Modeling the Injury Prevention Impact of Mandatory Alcohol Ignition Interlock Installation in All New US Vehicles

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Objectives. We estimated the injury prevention impact and cost savings associated with alcohol interlock installation in all new US vehicles.

Methods. We identified fatal and nonfatal injuries associated with drinking driver vehicle crashes from the Fatality Analysis Reporting System and National Automotive Sampling System's General Estimates System data sets (2006–2010). We derived the estimated impact of universal interlock installation using an estimate of the proportion of alcohol-related crashes that were preventable in vehicles < 1 year-old. We repeated this analysis for each subsequent year, assuming a 15-year implementation. We applied existing crash-induced injury cost metrics to approximate economic savings, and we used a sensitivity analysis to examine results with varying device effectiveness.

Results. Over 15 years, 85% of crash fatalities (> 59 000) and 84% to 88% of nonfatal injuries (> 1.25 million) attributed to drinking drivers would be prevented, saving an estimated $342 billion in injury-related costs, with the greatest injury and cost benefit realized among recently legal drinking drivers. Cost savings outweighed installation costs after 3 years, with the policy remaining cost effective provided device effectiveness remained above approximately 25%.

Conclusions. Alcohol interlock installation in all new vehicles is likely a cost-effective primary prevention policy that will substantially reduce alcohol-involved crash fatalities and injuries, especially among young vulnerable drivers. (*Am J Public Health.* 2015;105:1028–1035. doi:10.2105/AJPH.2014.302445)

Despite significant reductions in the 1980s, alcohol-involved motor vehicle crashes (AI-MVCs) remain a significant public health problem.[1–3] Since 1994, even as overall fatalities from crashes have declined, AI-MVC fatalities, as a proportion of all traffic fatalities, have remained higher than 30%.[1–3] In 2011, 9878 fatalities resulted from a crash with at least 1 intoxicated driver (blood alcohol content [BAC] ≥ 0.08 g/dL).[4] AI-MVCs are also a significant economic burden to communities, with societal costs estimated to be as high as $59 billion annually, which is 21% of the total annual economic cost ($277 billion) associated with MVC-related injury.[5]

Previous success reducing fatal and nonfatal injuries resulting from drink driving is largely attributable to successful enforcement of alcohol availability and alcohol-related driving laws (e.g., license suspension, minimum legal drinking age laws, 0.08 grams per deciliter BAC limits, zero tolerance laws, sobriety checkpoints), as well as the general deterrence effect conferred by impaired driving penalties.[6–9] However, these laws are difficult to enforce because they rely on police identification of impaired drivers.[3] As a result, alcohol-impaired driving arrests are rare, with estimates that an impaired driver drives an average of 80 times before being stopped for driving while intoxicated (DWI).[1,2] Even license suspension, which has previously provided the strongest evidence for reducing DWI recidivism, with reductions of impaired driver fatal crash risk by as much as 50%,[10–12] has limited impact. Previous studies have indicated that as many as 50% to 75% of offenders continue to operate a vehicle despite license suspension.[13–15] Furthermore, half of convicted DWI drivers continue to drive without a license even after they are eligible for reinstatement, citing successful evasion of police during their license suspension period.[16,17]

Difficulty detecting impaired drivers has led to the development of in-vehicle technological solutions that can prevent alcohol-impaired driving, including such devices as alcohol ignition interlocks.[1] Current interlock devices are designed as an alcohol breath-testing unit connected to the ignition switch of the vehicle that prevents driving if the driver's breath contains more than a predetermined limit of alcohol (typically BAC > 0.02 g/dL).[18–20] They are used in all 50 states for multiple DWI offenders, either as a Department of Motor Vehicles mandated condition of license reinstatement or as a component of DWI judicial sentencing. Interlocks are highly effective while installed on the vehicle, with a systematic review finding a 67% median reduction in DWI recidivism.[20–24] Limited evidence is available examining their associated impact on MVCs, but recent studies suggest that AI-MVCs may also decrease while interlocks are installed.[25–27]

Despite the clear public health benefit and existence of the technology for several decades, widespread interlock use is limited. In 2013, only 300 000 interlock devices were actively in use throughout the United States, representing less than a quarter of DWI offenders.[28] Limited usage is thought to result from low DWI conviction rates, state policies restricting interlocks to repeat DWI offenders, and a preference among offenders to have their license suspended rather than install devices that prevent impaired driving.[20] The weaknesses in the current enforcement model, combined with technological improvements in interlock devices, has generated interest in interlock use as a primary prevention tool. In 2008, the National Highway Traffic Safety Administration (NHTSA) launched the Driver Alcohol Detection System for Safety (DADSS) program, a 5-year collaborative industry and government program to explore the feasibility, benefits, and public policy challenges associated with widespread use of in-vehicle alcohol detection technologies. Application of alcohol interlocks to all new vehicles is one primary prevention strategy under discussion.

Literature examining interlock use as a primary prevention tool is limited. Bjerre et al[26] studied the installation of 300 interlocks in commercial vehicles (buses, taxis, trucks) in Sweden, finding that they prevented 3.4 drunk driving trips (BAC > 0.02 g/dL) for every 1000 potential car trips.[26] Lahausse and Fildes[29] modeled the injury prevention benefit associated with alcohol interlock installation in all newly registered Australian vehicles; they found that interlocks would prevent up to 24% of all fatalities and 11% of serious injuries annually. This study, however, was limited by the inability to analyze comprehensive Australian crash data, necessitating extrapolation of fatality data from a single Australian state, as well as the use of an estimated fatal-to-nonfatal injury ratio for the derivation of serious injury estimates. Furthermore, although these studies demonstrated the potential injury prevention impact of interlocks, no previous studies have analyzed fatal and nonfatal crash data to examine the primary prevention impact within the United States.

Our objectives for the present study were (1) to estimate the potential impact on fatalities and nonfatal injuries of alcohol interlock installation in all new vehicles, and (2) to estimate the potential decrease in economic costs associated with injury prevention by a universal alcohol-ignition interlock policy. Such data have the potential to provide a better understanding of how the mandatory installation of alcohol interlocks in new vehicles, as proposed within the DADSS program, might contribute to reducing AI-MVC fatalities and nonfatal injuries.

METHODS

AI-MVC fatalities and nonfatal injuries were identified for this analysis using data from the Fatality Analysis Reporting System (FARS) and National Automotive Sampling System's General Estimates System (NASS-GES). FARS is a nationwide census sponsored by the Department of Transportation that contains data on all fatal US traffic accidents that occur on public roadways that result in 1 or more motorist or nonmotorist death within 30 days.[30] By contrast, the NASS-GES data set is a nationally representative sample (50 000 cases/year from approximately 400 police jurisdictions in 60 areas of the United States) of police-reported MVCs involving at least 1 motor vehicle traveling on a public roadway that results in death, injury, or property damage.[31] The NASS-GES data set is weighted to provide a nationwide sample of all fatal and nonfatal MVCs. For our analysis, we characterized NASS-GES and FARS injuries using KABCO, which is an on-scene police officer reported injury severity scale (K: fatal injury, A: incapacitating injury, B: non-incapacitating injury, C: possible injury, O: uninjured).[32,33] Although there is minor variation in definitions at the state level, "A" class injuries are disabling injuries, where the victim cannot leave the scene without assistance (e.g., unconscious, obvious fractures, large open wounds). "B" class injuries are visible, but not disabling (e.g., lacerations, limping, abrasions), and "C" class injuries are minor without any visible external trauma (e.g., pain, momentary loss of consciousness).[32,33]

Inclusion and Exclusion Criteria

We identified all fatal and nonfatal crashes involving 1 or more drinking drivers in FARS and a nationally weighted sample of NASS-GES for 2006–2010, respectively. For NASS-GES, drinking drivers were identified by a positive BAC value (> 0.02 g/dL). Imputed values were used for missing variables in NASS-GES, including alcohol data (i.e., BAC).[31,34,35] Because imputed values were not available for FARS, we identified drinking drivers in FARS by either a positive BAC or as determined by police investigation of the crash event. Fatalities (FARS) and nonfatal injuries (A, B, C codes in NASS-GES) were associated with drinking driver(s). If multiple drinking drivers were involved, the fatalities or occupant injuries were distributed proportionally. We included all nonbus passenger vehicle and light truck vehicle-related crashes that resulted in a fatality or nonfatal injury in the final data set. We excluded motorcycle riders, heavy truck drivers, bus occupants, and nonmotorists unless their death or injury was the result of a drinking driver.

The resulting data set combined all FARS-identified fatalities and NASS-GES–identified nonfatal injuries (A, B, C codes) attributable to alcohol-involved passenger and light truck MVCs. We then adjusted injury and fatality data for MVCs that would have occurred if all drinking driver BACs were reduced to 0.02 grams per deciliter by using a previously published fatality correction factor of 0.90.[3] The corrected data set provided an estimate of preventable fatal and nonfatal injuries attributable to drinking drivers.

Estimating the Impact of Mandatory Alcohol Interlock Devices

We estimated the numbers of deaths and injuries prevented in the first year of a mandatory alcohol interlock policy as those preventable deaths and nonfatal injuries associated with drivers of vehicles less than 1 year old. In each subsequent year, the number of preventable deaths and non-fatal injuries was the cumulative sum of prevented deaths and injuries from previous years and those in that vehicle age year. We used a 15-year fleet implementation period for new vehicle technologies for this analysis based on previous DADSS estimates.[36] For the injury analysis, we assumed that interlock devices worked perfectly 100% of the time. Confidence intervals on nonfatal injury data from NASS-GES were estimated using the Taylor series method, accounting for the clustering and stratification in the GES sample design.

We applied National Safety Council cost estimates of unintentional MVC injury to preventable AI-MVC fatalities and nonfatal injuries to estimate cost savings.[32] These estimates are based on a measure of the dollars spent and income not received because of MVCs, including wage or productivity losses, medical expenses, administrative expenses (public or private insurance, police, and legal costs), motor vehicle damage, employers' uninsured costs, and lost quality of life. The comprehensive cost scale, which we used for cost–benefit analysis, is stratified using the KABCO injury scale. The average comprehensive costs for MVC fatalities and injuries used in our analysis were $4.36 million per fatality, $220 300 per incapacitating injury, $56 200 per nonincapacitating injury, and $26 700 per possible injury. We derived the benefit per equipped vehicle using the estimated cost savings associated with any given policy year divided by the estimated number of new vehicles (15 million/year). This was plotted against the number of years since policy

TABLE 1—Estimated Annual Number of Preventable Deaths and Injuries Due to Alcohol-Involved Motor Vehicle Crashes by Drinking Driver Age Group: United States

Drinking Driver Age Group, Years	Fatalities[a]	Incapacitating Injury, No. (95% CI)	Non-Incapacitating Injury, No. (95% CI)	Minor Injury, No. (95% CI)	Total Fatalities and Injuries
≤ 20	1 070	4 386 (2 937, 5 835)	8 956 (7 485, 10 427)	13 328 (11 197, 15 458)	27 740
21-24	1 588	5 484 (3 275, 7 692)	11 855 (9 562, 14 148)	14 210 (11 868, 16 552)	33 137
25-29	1 378	4 723 (3 085, 6 360)	10 313 (8 474, 12 152)	13 415 (11 445, 15 386)	29 829
30-44	2 493	7 897 (5 540, 10 252)	18 353 (15 319, 21 388)	23 846 (20 736, 26 956)	52 589
45-54	1 129	3 653 (2 260, 5 046)	8 089 (6 941, 9 238)	11 614 (9 536, 13 691)	24 485
55-64	502	1 139 (532, 1 746)	2 877 (2 476, 3 278)	3 829 (3 151, 4 506)	8 347
65-74	176	332 (204, 460)	830 (547, 1112)	979 (627, 1330)	2 317
> 74	101	306 (137, 475)	575 (369, 780)	787 (413, 1159)	1 769
Total	8 437	27 920	61 848	82 008	180 213

Note. CI = confidence interval.
[a]Fatality Analysis Reporting System data.

implementation to determine the number of years until the benefit per vehicle exceeded the device cost per vehicle (i.e., break-even point). Device cost was estimated at $400 based on previous literature estimates.[18,29] We tested the benefit per equipped vehicle curve at varying levels of interlock efficacy, using the assumption that if an interlock device worked 95% of the time, it would succeed in preventing 95% of preventable AI-MVCs.

RESULTS

A total of 46 871 fatalities involving 1 or more drinking drivers were identified from the FARS database for 2006–2010. A total of 22 979 drinking drivers associated with alcohol-involved crashes that resulted in nonfatal Injures (A, B, C codes) were identified in the NASS-GES data set (2006–2010). After adjusting to create a nationally weighted sample, this corresponded to 1 934 013 drinking drivers associated with nonfatal injuries.

Preventable Alcohol-Involved Crash Fatalities and Non-fatal Injuries

Table 1 displays the estimated annual preventable deaths and injuries caused by drinking drivers after adjusting for injury-related crashes that would have occurred regardless of alcohol involvement. Drinking drivers who were underage (<21 years old) or recently legal drinkers (21–29 years old) were responsible for 15% and 35% of the total number of injuries and fatalities, respectively. Among those aged 30 to 44 years, drinking drivers were responsible for 29% of the total fatalities and nonfatal injuries. Drinking drivers older than 45 years were only responsible for 20% of all fatalities or injuries associated with AI-MVCs.

Impact of Mandatory Alcohol Interlock Devices in All New Vehicles

Table 2 displays the cumulative estimates of fatalities and injuries prevented by installation of alcohol interlocks in all new vehicles. Assuming a 15-year implementation period, alcohol interlocks in all new vehicles would prevent more than 59 000 alcohol-related MVC fatalities and more than 1.25 million nonfatal injuries. Table 3 displays the 15-year cumulative prevention of alcohol-involved crash fatalities stratified by age, with the greatest benefit seen among recently legal drinking drivers ages 21 to 29 years, followed by those drivers who traveled the most number of vehicle miles annually[37] (30–44 years old), and then underage drinking drivers

TABLE 2—Cumulative Estimated Fatalities and Injuries Prevented by a Universal Alcohol Interlock Policy: United States

Injury Severity	Years Since Alcohol Interlocks Implemented in All New Vehicles, No. (95% CI)			
	Year 1	Year 5	Year 10	Year 15
Fatality[a]	854	7 397	27 330	59 554
Incapacitating injury	1 832 (1 311, 2 353)	22 241 (18 608, 25 872)	86 903 (75 989, 97 817)	191 035 (171 885, 210 184)
Non-incapacitating injury	4 321 (3 146, 5 495)	54 337 (48 911, 59 762)	204 003 (191 628, 216 377)	440 059 (421 079, 459 038)
Possible injury	7 997 (6 444, 9 549)	82 975 (75 911, 90 039)	291 592 (275 665, 307 518)	615 454 (591 608, 639 302)
Total	15 004	166 950	609 828	1 306 102

Note. CI = confidence interval.
[a]Fatality Analysis Reporting System data.

TABLE 3—Fifteen-Year Estimated Fatalities and Injuries Prevented by Injury Severity and Drinking Driver Age Group: United States

Drinking Driver Age Group, Years	Fatalities,[a] No.	Incapacitating Injury, No. (95% CI)	Non-Incapacitating Injury, No. (95% CI)	Minor Injury, No. (95% CI)	Total Fatalities and Injuries
≤ 20	7 604	29 920 (26 545, 33 296)	64 255 (60 689, 67 820)	93 107 (87 906, 98 308)	194 886
21–24	11 823	41 059 (35 811, 46 307)	87 447 (82 436, 92 459)	116 332 (110 185, 122 480)	256 661
25–29	10 123	32 955 (29 750, 36 160)	76 941 (72 977, 80 906)	104 423 (98 754, 110 093)	224 442
30–44	17 286	52 174 (47 612, 56 736)	124 839 (117 714, 131 963)	175 005 (167 699, 182 311)	369 304
45–54	7 422	22 878 (20 174, 25 582)	54 799 (52 043, 57 556)	82 469 (76 928, 88 010)	167 568
55–64	3 383	7 473 (6 533, 8 411)	20 714 (19 606, 21 822)	29 276 (27 157, 31 395)	60 846
65–74	1 218	2 237 (2 005, 2 470)	6 453 (5 683, 7 224)	8 654 (7 653, 9 656)	18 562
> 74	695	2 340 (1 931, 2 748)	4 611 (4 084, 5 137)	6 188 (5 131, 7 243)	13 834

Note. CI = confidence interval.
[a]Fatality Analysis Reporting System data.

(<21 years old). Taken together, implementation of alcohol interlocks in all new vehicles over a 15-year implementation period would prevent 83% of crash fatalities (Figure 1) and 84% to 88% of nonfatal injuries associated with drinking drivers.

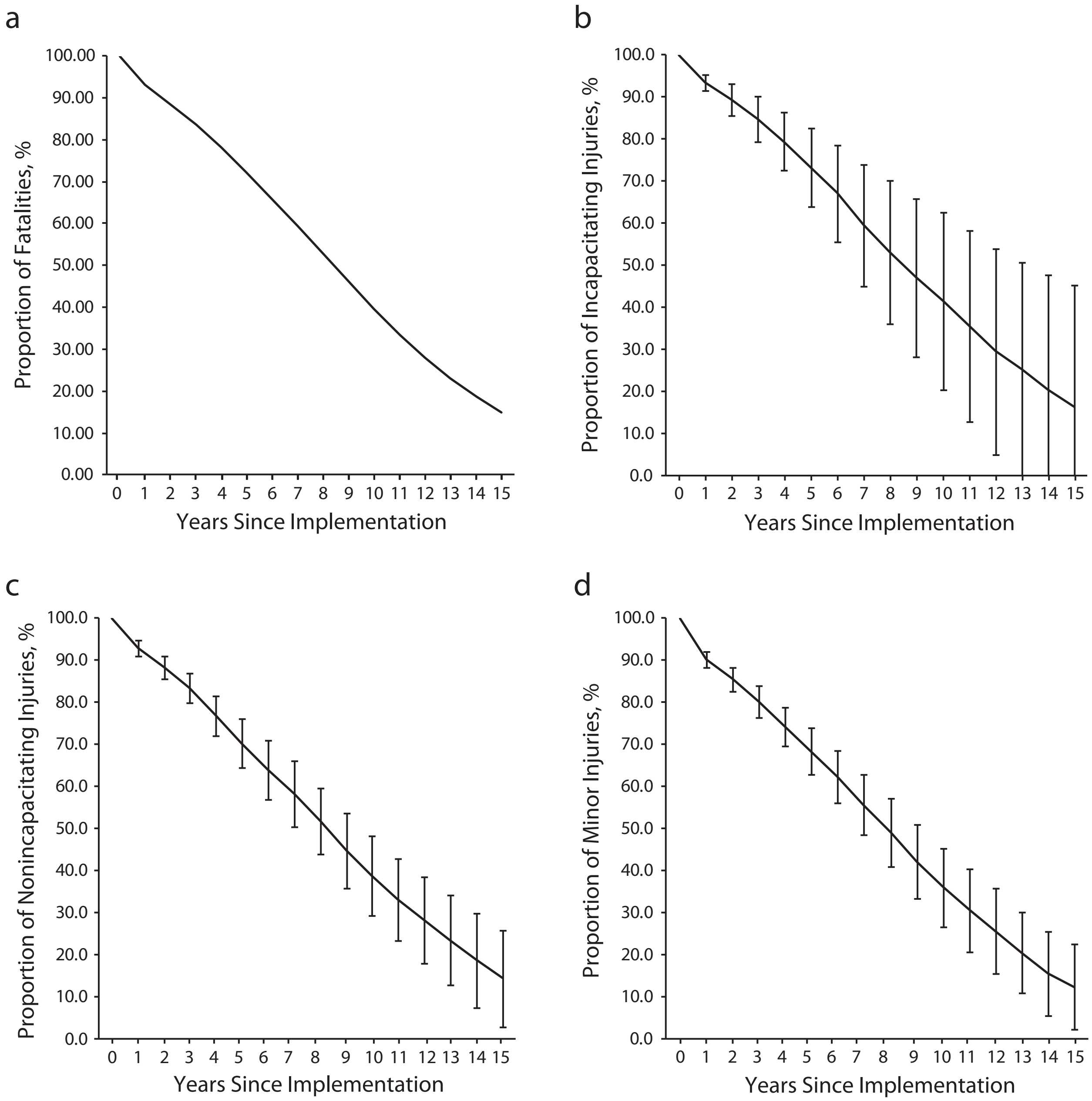
Societal cost savings associated with preventing fatalities and nonfatal injuries through alcohol interlock installation in all new vehicles is presented in Table 4. Over the 15-year implementation, interlocks are estimated to decrease the economic cost of fatal injuries by $260 billion and nonfatal injuries by $83 billion, totaling almost $343 billion in savings. Figure 2 displays the economic benefit per equipped vehicle (i.e., total injury cost savings or number of new vehicles) as a function of the years since interlocks become mandatory in all new vehicles, assuming a range of device efficacy parameters. Assuming the cost of a device is $400/vehicle and the interlocks function correctly 100% of the time, the injury cost benefit outweighs the device per vehicle cost after 3 years. As device effectiveness decays (Table 5), a greater number of years is required to achieve the same level of cost savings; however, universal implementation remains cost effective within the 15-year implementation time period until the effectiveness passes below 25%.

DISCUSSION

Our analysis had important implications with regard to the impact and feasibility of a primary prevention approach to the public health problem of alcohol-impaired driving and associated crash injury. Lund et al.[3] demonstrated that the benefit seen with interlocks was the result of how widely they are used, with a 13-fold decrease in fatalities if applied to all drivers compared with a policy limiting use to multiple DWI offenders. Our analysis was the first to model the full implications of a primary injury prevention policy that mandates interlocks in all new US vehicles using actual police-reported AI-MVC fatalities and nonfatal injuries. Our findings that alcohol interlocks would prevent 83% of alcohol-related crash fatalities and between 84% and 88% of nonfatal alcohol-related crash injuries, and would result in a total of 59 554 lives saved and 1.25 million nonfatal injuries prevented over 15 years demonstrates the strength of a primary prevention approach and achieves far superior results when compared with policies mandating interlocks only with repeat or first time offenders. Within 3 years of implementing mandatory interlocks in all new vehicles, we found an estimated 3200 fatalities would be prevented, which was more than previous literature estimates for either a repeat offender (143 deaths) or first time offender policy (785 deaths).[3] Our findings reinforced the need to expand current interlock programs and consider primary prevention applications.

Furthermore, although the injury prevention benefit was apparent for all ages, it was especially robust among younger drivers. Drivers who recently attained legal drinking status (21–29 years old) received the greatest benefit, with almost 35% of all prevented deaths and injuries. This subgroup has long been considered the most at-risk for potential alcohol-related crash injuries; this group has the highest percentage of drivers in fatal crashes with BAC levels of 0.08 or higher compared with other age groups.[4] In addition, we found a substantial benefit among underage drinking drivers (i.e., <21 years old), which is a subgroup highly vulnerable to alcohol's effects on driving. For underage drinking drivers, the relative risk of being killed in a crash more than doubles for each 0.02 grams per deciliter increase in BAC, and they are more likely to be involved in fatal or nonfatal crashes at similar BAC levels compared with older drivers.[38,39] This is believed to result from less driving experience, higher rates of consumption and driving after consuming alcohol, as well as a general pattern of increased risk taking among binge drinkers at this age.[40,41]

We also projected that interlock installation in all new vehicles would prevent an estimated $343 billion in unintentional injury costs over 15 years. NHTSA previously showed that the installation ($100–$250) and monthly costs for monitoring ($65–90) were cost effective for multiple DWI offenders compared with costs associated with incarceration or electronic monitoring.[18] Using a $400 estimated cost from previous cost effectiveness analyses,[29] we found that the financial benefit realized by preventing injury-related costs outweighed the device costs after 3 years of mandatory interlock installation in all new vehicles. Lahausse and Fildes[29] previously conducted a cost–benefit analysis of installing



Note. Whiskers indicate 95% confidence intervals.
Source. Fatalities were identified for using data from the Fatality Analysis Reporting System.

FIGURE 1—Remaining proportion of fatalities and nonfatal injuries resulting from drinking drivers, by years since implementation of universal alcohol interlocks and by (a) fatalities, (b) incapacitating injuries, (c) nonincapacitating injuries, and (d) minor injuries: United States.

interlocks in all newly registered vehicles in Australia, and found that at optimal effectiveness (approximately 95%), such a primary prevention program would be cost effective. However, they also found that the benefit dissipated as device effectiveness decreased below optimal levels.[29] Similarly, we found that as the optimal effectiveness decreases, the time to recoup the program costs lengthened, with more than 15 years required as device effectiveness diminished to less than 25%. Taken together, this suggests that the introduction of a mandatory US interlock program would be cost effective, but that the technology needs to be optimized before installation in all new vehicles and might require regular evaluations to ensure the devices are kept at peak effectiveness levels.

TABLE 4—Cumulative Estimate of Cost Savings Associated With Injury Prevention by Universal Alcohol Interlock Installation on All New Vehicles Assuming 100% Alcohol Interlock Device Effectiveness: United States

	Years Since Alcohol Interlocks Implemented in All New Vehicles, USD 100 000 (95% CI)			
Injury Severity	1	5	10	15
Fatality[a]	3 723	32 251	119 159	259 655
Incapacitating injury	404 (289, 518)	4 900 (4 099, 5 700)	19 145 (16 740, 21 549)	42 085 (37 866, 46 304)
Non-incapacitating injury	243 (177, 309)	3 054 (2 749, 3 359)	11 465 (10 769, 12 160)	24 731 (23 665, 25 798)
Possible injury	214 (172, 255)	2 215 (2 027, 2 404)	7 786 (7 360, 8 211)	16 433 (15 796, 17 069)
Total estimated societal cost savings	4 583	42 420	157 554	342 904

Note. CI = confidence interval. 2010 National Safety Council cost estimates for unintentional injury. Numbers may not add up to reported totals exactly because of rounding.
[a]Fatality Analysis Reporting System data.

Several barriers to the wider implementation of a universal alcohol interlock program have been previously identified. First, current devices are not technologically advanced enough for placement in all new vehicles, primarily due to slow reading times, the need for frequent calibrations, and mouthpiece care requirements.[1,36] However, newer technology exists or is under development as part of the DADSS program to create interlock devices that are passive and unobtrusive for the driver. This includes a variety of technologies to passively sample a driver's breath or sweat to determine BAC and specialized infrared sensors to detect BAC through contact with the vehicle ignition switch, steering wheel, or gearshift. Public acceptability has also been identified as a potential barrier; however, a recent telephone survey of US adults found that 75% of respondents recognized alcohol-impaired driving as a problem in their communities, 84% supported interlocks for convicted DWI offenders, and 64% reported that advanced alcohol detection devices in all vehicles was a good or very good idea.[42] Although support was highest among those who did not drink, mandatory interlocks were also supported by a majority of respondents who reported drinking, drinking within 2 hours of alcohol consumption, as well as among those respondents who had previously reported driving above the legal limit. In addition, 42% of respondents reported that they would want the device in their next vehicle if available at a reasonable cost (<$500). Taken together, emerging technological advances and greater public awareness of interlock devices are likely to aid in overcoming barriers to their inclusion in all new vehicles.

TABLE 5—Fifteen-Year Cumulative Estimates of Fatalities, Nonfatal Injuries, Cost Savings, and Economic Benefit per Vehicle Equipped at Varying Degrees of Alcohol Interlock Effectiveness: United States

Effectiveness Level, %	15-Year Fatalities,[a] No.	15-Year Nonfatal Injuries, No.	Estimated 15-y Cost Savings,[b] USD 100 000	Economic Benefit per Equipped Vehicle, $
100	59 554	1 246 548	342 903	1 524
75	44 665	934 911	257 177	1 143
50	29 777	623 274	171 451	762
25	14 888	311 637	85 726	381

[a]Fatality Analysis Reporting System data.
[b]2010 National Safety Council Cost Estimates for Unintentional Injury.

Although universal alcohol interlock installation is likely several years away, there are clear opportunities for short-term expansion of current programs. First, previous studies have demonstrated that use of interlocks among first-time DWI offenders has both strong public support[42,43] and the potential for a 5-fold decrease in preventable AI-MVC deaths.[3] In addition, previous evidence of low DWI conviction rates, low Department of Motor Vehicles program participation by offenders with suspended licenses, and the finding that deterrence only lasts for the duration of the device installation[20,21,23] suggests that current programs should be expanded to utilize interlocks during the preconviction period as a mandatory aspect of DWI sentencing, as well as for longer periods of time. Second, although we did not include it in our analysis, the success of the Swedish primary prevention program suggested an opportunity for a trial program of interlock devices applied to US public fleet vehicles (e.g., buses, taxis, trucks). In addition to increasing public awareness, this would serve as an ideal opportunity to test new technologies as they become available. Finally, our study suggested that 7604 fatalities and 187 282 nonfatal injuries could be prevented if interlocks were mandatory for underage drinkers (<21 years old). As all US states have "zero tolerance" laws that prohibit underage drink driving, requiring alcohol interlocks as a mandatory condition of graduated driver licensing laws may provide an additional opportunity for injury prevention among this high-risk population. Although requiring further study, this application might establish a behavioral pattern that driving after drinking is unacceptable and could translate into later driving habits. Additional government support with legislation providing a tax credit or insurance discount might also aid in wider public acceptance as a safety option for purchased vehicles.

Limitations

Although our analysis utilized the best available data, several assumptions limit the results. First, because universal alcohol ignition interlocks are still under development, the effectiveness of the device is not known. The Australian study suggested that limited effectiveness substantially altered the injury benefit expected, and as our cost analysis

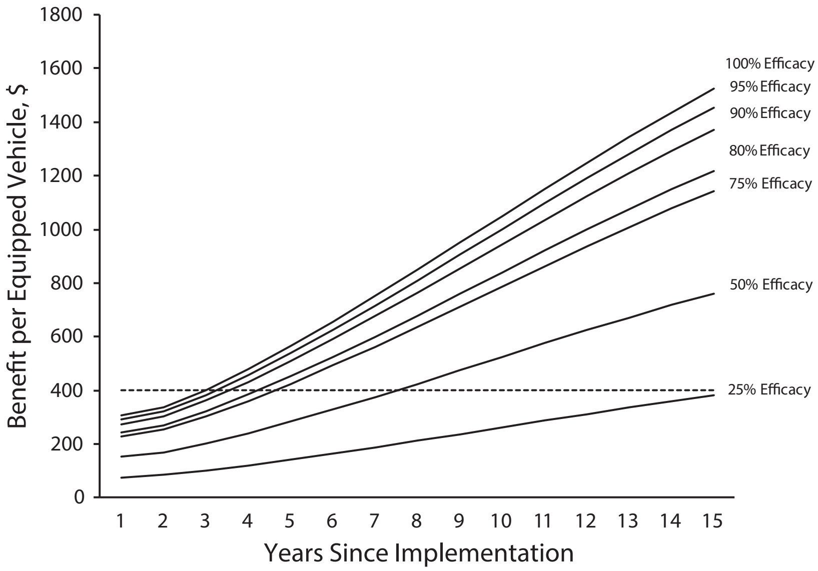


FIGURE 2—Economic benefit per equipped vehicle (cumulative cost savings per vehicles sold with alcohol ignition interlock devices) as interlocks introduced in all new vehicles: United States.

demonstrated, lower levels of effectiveness significantly limited the success of a universal program. Future studies that consider interlock performance data from the DADSS program might provide more accurate device estimates. Our analysis also assumed that the baseline crash population would not change substantially over time and did not account for potential future improvements in vehicle technology that would make vehicles safer or decreases in drink driving that would occur regardless of an interlock policy. The cost analysis also assumed a flat number of vehicle sales (i.e., 15 million/year), which potentially underestimates the cost estimate if the number of vehicles sold is higher without gaining any additional reduction in AI-MVCs. In addition, we corrected for crashes that would have occurred, regardless of alcohol use, by using a previously published correction factor.[3] The application of this correction to NASS-GES injury data was likely less accurate for moderate and minor injuries (B/C codes). The use of KABCO also has been previously shown to have limitations,[44] especially for differentiating among nonfatal injury types. These results should be interpreted cautiously, but KABCO remains the best available injury scale for a nationwide analysis of AI-MVC injuries. Cost metric data were obtained from national safety council estimates, but these estimates do not account for differences in the ages of those injured. Younger drivers likely have higher long-term care costs than older drivers, and this factor would increase the benefit-to-cost ratio for mandatory use among younger drivers.

Conclusions

In conclusion, alcohol-impaired driving is a major contributor to MVC injuries, and we have demonstrated the potential for substantial reductions in alcohol-related traffic fatalities and nonfatal injuries with the widespread application of in-vehicle technologies that prevent drinking drivers from starting the vehicle. We have also shown that the device would be cost effective, with the cost savings associated with the prevention of significant unintentional injury-related costs outweighing the individual device installation costs after three years. Future studies should continue to evaluate the effectiveness of these devices as a primary injury prevention tool and understand how best to deploy interlocks to prevent impaired driving. Regardless, the development of newer, unobtrusive, in-vehicle technologies that serve as a primary prevention measure might represent an important element to further reducing alcohol-related crashes and injuries. ■

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Contributors

P. M. Carter had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. P. M. Carter was also responsible for data acquisition, analysis, interpretation, and drafting of the article, including both the initial draft and subsequent revisions. J. D. Rupp and C. A. C. Flannagan were responsible for the study concept, design, data analysis, and critical revisions of the article. R. M. Cunningham and C. R. Bingham were responsible for assistance with drafting of the article and critical revisions to article drafts.

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Human Participant Protection

No protocol or institutional review board approval was needed for this study because all data were de-identified and collected anonymously from public health surveillance systems.

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