assumed value of saving a life and preventing an injury. These values are based on estimates of things like medical costs, lost productivity, and insurance. The grey 'Other' slice consists of the following interventions: Alcohol Interlocks ($22.00M benefit), License Plate Impoundment ($25.50M benefit).

## Potential Implementation Cost of Selected Interventions




The cost bar, $37.33M, is the total cost to Pennsylvania to implement all interventions in the legend. The cost of each individual intervention is shown in the legend. Costs include things like police and other staff costs, equipment, and publicity. The fines and fees bar, $28.44M, is the amount of money that would be paid to state and local jurisdictions by violators.

## Intervention Details

denotes selected by model

| Intervention | Lives Saved | Injuries Prevented | Cost to Implement | Fines and Fees | Net Cost | Benefits |
|---|---|---|---|---|---|---|
| ***Alcohol Interlocks** | 12 | 173 | $164,000 | $0 | $164,000 | $22,004,000 |
| ***Increased Seat Belt Fine** | 59 | 5548 | $0 | $7,774,000 | -$7,774,000 | $210,448,000 |
| ***In Person Renewal** | 16 | 1005 | $1,942,000 | $0 | $1,942,000 | $46,196,000 |
| ***License Plate Impoundment** | 14 | 194 | $851,000 | $8,497,000 | -$7,646,000 | $25,501,000 |
| ***Limits on Diversion** | 6 | 79 | $32,765,000 | $16,116,000 | $16,649,000 | $10,839,000 |
| ***Motorcycle Helmet** | 51 | 935 | $3,786,000 | $203,000 | $3,583,000 | $97,865,000 |
| ***Primary Enforcement Seat Belt Law** | 57 | 5394 | $14,617,000 | $5,071,000 | $9,546,000 | $204,056,000 |
| ***Saturation Patrols** | 65 | 919 | $14,433,000 | $6,204,000 | $8,229,000 | $118,794,000 |
| ***Seat Belt Enforcement Campaign** | 44 | 4161 | $4,544,000 | $1,031,000 | $3,513,000 | $157,456,000 |
| ***Speed Camera** | 65 | 2361 | $11,607,000 | $4,727,000 | $6,880,000 | $150,186,000 |
| ***Vehicle Impoundment** | 16 | 219 | $31,828,000 | $26,328,000 | $5,500,000 | $29,084,000 |
| ***TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS*** | ***326*** | ***15296*** | ***$37,327,000*** | ***$28,436,000*** | ***$8,891,000*** | ***$828,450,000*** |
| ***ADJUSTED TOTAL OF SELECTED INTERVENTIONS*** | ***320*** | ***14950*** | ***$37,327,000*** | ***$27,809,000*** | ***$9,518,000*** | ***$811,080,000*** |

This table shows only the interventions that were selected for analysis. The interventions in ***bold italics*** and marked with an asterisk are not currently implemented in Pennsylvania. The shaded rows are the ones selected by MV PICCS based on two criteria. First, only interventions whose net cost is less than the budget provided were selected. Second, interventions are prioritized based on their cost-effectiveness ratio, which is the benefit divided by the net cost.

The row 'TOTAL OF ALL SELECTED INDIVIDUAL INTERVENTIONS' sums all of the shaded rows.

The row 'ADJUSTED TOTAL OF SELECTED INTERVENTIONS' makes some adjustments based on the selection of related interventions. This is a more realistic assessment because some interventions target the same groups of drivers (for example, alcohol impaired drivers).

# Sensitivity Analysis Input Values

Benefit of preventing one injury: $21,770
Benefit of saving one life: $1,519,802

| Interventions | Injury Reduction Factor | Fatality Reduction Factor |
|---|---|---|
| Alcohol Interlocks | 24% | 24% |
| Increased Seat Belt Fine | 7.2% | 7.2% |
| In Person Renewal | 9% | 9% |
| License Plate Impoundment | 27% | 27% |
| Limits on Diversion | 11% | 11% |
| Motorcycle Helmet | 28.9% | 28.9% |
| Primary Enforcement Seat Belt Law | 7% | 7% |
| Saturation Patrols | 17.9% | 17.9% |
| Seat Belt Enforcement Campaign | 5.4% | 5.4% |
| Speed Camera | 12% | 12% |
| Vehicle Impoundment | 30.4% | 30.4% |

Through sensitivity analysis, MV PICCS allows users to change the defaults in the tool for two types of values: the benefit of saving one life or preventing one injury, and for the effectiveness of any intervention (the percent of deaths or injuries that it would reduce if implemented). The table above shows the default values; any changes made by the user are highlighted in yellow. Other default values cannot be changed.

# Chapter Six. Limitations and Future Refinements

Building a model of this type, particularly for the state level, requires many assumptions. In many cases, the available data and evidence base do not provide as much information as would be ideal, and there is certainly room for reasonable disagreement about the assumptions we have made. For 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, in the absence of better information, we assume that the reductions in the number of injuries for other interventions are proportional to the reductions in the number of deaths. Moreover, the estimates of the effects are based on studies identified in our original literature review conducted in 2014 and thus might not reflect the most up-to-date evidence from the literature.

As another example, the cost-effectiveness estimates assume the level and characteristics (e.g., whether there was a publicity campaign) of implementation of the successful intervention in the jurisdiction where it was originally implemented and evaluated. If the intervention is not implemented at the same level (e.g., not as much publicity about a seat belt enforcement campaign) as assumed in the tool, the estimated costs and effects reported in the tool might not reflect actual results.

The data that are used in the analysis also have limitations. We were able to partially address some of these limitations in this update to the tool. For example, when we originally built the tool, 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. Although we still could not identify a comprehensive source for the injury data, in this update to the tool, we were able to refine the methods to generate more-accurate estimates of the total number of injuries (see Table 3.1 in Chapter Three). Similarly, the FBI DWI arrest data are incomplete and thus understate the number of arrests. In this update, we adjusted the DWI arrest data by assuming that the arrest rate is constant across reporting and nonreporting jurisdictions in a particular state and extrapolating that to a total for the state.

Given the number of assumptions and the limitations noted, we have tried to be very transparent, describing our assumptions and calculations in detail in both the original report and this update, so readers can assess the assumptions themselves. Those who disagree with the assumptions can conduct a limited set of sensitivity analyses with the tool by adjusting the model parameters (i.e., value of an injury prevented, value of a fatality prevented, and percentages of injuries and fatalities that an intervention reduces) and use that analysis to inform their selections of the most cost-effective interventions.

## Possible Future Refinements

Several other refinements to MV PICCS could be made in future revisions. These include

- **the ability to compare multiple intervention combinations within a state.** Right now, MV PICCS can display the results of only one model run per state. A user who wants to compare different combinations of interventions, different budgets, or different inputs using sensitivity analysis must run each model separately and save or print the results in a PDF for a side-by-side comparison. One future refinement would be the capability of making these comparisons within the tool itself.
- **the ability to produce machine-readable data for further analysis.** The current **Print Report** button creates a PDF with the same graphics and data tables that are displayed on screen. A future refinement would be to allow the user to download the results as an Excel file to conduct any further analysis.
- **the ability to reverse-engineer the budget.** Currently, the user has to submit a specific budget, and the tool selects interventions based on that budget. In a reverse-engineered tool, the user would be able to ask, "What budget do I need to reduce fatalities in my state by X percent?" The tool would be able to provide a budget and a suite of interventions to reach that target.

Some other desirable characteristics are probably too difficult to enact without creating an entirely new tool. Because of the complexity of the cost calculations, it would be difficult to add specific cost elements to the list of inputs that users could change via the sensitivity analysis. Similarly, it would be conceptually difficult to add in the long-term consequences of enacting certain interventions (for example, rates of drunk driving might go down with aggressive use of drunk-driving interventions, which would then change the number of drunk-driving arrests per year, which would lead to changes in costs and arrest rates). However, given that the literature generally focuses on short-term responses, many more assumptions would be required, and the complexity would increase enormously.

## Conclusion

The estimates that the tool provides are approximations. They are meant to give decisionmakers a sense of the relative costs and effects of different interventions under consideration. The tool might not capture some other costs and benefits that should be considered (e.g., the improved employment or quality of life among people who are deterred from driving while drunk) or political issues that make some interventions more feasible than others, such as opposition to certain types of laws. In essence, the outputs 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 continues to be of great use to state decisionmakers. Although information about which interventions are effective has been generally available, MV PICCS 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.

# Appendix A. Interventions Considered but Not Included

As noted in Chapter Two, we ultimately decided not to include two new interventions: lowering BAC limits to 0.05 from 0.08 and cell phone and texting bans. This appendix summarizes the literature we reviewed for both interventions.

## Lowering Blood Alcohol Concentration Limits to 0.05

Currently in the United States, all states and the District of Columbia use a BAC limit of 0.08 (measured in grams of alcohol per 100 deciliters of blood) as the basis for a DWI charge. This intervention would lower that BAC level from 0.08 to 0.05. Many other countries have BAC levels of 0.05 or even lower (World Health Organization, 2014).[19]

The jurisdictions where 0.05 BAC limits have been shown to be effective use enhanced enforcement of various types. Australia, which has the largest number of studies, has long used random breath testing (RBT) (Henstridge, Homel, and Mackay, 1997). An Austrian study found that the 0.05 limit decreased injury crashes by 7.6 percent, noting that “lowering the legal BAC-limit from .08% to .05% in combination with intensive police enforcement and reporting in the media leads to a positive short term effect” (Bartl and Esberger, 2000). The paper does not explain how this intensive police enforcement was applied. In contrast, in Canada, a lack of long-term effectiveness in lowering the BAC limit to 0.05 was attributed to the fact that “perceived certainty and perceived celerity did not seem to be increased much, nor for very long” (Vingilis et al., 1988, p. 16).

The main ways to increase enforcement are through various types of sobriety checks, which give police the authority to stop a driver to administer a breath test, regardless of whether the vehicle is being driven erratically. These checks can be distinguished by the operational characteristics, the level of publicity, and the intensity of use. MV PICCS already contains fatality reduction estimates for two types of checkpoint programs: sobriety checkpoints and saturation patrols. Australia uses a type of checkpoint not used in the United States: RBT.

[19] The state of Utah passed a law lowering the BAC limit to 0.05, but the law does not take effect until December 31, 2018 (Fell and Voas, 2017).

RBT allows police to pull over any driver for immediate breath testing, regardless of the driver's behavior. It can be carried out on either a mobile or stationary basis; generally, the enforcement is along the roadside, with police vehicles available to follow drivers who attempt to evade the checkpoint (Ferris et al., 2015). One important distinction separates RBT from the types of checkpoints generally operated in the United States:

> In the Random Breath Testing (RBT) program in Australia, cars are stopped at checkpoints or by roving units, regardless of suspicion of alcohol use, and a breath alcohol test is administered. In the United States, sobriety checkpoints stop cars randomly, and breath alcohol tests are administered only if the use of alcohol is suspected through odor, actions, presence of containers, or other means. The key feature of both interventions is that vehicles are stopped regardless of the suspicion of alcohol use, but in the Australian RBT all drivers who are stopped receive a breath test while only drivers suspected of drinking are tested in the United States. (Peek-Asa, 1999, p. 58)

We identified five studies that conducted meta-analyses of checkpoints; many of them include the same original studies:

- The most recent, reported in Bergen et al., 2014, reviewed studies only from 2000 to 2012, finding a median reduction of 8.9 percent in fatalities related to drunk driving. (This study combined findings from both checkpoints and RBT because only one RBT study was identified. All other studies were conducted in the United States.)
- The Bergen et al. work updated a review by Shults et al., 2001, that found decreases in fatal crashes by 20 and 26 percent with sobriety checkpoints in two studies and a median 22-percent decrease in fatal crashes with RBT. (Elder et al., 2002, analyzes the same group of studies and reaches similar figures.)
- In Erke, Goldenbeld, and Vaa, 2009, the authors conducted a meta-analysis of studies of various checkpoint types, including RBT, looking at their effectiveness in reducing crashes. Overall, when controlling for publication bias, they found that, on average, checkpoints reduced crashes (both injury and fatality) by 14 percent. Broken down by crash type, checkpoints reduced injury crashes by 16 percent and fatal crashes by 6 percent. Comparing different countries, they found that Australia had the best results, with a 17-percent reduction, while the U.S. reduction was 8 percent. (The report did not provide a figure for Australian programs by reduction in injury versus fatal crashes.)
- A meta-analysis of various police interventions found that RBT reduced the percentage of injury crashes by 30.6 percent, while checkpoints reduced them by 22.8 percent (Blais and Dupont, 2005).

The estimate in the original MV PICCS is from Fell, Tippetts, and Levy, 2008, which looks across multiple U.S. states. Our own interpretation of that analysis led to our estimate of the 8.1-percent reduction that we use in the tool for sobriety checkpoints.

We think that the Australian evidence presents a good proxy for U.S. conditions (compared with European countries, Australia has higher rates of driving and more rural driving), and it has been successful in reducing traffic crash fatalities. When Australia made 0.05 the legal BAC limit throughout the country in 1991 (it had previously been enacted by some but not all provinces), there were approximately 12.2 deaths from crashes per 100,000 people (Bureau of Infrastructure, Transport and Regional Economics, 2012, Table 29), a rate similar to the current U.S. rate (11.3 for 2015). Since then, the country has seen a substantial decrease in crash fatalities. By 2011, it had fallen to 5.1 (Bureau of Infrastructure, Transport and Regional Economics, 2016, Table 2.1).

Because both RBT and 0.05 BAC limits have been in use for several decades in Australia, sorting out their effects is difficult. One early and often-cited study found large reductions for both RBT and 0.05: For Henstridge, Homel, and Mackay, 1997, the authors found reductions in the number of fatal crashes ranging from 24 to 48 percent (depending on the province), but these large reductions were not sustained over time. The 0.05 limit was also found to contribute to reductions in the number of fatal crashes, even when controlling for RBT: 8 percent in one province and 18 in another. The report did not look at whether these reductions were sustained over time.

On the other hand, a more recent study found different results. Nghiem, Commandeur, and Connelly found that RBT in Queensland province (both its introduction in 1988 and its expansion in 1998) was associated with decreases in fatalities of 11.3 and 26.2 percent, while the Safe4Life program that prioritizes enforcement of drunk- and drugged-driving laws reduced fatalities by 14.3 percent (Nghiem, Commandeur, and Connelly, 2016). However, they noted, "We found that there was not enough statistical evidence to confirm the effects of the first initiatives to limit BAC to 0.1 in 1968, and to 0.05 in 1982" (Nghiem, Commandeur, and Connelly, 2016, p. 71).

A study comparing results of RBT across all Australian provinces found that the program considered the most effective is in the province of New South Wales. The main differentiator is the ratio of RBT to licensed drivers (1 to 1), meaning that, on average, in a given year, a driver can expect to be pulled over once. This intensity has increased over time, and the crash reductions have been maintained (Ferris et al., 2015).

### *Challenges in Incorporating Lower Blood Alcohol Concentration Limits into MV PICCS 3.0*

Informed by this review, we considered two ways in which lower BAC limits could be incorporated into the tool. Each has significant drawbacks.

#### Restrict 0.05 to Be Selected Only When Sobriety Checkpoints Are Selected

One way to incorporate lower BAC limits into MV PICCS is to allow users to select the 0.05 intervention only when sobriety checkpoints are selected. This could be programmed into the tool relatively easily—the 0.05 check box would be grayed out unless sobriety checkpoints were also selected. (Alternatively, we could have two sobriety checkpoint boxes, one for 0.08 and one for 0.05, and the user could select only one.)

The drawback to this solution is that, when sobriety checkpoints are used, the tool already uses an assumption of an 8.1-percent reduction in the number of fatalities related to drunk driving (Fell, Langston, et al., 2008). This is higher than most studies of the effectiveness of 0.05. Henstridge, Homel, and Mackay found an 18-percent reduction in one Australian province and 8 percent in another (Henstridge, Homel, and Mackay, 1997); Bartl and Esberger found 7.6 percent in Austria (Bartl and Esberger, 2000); and Blais, Bellavance, et al. found 3.7 percent across most Canadian provinces (Blais, Bellavance, et al., 2015). The abstract for Fell and Scherer, unpublished draft, states that the authors, in their meta-analysis, found an average 11.1-percent reduction in fatal crashes, but this includes BAC levels lower than 0.05. We have not been able to review the full paper; at the time this report was written, it was not published, and the authors provided only the abstract.

Given the overlap between BAC and enforcement, it does not seem appropriate to attribute all of the potential reductions in the number of fatal crashes to reductions in the BAC limit alone. We have been unable to locate any checkpoint studies in countries where we are confident that there was a BAC limit of 0.05 when the study was conducted. One problem is that many of the studies cited in Erke, Goldenbeld, and Vaa, 2009, which we used as a starting point, are quite old (e.g., Mercer, 1985; Mercer, Cooper, and Kristiansen, 1996; L'Hoste, Duval, and Lassarre, 1983; Törnros, 1995; Derby and Hurst, 1987; and Mathijssen and de Craen, 2004) and do not report the BAC limit at the time. Also, disappointingly, some of these studies—many of which were short term in nature—did not find significant reductions.

### Combine a 0.05 Blood Alcohol Concentration Limit with Random Breath Testing

Another strategy would be to assume that a 0.05 BAC limit would be combined with RBT. Ferris et al. found that New South Wales province in Australia had the most successful program within that country (Ferris et al., 2015). RBT was introduced in 1982 (the BAC limit had been lowered to 0.05 in 1980—Henstridge, Homel, and Mackay, 1997). Over time, the frequency of RBT has increased to 4.42 million stops for a population of 4.89 million licensed drivers, meaning that a driver can expect to be stopped an average of once per year for a breath test (Ferris et al., 2015). An earlier study noted the importance of pairing a 0.05 BAC limit with RBT: "any effects of the .05 law may not have been sustained if RBT had not been introduced two years later" (Homel, 1994, p. 147).

Ferris et al., 2015, also provides a list of best practices for RBT. To be as effective as possible, RBT should be

- highly visible and random, such that drivers perceive a high likelihood of being pulled over
- emphasized during times when people are likely to be drinking
- difficult for drivers to avoid
- certain in terms of punishment (that is, all drivers who are over the limit should face consequences)

- supported by effective publicity.

Henstridge, Homel, and Mackay found a 15-percent reduction in all fatal crashes (not exclusively those related to drunk driving) in effect a decade after RBT was introduced (Henstridge, Homel, and Mackay, 1997, Table 3.8). This rate plateaued in the late 1990s, but analysis for 2000 through 2012 found reductions in the rate of alcohol-related crashes per 100,000 licensed drivers, from 5.05 to 2.78 (Ferris et al., 2015). These are not directly comparable to Henstridge's figures because the metric is alcohol-related crashes (presumably of any level of severity) and not fatal crashes.

However, RBT appears to be unconstitutional, based on the U.S. Supreme Court decision in *Mich. Dep't of State Police v. Sitz* (496 U.S. 444, 110 S. Ct. 2481, June 14, 1990). The court ruled that sobriety checkpoints did not constitute unreasonable search and seizure. However, *only* a driver who gave police officers reason to believe that he or she was drunk could be subject to breath testing (Fell, Lacey, and Voas, 2004). Therefore, it would be difficult to assume that states could adopt RBT, which might negate some of the effectiveness that Australia experienced after lowering its BAC limit.

## Cell Phone and Text Messaging Laws

Goodwin et al., 2015, includes information on laws about cell phone and text messaging along with high-visibility enforcement (HVE) of these laws. This section combines the law and enforcement sections verbatim from Goodwin et al., 2015, as well as other literature we review that was not mentioned in those sections. Table A.1 provides information on cell phone and texting bans, by state.

**Table A.1. State Bans on Cell Phone Use, 2017**

| State or District | Handheld Ban | Cell Phone Ban: School Bus Drivers | Cell Phone Bans: Novice Drivers | Text Messaging Ban |
|---|---|---|---|---|
| Ala. | — | — | 16, or 17 with intermediate license <6 months[a] | Yes[a] |
| Alaska | — | — | — | Yes[a] |
| Ariz. | — | Yes[a] | — | <18 in graduated driver's license only[b] |
| Ark. | 18–20 years old[a] | Yes[a] | <18[b] | Yes[a] |
| Calif. | Yes[a] | Yes[a] | <18[b] | Yes[a] |
| Colo. | — | — | <18[a] | Yes[a] |
| Conn. | Yes[a] | Yes[a] | <18[a] | Yes[a] |
| Del. | Yes[a] | Yes[a] | Learner or intermediate license[a] | Yes[a] |
| D.C. | Yes[a] | Yes[a] | Learner's permit[a] | Yes[a] |
| Fla. | — | — | — | Yes[b] |

| State or District | Handheld Ban | Cell Phone Ban: School Bus Drivers | Cell Phone Bans: Novice Drivers | Text Messaging Ban |
|---|---|---|---|---|
| Ga. | — | Yes[a] | <18[a] | Yes[a] |
| Hawaii | Yes[a] | — | <18[a] | Yes[a] |
| Idaho | — | — | — | Yes[a] |
| Ill. | Yes[a] | Yes[a] | <19[a] | Yes[a] |
| Ind. | — | — | <21[a] | Yes[a] |
| Iowa | — | — | Restricted or intermediate license[a] | Yes[a] |
| Kan. | — | — | Learner or intermediate license[a] | Yes[a] |
| Ky. | — | Yes[a] | <18[a] | Yes[a] |
| La. | Learner or intermediate license[c] | Yes[a] | First year of license[d] | Yes[a] |
| Maine | — | — | Learner or intermediate license[a] | Yes[a] |
| Md. | Yes[a] | — | <18[b] | Yes[a] |
| Mass. | — | Yes[a] | <18[a] | Yes[a] |
| Mich. | — | Yes[a] | Level 1 (learner's permit) or 2 (intermediate) license[a] | Yes[a] |
| Minn. | — | Yes[a] | <18 with learner or provisional license[a] | Yes[a] |
| Miss. | — | Yes[a] | | Yes[a] |
| Mo. | — | — | — | <21 only[a] |
| Mont. | — | — | — | — |
| Neb. | — | — | <18 with learner or intermediate license[b] | Yes[b] |
| Nev. | Yes[a] | — | — | Yes[a] |
| N.H. | Yes[a] | — | <18[a] | Yes[a] |
| N.J. | Yes[a] | Yes[a] | Permit or provisional license[a] | Yes[a] |
| N.M. | — | — | Learner or provisional license[a] | Yes[a] |
| N.Y. | Yes[a] | — | — | Yes[a] |
| N.C. | — | Yes[a] | <18[a] | Yes[a] |
| N.D. | — | — | <18[a] | Yes[a] |
| Ohio | — | — | <18[a] | Yes[b] |
| Okla. | Learner or intermediate license[a] | — | — | Yes[a] |
| Ore. | Yes[a] | — | <18[a] | Yes[a] |
| Pa. | — | — | — | Yes[a] |
| R.I. | Yes[a] | Yes[a] | <18[a] | Yes[a] |
| S.C. | — | — | — | Yes[a] |
| S.D. | — | — | Learner or intermediate license[b] | Yes[b] |

| State or District | Handheld Ban | Cell Phone Ban: School Bus Drivers | Cell Phone Bans: Novice Drivers | Text Messaging Ban |
|---|---|---|---|---|
| Tenn. | — | Yes[a] | Learner or intermediate license[a] | Yes[a] |
| Texas | — | Yes, with passenger ≤17[a] | <18[a] | Yes[a] |
| Utah | — | Yes[a] | <18[a] | Yes[a] |
| Vt. | Yes[a] | — | <18[a] | Yes[a] |
| Va. | — | Yes[a] | <18[b] | Yes[a] |
| Wash. | Yes[a] | — | Learner or intermediate license[a] | Yes[a] |
| W.Va. | Yes[a] | — | <18 with learner or intermediate license[a] | Yes[a] |
| Wis. | — | — | Learner or intermediate license[a] | Yes[a] |
| Wyo. | — | — | <18[a] | Yes[a] |

SOURCE: GHSA, undated (a).
[a] Primary law.
[b] Secondary law.
[c] Regardless of age.
[d] Primary for <18.

On cell phone and text messaging laws,

> States have been very active in using legislation to address [the issue of cell phone use while driving]. Since 2000, every State has considered legislation to curtail distracted driving or driver cell phone use. In 2013, legislators in 40 States considered approximately 170 bills related to distracted driving (Teigen and Shinkle, 2014, p. 8). No State completely bans all types of cell phone use for all drivers. Bans on texting are more common than bans on hand-held cell phone use. Overall, public support is high for this legislation. In surveys of the general public, between 70% and 80% favor bans on hand-held cell phone use, and 88% to 96% support bans on texting while driving (AAA Foundation for Safety [AAFTS], 2013; Guarino, 2013; Schroeder, Meyers, and Kostyniuk, 2013). (Goodwin et al., 2015, p. 4-11)

On HVE:

> Similar to sobriety checkpoints, the object [of HVE] is to deter cell phone use by increasing the perceived risk of [arrest]. The HVE model combines dedicated law enforcement with paid and earned media supporting the enforcement activity. Enforcement officers actively seek out cell phone users through special roving patrols, or through spotter techniques where a stationary officer will radio ahead to another officer when a driver using a cell phone is detected. Officers report that higher vantage points, [sport utility vehicles], and unmarked vehicles can assist in identifying violators ([Chaudhary et al., 2014]). Both earned and paid media are critical to ensure [that] the general public is aware of the enforcement activity, and to create the impression that violators will be caught. (Goodwin et al., 2015, p. 4-14)

### *History*

> Cell phones have become an essential feature of modern life. In a NHTSA survey of more than 6,000 U.S. residents, 60% admitted to answering phone calls while driving and 51% reported making phone calls ([Schroeder, Meyers, and Kostyniuk, 2013]). Half (50%) of cell phone users reported no differences in their driving when using a cell phone. (Goodwin et al., 2015, p. 4-11)

The most recent observational survey on electronic device use, conducted in 2015, found that 3.8 percent of drivers were using handheld cell phones, the lowest percentage since the survey began in 2006 (the percentage peaked in 2007, when 6.2 percent of drivers were using handheld phones). However, the rate of visible-headset cell phone use has remaned flat, at 0.6 percent, while texting (defined as visible manipulation of a handheld device) remained at the 2014 peak of 2.2 percent (Pickrell, Li, and KC, 2016, Figure 1).

Goodwin et al., 2015, discusses some of the literature on the distracting effect of cell phone use while driving. There is general consensus that cell phone use is a distraction, but debate centers around whether this distraction necessarily results in more crashes.

As for HVE, this type of intervention has been used to significant effect for curbing alcohol-impaired driving and increasing seat belt use (Goodwin et al., 2015). The strategy departs from typical enforcement strategy by focusing on publicizing police presence and targeting of certain types of offenses.

### *Implementation*

As of November 2017, talking on a handheld cell phone was prohibited in 15 states (California, Connecticut, Delaware, Hawaii, Illinois, Maryland, Nevada, New Hampshire, New Jersey, New York, Oregon, Rhode Island, Vermont, Washington, and West Virginia) and the District of Columbia.[20] All but three states (Arizona, Missouri, and Montana) and the District of Columbia ban texting while driving. Most of these are primary bans (IIHS, 2017f).

> In addition, several local jurisdictions such as Chapel Hill, North Carolina; Chicago, Illinois; and Cheyenne, Wyoming, have enacted their own restrictions on cell phones. (Vegega, Jones, and Monk, 2013, p. 17)
>
> To date, only a handful of States have implemented high visibility enforcement programs to address talking and texting among drivers. (Goodwin et al., 2015, p. 4-14)

### *Effectiveness*

> Evaluations in New York, Connecticut, the District of Columbia, and . . . other countries consistently show that cell phone laws reduce hand-held phone use by about 50% shortly after the laws take effect ([McCartt, Hellinga, and Bratiman, 2006]). Moreover, these reductions in hand-held cell phone use are maintained 3

[20] Rhode Island’s law takes effect in June 2018.

> to 7 years later ([McCartt, Hellinga, Strouse, et al., 2010]). (Goodwin et al., 2015, p. 4-12)

Reductions varied by jurisdiction; using Poisson regression, the McCartt, Hellinga, Strouse, et al., 2010, study found that, five years later, rates of handheld phone use were 43 percent lower in the District of Columbia than would have been expected without the ban, 65 percent lower in Connecticut 3.5 years later, and 24 percent lower in New York seven years later, based on observed use by drivers. The actual observed rates of cell phone use were quite low: 1.1 percent immediately after the ban in New York (McCartt and Geary, 2004) and 3.5 percent in Washington, D.C. (McCartt and Hellinga, 2007). McCartt, Hellinga, Strouse, et al., 2010, suggests that one possible reason for this difference is differences in intensity of enforcement.

> However, it is unknown whether these laws lead to increased use of hands-free devices. (Goodwin et al., 2015, p. 4-12)
>
> The effectiveness of hand-held cell phone bans in reducing crashes is unclear. Nikolaev, Robbins, and Jacobson (2010) examined driving injuries and fatalities in 62 counties in New York State both before and after a hand-held cell phone ban took effect. Forty-six counties showed a significant decrease in injury crashes following the ban, and 10 counties showed a less-significant decrease in fatal crashes. Although encouraging, the study did not include a control group to account for other factors that may have decreased crashes. A study by the Highway Loss Data Institute (HLDI) investigated State-level automobile insurance collision claims in California, Connecticut, New York and the District of Columbia. When compared to neighboring States, there was no change in collision claim frequency after these jurisdictions implemented hand-held cell phone bans ([“Hand-Held Cellphone Laws and Collision Claim Frequencies,” 2009]). However, the data from the Highway Loss Data Institute is proprietary and an independent analysis of the data has not been conducted. Also, not all crashes result in a collision claim, so collision claim rates may differ from crash rates. (Goodwin et al., 2015, p. 4-12)

A 2012 study comparing the effectiveness of a cell phone ban in urban versus rural areas found that the ban decreased crashes in the urban area by 1.6 per 1,000 residents but was actually associated with a small, nonsignificant increase in the number of crashes in the rural area (0.5 per 1,000 residents) (Jacobson et al., 2012). A 2013 study of New Jersey’s cell phone ban, comparing three years pre- and postban, found no significant change in fatalities due to cell phone use (Maher and Ott, 2013). Burger, Kaffine, and Yu did not find any evidence that a 2008 ban on handheld phone use in California reduced crashes, comparing six months before and after the ban (Burger, Kaffine, and Yu, 2014). A 2014 review of 11 existing studies on the effectiveness of bans (seven cell phone bans, two texting bans, and two types of multiple-factor bans) found mixed results. Of the seven cell phone bans, two showed signification reductions in crash rates for the jurisdictions studied, one found no significant reduction, and four found signification reductions in some locations and circumstances (e.g., poor weather conditions) but not in others. For the texting and multiple-factor bans, results were also mixed. All studies had some methodological concerns, some more problematic than others (McCartt, Kidd, and Teoh, 2014).

A 2016 study looked at a period of 19 years in multiple states at four types of bans: primary cell phone ban, secondary cell phone ban (meaning that the driver can be pulled over only for committing another offense), primary texting bans, and secondary texting bans. The authors found that primary cell phone bans reduced fatalities by 10 percent, while secondary bans had essentially zero impact. Texting bans were less effective than primary cell phone bans. The results were consistent even when controlling for the effects of the 2008–2009 recession and the price of gasoline, but the magnitude of the estimated effect was substantially reduced (e.g., the primary cell phone ban reduced fatalities by 3 percent) when controlling for state-specific time trends (Rocco and Sampaio, 2016).

A 2016 review specifically of cell phone bans and their effectiveness for young drivers looked at 11 studies and determined, "Overall, evidence of the effectiveness of young drivers' cell phone restrictions is inconclusive" (Ehsani, Ionides, et al., 2016, p. 35). Lim and Chi reached a similar conclusion: "We found that handheld cell phone bans targeting *all* drivers reduced fatal crashes involving young drivers, but there was insufficient evidence that complete cell phone bans targeting only *young* drivers reduced fatal crashes" (Lim and Chi, 2013).

> Two studies have examined the effectiveness of laws prohibiting texting while driving. One study evaluated the effect of a texting ban in Michigan ([Ehsani, Bingham, et al., 2014]); the other examined insurance collision claims in States with texting bans compared to neighboring States without such bans (["Texting Laws and Collision Claim Frequencies," 2010]). Both studies found small *increases* in various types of crashes and collision claims following enactment of texting bans. One possible explanation is that texting drivers attempt to avoid detection by hiding their phones from view, which may result in more time with drivers' eyes off the roadway. (Goodwin et al., 2015, p. 4-12; emphasis in the original)

A study in 2014 showed that states with primary texting bans had, on average, a 3-percent reduction in fatalities (Ferdinand et al., 2014).

> Results from the NHTSA HVE program suggest [that] hand-held cell phone use among drivers dropped 57% in Hartford and 32% in Syracuse (Chaudhary et al., 2014). The percentage of drivers observed manipulating a phone (e.g., texting or dialing) also declined. Public awareness of distracted driving was already high before the program, but surveys suggest [that] awareness of the program and enforcement activity increased in both Hartford and Syracuse. Surveys also showed [that] most motorists supported the enforcement activity. In California and Delaware, similar reductions in cell phone use were observed following the campaign, although decreases were also noted in comparison communities ([Schick, Vegega, and Chaudhary, 2014]). Although the results are encouraging, the effect of these HVE campaigns on crashes is unknown. Note that the evidence for effectiveness is based on community and smaller statewide programs that targeted hand-held cell phone use. There is no evidence available

> that HVE programs targeting texting will be as effective. (Goodwin et al., 2015, pp. 4-14–4-15)

An issue complicating the enforcement of texting bans is the difficulty in detecting whether a driver is texting. Wilson and Stimpson, 2010, makes the point that drivers who are texting might drive normally for long periods of time, complicating detection compared with detecting drunk drivers, who are more consistently impaired.

### *Measuring Effectiveness*

As described above, there is considerable difficulty detecting the impact that cell phone and texting bans have on crashes. Most studies thus far have focused on the effect of a ban on cell phone usage, but this is difficult to translate into such a ban's effect on crashes (McCartt and Geary, 2004; McCartt and Hellinga, 2007). Abouk and Adams, 2013; Ferdinand et al., 2014; and Rocco and Sampaio, 2016, use national crash data to detect effects, which could be a method for future evaluation.

A further complication is variation in road conditions; worse conditions increase the danger of driving and can make the use of cell phones more risky. One study found that laws permitting only hands-free use reduce crashes, but only in bad weather or wet road conditions (Kolko, 2009).

As for HVE, no studies have measured its effectiveness at crash reduction. It might be difficult to disentangle the effect of a cell phone ban from that of an HVE campaign.

### *Costs*

Goodwin et al., 2015, explains that the cost of instituting a cell phone ban consists of the publicizing and enforcement costs. Although not all bans are instituted in conjunction with an HVE campaign, the costs of the HVE campaign could likely be scaled according to local preferences.

Regarding these HVE costs:

> High visibility enforcement campaigns are expensive. They require time from law enforcement officers to conduct the enforcement. In addition, time is needed from State highway safety office and media staff and often from consultants to develop, produce, and distribute advertising, educational materials, and other communications tools. In the NHTSA demonstration program, both Connecticut and New York received $200,000 to implement and evaluate the program, and each State contributed an additional $100,000 to the Federal funds. Paid media costs for the program in the two States were over $500,000. (Goodwin et al., 2015, p. 4-15)

### *Time to Implement*

A cell phone ban can be implemented at any time. Again, it is in enforcement that issues of cost and timeline become more relevant. Goodwin et al., 2015, suggests that an HVE campaign can require four to six months to plan and implement.

### *Other Issues*

> Cell phone blockers: In recent years, several manufacturers have created systems that can block a cell phone from making (or receiving) calls while a person is driving. These systems detect when the phone is in motion. During that time, incoming calls are automatically diverted to voicemail and incoming texts are not shown until the driver has stopped moving. Typically, these systems allow exceptions for phone calls from pre-specified numbers, and all allow emergency calls to 911. Although these systems are potentially applicable to all drivers, they have largely been marketed to parents of teen drivers. Researchers at the Texas [A&M] Transportation Institute (TTI) tried to evaluate a cell phone disabling device for teens; however, they encountered difficulty recruiting families and very strong resistance by parents and teens to the device ([Benden, Fink, and Stafford, 2012]). NHTSA funded a study examining the effect of a filtering/blocking application on the cell phones of 44 Michigan DOT employees. When the application was active, participants placed and answered fewer calls while their [vehicles were] in motion. However, participants were not very accepting of the application, and the application was not completely reliable ([Funkhouser and Sayer, 2013]). (Goodwin et al., 2015, p. 4-13)
>
> Voice-to-text technology: There are several applications that allow drivers to send and receive text messages using voice rather than manual entry. Although the research on these applications is limited, it appears [that] voice-to-text technology may offer little or no safety benefit. In a recent study, 42 participants drove instrumented vehicles on a closed course while texting manually or using one of two voice-to-text applications. In all three conditions, reaction times were slower and drivers spent more time looking away from the roadway (Yager, 2013). More research is needed, but the findings suggest [that] texting impairs driving performance, regardless of what method of texting is used. (Goodwin et al., 2015, p. 4-13)

# Appendix B. Productivity and Medical Adjustments to the Value of a Life

Table B.1 shows the full list of adjusters and values of preventing an injury and saving a life.

**Table B.1. State-Specific Price Multipliers and Values of Saving a Life and Preventing an Injury**

| State | MV PICCS 2.0 Multiplier: Productivity (Market and Household) | MV PICCS 2.0 Multiplier: Medical | MV PICCS 3.0 Multiplier: Productivity (Market and Household) | MV PICCS 3.0 Multiplier: Medical | MV PICCS 2.0 Value of Preventing an Injury | MV PICCS 2.0 Value of Saving a Life | MV PICCS 3.0 Value of Preventing an Injury, in Dollars | MV PICCS 3.0 Value of Saving a Life, in Dollars |
|---|---|---|---|---|---|---|---|---|
| Ala. | 0.839 | 0.898 | 0.8692 | 0.8456 | 20,409 | 1,136,673 | 20,488 | 1,385,639 |
| Alaska | 1.045 | 1.282 | 1.4063 | 1.0885 | 24,160 | 1,365,258 | 24,875 | 2,124,519 |
| Ariz. | 0.855 | 0.976 | 1.0203 | 0.8415 | 20,962 | 1,155,854 | 21,428 | 1,592,587 |
| Ark. | 0.779 | 0.893 | 0.8868 | 0.8162 | 19,897 | 1,073,258 | 20,480 | 1,409,378 |
| Calif. | 1.077 | 1.071 | 1.1151 | 1.0814 | 23,272 | 1,392,753 | 23,002 | 1,725,499 |
| Colo. | 1.063 | 1.010 | 1.0393 | 1.0564 | 22,827 | 1,376,185 | 22,420 | 1,621,340 |
| Conn. | 1.402 | 1.119 | 1.1203 | 1.3899 | 26,158 | 1,736,869 | 24,287 | 1,736,533 |
| Del. | 1.052 | 1.160 | 1.0760 | 1.0173 | 23,554 | 1,369,027 | 22,494 | 1,671,122 |
| D.C. | 1.582 | 1.058 | 1.0310 | 1.6863 | 27,281 | 1,924,863 | 24,924 | 1,617,953 |
| Fla. | 0.996 | 0.979 | 1.0009 | 0.9653 | 22,118 | 1,304,619 | 21,807 | 1,567,579 |
| Ga. | 0.867 | 0.989 | 0.8692 | 0.8456 | 21,130 | 1,168,892 | 21,411 | 1,569,985 |
| Hawaii | 1.016 | 1.061 | 1.4063 | 1.0885 | 22,725 | 1,328,136 | 23,393 | 1,817,048 |
| Idaho | 0.808 | 0.919 | 1.0203 | 0.8415 | 20,273 | 1,104,607 | 20,972 | 1,522,845 |
| Ill. | 1.044 | 0.993 | 0.8868 | 0.8162 | 22,581 | 1,355,647 | 22,292 | 1,592,044 |
| Ind. | 0.871 | 0.890 | 1.1151 | 1.0814 | 20,624 | 1,170,179 | 21,165 | 1,518,318 |
| Iowa | 0.907 | 0.893 | 1.0393 | 1.0564 | 20,931 | 1,208,227 | 21,383 | 1,498,474 |
| Kan. | 0.952 | 0.893 | 1.1203 | 1.3899 | 21,295 | 1,255,677 | 21,478 | 1,493,235 |
| Ky. | 0.806 | 0.938 | 1.0760 | 1.0173 | 20,360 | 1,103,061 | 20,685 | 1,455,114 |
| La. | 0.900 | 0.923 | 1.0310 | 1.6863 | 21,038 | 1,201,734 | 21,212 | 1,489,029 |
| Maine | 0.873 | 1.019 | 1.0009 | 0.9653 | 21,341 | 1,176,107 | 22,549 | 1,750,955 |
| Md. | 1.192 | 1.005 | 1.0036 | 0.8633 | 23,842 | 1,512,060 | 22,964 | 1,585,503 |
| Mass. | 1.271 | 1.250 | 1.1820 | 1.0734 | 25,812 | 1,602,615 | 23,904 | 1,753,836 |

| State | MV PICCS 2.0 Multiplier: Productivity (Market and Household) | MV PICCS 2.0 Multiplier: Medical | MV PICCS 3.0 Multiplier: Productivity (Market and Household) | MV PICCS 3.0 Multiplier: Medical | MV PICCS 2.0 Value of Preventing an Injury | MV PICCS 2.0 Value of Saving a Life | MV PICCS 3.0 Value of Preventing an Injury, in Dollars | MV PICCS 3.0 Value of Saving a Life, in Dollars |
|---|---|---|---|---|---|---|---|---|
| Mich. | 0.909 | 0.937 | 0.9697 | 0.8082 | 21,187 | 1,211,639 | 20,984 | 1,472,385 |
| Minn. | 1.063 | 0.986 | 1.0179 | 1.0581 | 22,697 | 1,375,474 | 22,540 | 1,642,641 |
| Miss. | 0.747 | 0.978 | 0.9659 | 0.8617 | 20,101 | 1,042,033 | 20,631 | 1,482,759 |
| Mo. | 0.891 | 0.936 | 0.9507 | 0.9390 | 21,036 | 1,192,629 | 21,379 | 1,521,415 |
| Mont. | 0.841 | 0.969 | 0.9466 | 0.9688 | 20,811 | 1,140,884 | 21,792 | 1,647,731 |
| Neb. | 0.945 | 0.906 | 0.9202 | 0.8146 | 21,309 | 1,248,681 | 21,295 | 1,449,998 |
| Nev. | 1.048 | 1.038 | 0.9441 | 0.9072 | 22,858 | 1,361,197 | 22,312 | 1,659,076 |
| N.H. | 1.075 | 1.205 | 1.1350 | 0.9389 | 23,984 | 1,394,612 | 23,149 | 1,746,076 |
| N.J. | 1.274 | 1.043 | 1.0115 | 1.2337 | 24,711 | 1,599,650 | 23,589 | 1,675,891 |
| N.M. | 0.815 | 0.963 | 1.1340 | 1.2743 | 20,568 | 1,113,291 | 21,328 | 1,569,591 |
| N.Y. | 1.227 | 1.070 | 0.9323 | 0.8694 | 24,478 | 1,550,890 | 24,247 | 1,892,353 |
| N.C. | 0.871 | 1.004 | 1.0548 | 1.0617 | 21,244 | 1,173,554 | 21,718 | 1,621,711 |
| N.D. | 0.902 | 0.926 | 0.9408 | 0.7692 | 21,070 | 1,203,932 | 21,912 | 1,551,432 |
| Ohio | 0.903 | 0.947 | 0.9677 | 0.9115 | 21,192 | 1,205,608 | 21,218 | 1,495,665 |
| Okla. | 0.885 | 0.947 | 1.0603 | 0.8688 | 21,047 | 1,186,628 | 21,283 | 1,509,638 |
| Ore. | 0.901 | 1.043 | 0.9150 | 0.9730 | 21,698 | 1,206,342 | 22,577 | 1,780,744 |
| Pa. | 1.005 | 0.974 | 1.0675 | 0.9857 | 22,163 | 1,313,961 | 21,770 | 1,519,802 |
| R.I. | 1.022 | 1.114 | 1.1300 | 1.0944 | 23,061 | 1,336,032 | 22,883 | 1,729,045 |
| S.C. | 0.803 | 1.000 | 1.0770 | 1.2855 | 20,673 | 1,101,733 | 21,155 | 1,558,656 |
| S.D. | 0.878 | 0.932 | 1.0035 | 0.8430 | 20,909 | 1,178,803 | 21,830 | 1,591,142 |
| Tenn. | 0.862 | 0.912 | 1.2358 | 1.1998 | 20,671 | 1,161,340 | 20,933 | 1,460,075 |
| Texas | 0.963 | 0.950 | 1.0412 | 0.8803 | 21,693 | 1,268,964 | 21,432 | 1,514,964 |
| Utah | 0.808 | 0.918 | 0.9887 | 1.0100 | 20,267 | 1,104,578 | 20,693 | 1,479,173 |
| Vt. | 0.950 | 1.008 | 0.9490 | 0.9011 | 21,904 | 1,256,973 | 22,307 | 1,659,737 |

| State | MV PICCS 2.0 Multiplier: Productivity (Market and Household) | MV PICCS 2.0 Multiplier: Medical | MV PICCS 3.0 Multiplier: Productivity (Market and Household) | MV PICCS 3.0 Multiplier: Medical | MV PICCS 2.0 Value of Preventing an Injury | MV PICCS 2.0 Value of Saving a Life | MV PICCS 3.0 Value of Preventing an Injury, in Dollars | MV PICCS 3.0 Value of Saving a Life, in Dollars |
|---|---|---|---|---|---|---|---|---|
| Va. | 1.071 | 0.935 | 0.9592 | 0.9011 | 22,484 | 1,382,400 | 22,438 | 1,569,279 |
| Wash. | 1.047 | 1.149 | 1.1570 | 0.9113 | 23,454 | 1,363,429 | 23,329 | 1,809,018 |
| W.Va. | 0.765 | 0.915 | 0.9656 | 1.0112 | 19,904 | 1,059,148 | 20,872 | 1,488,239 |
| Wis. | 0.934 | 1.030 | 1.1180 | 1.0477 | 21,894 | 1,240,754 | 22,049 | 1,640,972 |
| Wyo. | 1.120 | 0.954 | 0.9958 | 0.8125 | 22,984 | 1,434,630 | 22,468 | 1,535,349 |

SOURCE: Productivity and medical adjustment factors, CDC, 2014, § 4.4. Others, calculations by the authors.

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