State alcohol ignition interlock laws and fatal crashes

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ABSTRACT

Background: Alcohol-impaired driving results in thousands of deaths annually. Alcohol ignition interlocks require a negative breath test to start a vehicle's engine, and 45 states have mandated some form of interlock law for drivers convicted of driving while intoxicated (DWI).

Methods: Differences in three interlock laws were evaluated by comparing alcohol-impaired passenger vehicle drivers involved in fatal crashes between 2001–2014 in the United States across state and time. State/time differences unrelated to interlock laws were controlled for by fitting a Poisson model. The exposure measure was the number of passenger vehicle drivers in fatal crashes that did not involve impaired drivers. Laws requiring interlocks for drivers convicted of DWI covered: repeat offenders, repeat offenders and high-BAC offenders, all offenders, or none.

Results: The number of states with all-offender interlock laws during the study period went from three in 2001 to 22 in 2014, and the number of states with any of the three laws increased from 19 to 45. All-offender laws were associated with 16% fewer drivers with 0.08+ BAC involved in fatal crashes, compared to no law. Repeat-offender laws were associated with a nonsignificant 3% reduction in impaired drivers, compared to no law. Repeat and high-BAC laws were associated with an 8% reduction in impaired drivers in fatal crashes, compared to no law.

Conclusion: Laws mandating alcohol ignition interlocks, especially those covering all offenders, are an effective impaired driving countermeasure that reduces the number of impaired drivers in fatal crashes.

Key Words: alcohol ignition interlock laws; Fatality Analysis Reporting System (FARS); impaired driving

Introduction

In 2016, 10,497 people died in crashes involving drivers with blood alcohol concentration (BAC) 0.08+ g/dL in the United States (National Highway Traffic Safety Administration [NHTSA], 2017), and such crashes cost society an estimated $125 billion in 2010 alone (Zaloshnja, Miller, & Blincoe, 2013). Between 1982 and 1997, substantial progress was made to reduce crash deaths involving alcohol-impaired drivers (Fell & Voas, 2006). However, since then progress has largely stalled (Dang, 2008; Fell, Tippetts, & Voas, 2009). U.S. state laws adopted over the past 100 years to control and reduce alcohol-impaired driving vary considerably between states (NHTSA, 2016). These laws form the legal structure that enables law enforcement to stop drivers on public roads and arrest them for driving while intoxicated (DWI), with probable cause.

In the late 1990s, states began enacting laws that required alcohol ignition interlock devices to be installed on the vehicles of certain offenders convicted of DWI, as an alternative or adjunct to the traditional license suspension system. When installed on a vehicle, the interlock controls impaired driving by preventing the engine from starting unless the driver blows into a sensor with a breath-estimated BAC less than a set level, usually 0.02–0.04 g/dL depending on state requirements. Currently, all states and the District of Columbia (DC) have legislation allowing or requiring the use of interlocks as a sanction for a DWI offense. Research has shown that interlocks reduce DWI recidivism by 64% while fitted on the DWI offender's vehicle (Willis, Lybrand, & Bellamy, 2004; Elder et al., 2011), and so state laws requiring their installation are expected to be more beneficial than those laws simply allowing for it. Currently, laws that require interlocks target three types of DWI offenders: repeat offenders, those with high BAC (0.15+ g/dL), and first-time offenders. First-time offender laws have generally appeared only in conjunction with repeat offender laws, so these effectively cover all offenders and are referred to as such.

Two important aspects of interlocks and their laws are their potential as a specific deterrent and general deterrent. Specific deterrence refers to drivers' experiences with interlocks affecting their future impaired driving behavior, whereas general deterrence refers to drivers' future behavior changes in response to knowledge about (without actually experiencing) interlocks as a DWI sanction. With the

exception of one study (Rauch, Ahlin, Zador, Howard, & Duncan, 2011), research has found that recidivism increases after the interlock is removed (Elliott &Morse, 1993; Weinrath, 1997; Beck, Rauch, Baker, & Williams, 1999; Bjerre, 2003) and interlock installation rates tend to be low (McCartt, Leaf, & Farmer, 2018; Elder et al., 2011; U.S. Government Accountability Office, 2014). This limited evidence of specific deterrence and the rarity with which interlock sanctions are applied indicate that general deterrence would be the primary mechanism by which interlock laws could affect impaired driving crashes. Moreover, the risk of impaired drivers being arrested for DWI in the first place is low, ranging from 1 in 1,000 (Zaloshnja et al., 2013) to about 1 in 50 (Hedlund & McCartt, 2002; Zador, Krawchuck, & Moore, 2001; Dowling, MacDonald, & Carpenter, 2011; Quinlan et al., 2005; Bergen, Shults, & Rudd, 2011). Additionally, it has been estimated that for every arrest, an impaired driver with an illegal BAC makes 1,016 trips that go undetected (Beitel, Sharp, & Glauz, 2000), further highlighting the importance of general deterrence.

Evaluations of the interlock laws in the U.S. have largely been limited to single-state studies measuring effects on DWI recidivism rather than on crashes. Research has indicated that drivers experience lower recidivism rates while interlock devices are on their vehicles than offenders whose license has been suspended (Elliott & Morse, 1993; Weinrath, 1997; EMT Group, 1990; Beck et al., 1999), and first offenders experience lower 2-year recidivism rates (McCartt et al., 2018). However, some studies have investigated how interlock laws affected crash rates. McCartt, Leaf, Farmer, and Eichelberger (2013) found that after Washington state's interlock law included all offenders, single-vehicle nighttime crashes (a surrogate for impaired driving crashes) reported to police declined 8% per population. A national study found that states with all-offender interlock laws had 15% fewer alcohol-involved crash deaths than states with less stringent interlock laws (Kaufman & Wiebe, 2016). McGinty et al. (2016) found a 7% decline in fatal crashes involving at least one driver with 0.08+ g/dL BAC per licensed driver, and an 8% decline when looking at 0.15+ g/dL impairment. Though informative, a limitation of these studies is that they did not use adequate comparison groups, which means their

exposure measures did not account for things like economic changes, amount of driving, or changes in vehicle crashworthiness – all of which varied during the study periods.

The objective of the current study is to estimate the effect of interlock laws on fatal impaired-driving crashes while using a comparable comparison group, which would help to account for these potential additional influences.

Methods

State interlock laws were coded from a systematic review of state legal codes. The current study examined years between 2001 and 2014. The onset of 2001 was selected as the start date because the actual codified text of the laws became clearer to interpret at that time. The end date of 2014 was selected because at the time of the current study, it was the most recent year for which all data required for the study was available. Portions of the interlock law in California varied from county to county. As a result, California was excluded from this study. For this analysis, states' interlock laws were coded as interlocks required for no specific class of offender (referred to as none or no law), repeat offenders, repeat offenders and high-BAC offenders, or all offenders. These categories represented all combinations of interlock laws that existed during the study period.

The primary unit of analysis for this study was the state-quarter. Data on passenger vehicle drivers involved in fatal crashes during 2001–2014 were extracted from the Fatality Analysis Reporting System (FARS), a census of fatal crashes in the United States. Quarterly counts of impaired drivers at three levels (BAC 0.01+, 0.08+, and 0.15+ g/dL) were calculated using the multiple imputation results for missing BAC values provided in FARS (Subramanian, 2002). These formed the outcome measures of the study.

Covariates included interlock laws, per se laws (which make it a crime to drive at or above a certain BAC, 0.08 or 0.10 g/dL), state, quarter, unemployment rate (obtained from the U.S. Bureau of Labor Statistics), and counts of passenger vehicle drivers involved in fatal crashes that did not involve any impaired drivers. Laws were coded as "0" if they were absent for all or part of a quarter, and "1" if they were present for the duration of the quarter. The count of passenger vehicle drivers in crashes not

involving any impaired drivers, henceforth referred to as drivers in unimpaired fatal crashes, was taken as a stricter measure than counts of unimpaired drivers, to minimize influence from interlock laws if they affect the number of impaired drivers – who may collide with unimpaired drivers. Drivers in unimpaired crashes are affected by many of the same factors as impaired drivers are: exposure (e.g. vehicle miles traveled, population), improvements in passenger vehicle crashworthiness and crash avoidance technology, changes to speed limits, etc.; so this controls for unobserved exposures. Each of the covariates in the current study clearly may be associated with the number of impaired drivers in fatal crashes, and all except interlock and per se laws likely are also associated with the number of drivers in unimpaired fatal crashes. Interaction terms were included between drivers in unimpaired fatal crashes and state, quarter, and unemployment rate to allow for these relationships.

The number of impaired passenger vehicle drivers in fatal crashes was modeled against the covariates/interactions using Poisson regression with a log link and an estimated scale parameter to allow for overdispersion. Exponentiating parameter estimates allowed for a straightforward interpretation as percent change in number of impaired drivers for a one-unit increase in the covariate (e.g. law vs. no law, one percentage point increase in unemployment rate, etc.). Effects of interlock laws, adjusted for other covariates, were provided. Some discussion of the other covariates was provided in place of listing all the parameter estimates. Statistical significance of interlock law effects was determined from the Wald chi-squared tests provided in SAS GENMOD Procedure output. One model was run for each level of impairment.

General deterrence was measured by examining the effects on the population of passenger vehicle drivers in FARS that did not have prior (within 3 years of the crash) DWI convictions. These drivers were unlikely to have experienced interlock interventions first-hand, and form the vast majority of the total study sample. Specific deterrence is impossible to measure in FARS, but drivers with prior DWI convictions were taken as a surrogate, since that sample would contain drivers who experienced interlocks as a DWI sanction. The sample includes drivers who were convicted of DWI but did not receive interlocks as well, so it was not interpreted as a direct measure of specific deterrence. Both

impaired and unimpaired drivers in fatal crashes were restricted to either those with prior DWI or those without prior DWI convictions. This resulted in six models being fitted.

Results

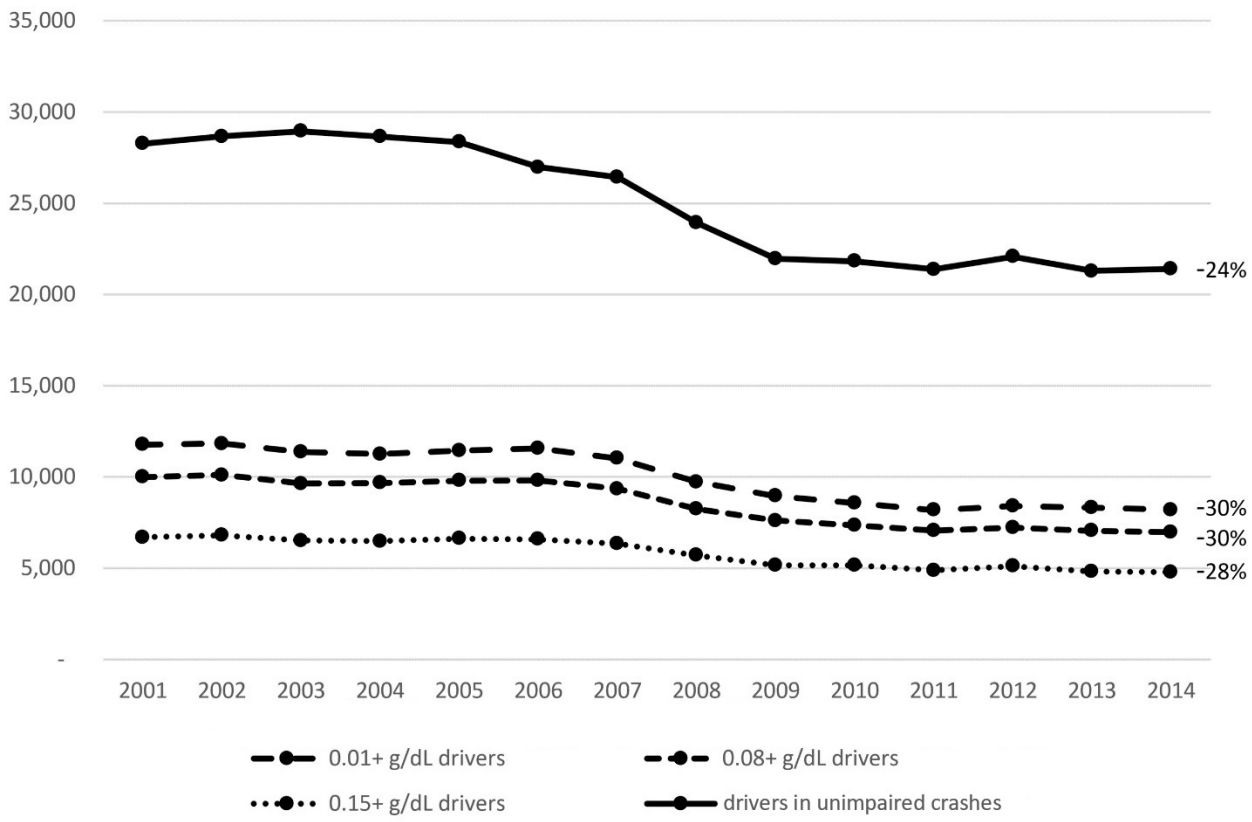
Midyear counts of states with interlock laws are provided in Table 1. Laws covering repeat offenders were the most common laws earlier in the study period, and provisions covering high-BAC offenders or first offenders were added to these later on. In 2001, three states required all offenders to get interlocks, three required it of repeat and high-BAC offenders, and 13 required only repeat offenders to get interlocks. By 2014, 20 states required interlocks for all DWI offenders, 13 for repeat and high-BAC offenders, and 12 for only repeat offenders – leaving five states and the District of Columbia (which had no such law throughout the study period) that did not require interlocks of any specific group of offenders.

Table 1: States with interlock laws by calendar year, as of July 1 (excludes California)

	Repeat	Repeat and high-BAC	All offenders
2001	13	3	3
2002	15	5	3
2003	16	7	3
2004	16	7	4
2005	14	9	5
2006	14	10	5
2007	11	14	5
2008	14	13	7
2009	14	11	12
2010	15	14	12
2011	13	15	16
2012	12	15	18
2013	11	14	19
2014	12	13	20

Figure 1 shows trends throughout the study period of the four study populations: drivers in unimpaired fatal crashes, and the three groups of impaired drivers in fatal crashes. All groups experienced downward trends from 2001–2014, but the decrease was larger for impaired drivers than for drivers in unimpaired crashes (28%–30% decline, vs. 24%).

Figure 1. Trends in impaired passenger vehicle drivers at the 0.01+, 0.08+, and 0.15+ g/dL levels in fatal crashes and passenger vehicle drivers in unimpaired fatal crashes, 2001–14



The main results are provided in Table 2. Effects were statistically significant at the 0.05 level except those comparing repeat-offender law with no law. Interlock laws covering repeat offenders were associated with 3% fewer impaired drivers (at all levels) in fatal crashes, compared to no laws. Requiring interlocks for high-BAC offenders as well as repeat offenders, compared to none, was associated with an 8% benefit for impaired drivers (all levels). All-offender laws were associated with a 16% benefit over no law for 0.01+ and 0.08+ g/dL drivers and a 12% benefit for drivers with BAC 0.15+ g/dL.

Per se laws were associated with small reductions (a significant 4.6% for 0.08 vs. none and a nonsignificant 2.1% for 0.10 vs. none) in impaired drivers in fatal crashes, and a higher unemployment rate was associated with fewer impaired drivers. The interaction terms for unemployment rate were small compared to the main effect, simplifying interpretation. The large number of interaction terms between drivers in unimpaired crashes and state/quarter limits interpretability.

Table 2: Estimated effects of interlock laws on impaired drivers in fatal crashes, 2001–2014

	0.01+ g/dL	0.08+ g/dL	0.15+ g/dL
All-offender vs. none	-16.1*	-15.9*	-12.5*
High-BAC and repeat vs. none	-8.2*	-8.0*	-7.7*
Repeat-only vs. none	-2.7	-2.6	-3.2

* statistically significant at the 0.05 level

Table 3 provides the analyses disaggregated by drivers' prior DWI status. Drivers without prior DWIs comprised about 92% of the impaired (0.08+ g/dL) drivers sample. The results for drivers without prior DWIs were quite similar to those of all drivers in Table 2, but all slightly smaller in magnitude. Beneficial effects for drivers with prior DWIs followed a similar pattern, but were much larger in magnitude.

Table 3. Estimated effects of interlock laws on impaired drivers in fatal crashes, 2001–2014 by drivers' prior DWI status

Drivers *without* prior DWI	0.01+ g/dL	0.08+ g/dL	0.15+ g/dL
All-offender vs. none	-13.8*	-13.8*	-9.8*
High-BAC and repeat vs. none	-6.2*	-6.1*	-5.3*
Repeat-only vs. none	-1.6	-1.8	-2.0

Drivers *with* prior DWI	0.01+ g/dL	0.08+ g/dL	0.15+ g/dL
All-offender vs. none	-32.4*	-31.2*	-30.0*
High-BAC and repeat vs. none	-23.4*	-23.6*	-26.4*
Repeat-only vs. none	-10.1*	-9.8*	-12.6*

* statistically significant at the 0.05 level

Discussion

This analysis found that all-offender laws are effective at reducing impaired driving fatal crashes (16% fewer drivers with BAC 0.08+), compared to no law. Repeat-offender laws were associated with a small benefit (3% reduction in impaired drivers) compared to no law, and there was an additional benefit of including high-BAC offenders (8% compared to no law). Larger benefits were observed for drivers with prior DWI convictions, possibly suggesting an additional specific deterrence effect. However, it is possible that only a fraction of those with prior DWIs received interlocks, so another possible explanation is that these drivers have an increased familiarity with the impaired driving criminal justice system, and

thereby were more attuned to changes in sanctions. Surprisingly, the current study found an additional benefit of introducing laws requiring interlocks for first offenders on drivers with prior DWIs (who, by definition, are repeat offenders and would thereby not be directly impacted by first offender laws). This could be due to their interpretation of this law being indicative of a more punitive legal system, which may result in a reduction in their own alcohol-related crashes.

In 2014, close to half of the states had laws requiring interlocks for all DWI offenders. Additional benefits are expected to be realized as more states enact such laws. Despite requirements to install interlocks, however, actual interlock installation rates often are far from 100% of offenders (McCartt et al., 2018; Roth, Voas, & Marques, 2009; Willis et al., 2004; Marques, Tippetts, Voas, & Beirness, 2001). Though examining interlock installation rates was beyond the scope of the current study, future research may look at ways to increase interlock installation rates. In this study, laws that require interlock installation fell into two general categories: interlock installation required to drive during post-conviction license suspension, or interlock installation required to reinstate a driver license after conviction. While the latter is a stronger requirement, evaluations of these requirements must be reserved for future studies.

This effort is not free of limitations. The primary outcome measure in the current study was limited to alcohol-related fatal crashes, which could arguably be called a relatively rare and severe occurrence after consuming alcohol. Indeed, to assess the broader impact of alcohol ignition interlocks, nonfatal alcohol-related crashes should be assessed as well. However, alcohol reporting in nonfatal crashes is incomplete and highly variable in quality from state to state; hence only fatal crashes were investigated. Further, the current study used alcohol-related outcomes and alcohol-related legislation as predictors, but we did not examine the impact of alcohol consumption itself. Total alcohol consumption was considered for use in the current model, however, that data is only available as total gallons of ethanol consumed by state and year. As the current study examined only a small subset of the population (i.e., those involved in fatal crashes), the total population alcohol consumption variable seemed convoluted and hence was excluded from our analyses. Also, potential changes in population alcohol consumption would be in the causal pathway between interlock laws and fatal crashes, so the overall

effects could not be measured as precisely. Future research should assess how the introduction of alcohol ignition interlock devices and the laws associated with them changed individual alcohol consumption among this high-risk population.

However, despite the limitations discussed above, this study demonstrates several important associations. First, we found that interlock laws, especially those covering all offenders, are an effective impaired driving countermeasure for fatal crashes. Second, the current study shows that the laws are especially effective at preventing fatal crashes among drivers with a history of DWI – a population of drivers at high risk for recidivism and crash involvement. As such, jurisdictions that do not currently have all-offender alcohol ignition interlock laws could expect large reductions in impaired driving crash deaths if they do adopt these laws.

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