Potential effectiveness of seat belt interlocks

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Abstract

Seat belt interlocks are a vehicle safety technology that aims to increase seat belt usage by restricting the vehicle from being driven until occupants have fastened their seat belts. The aim of this study was to estimate the potential effectiveness of mandatory seat belt interlocks on new vehicles. Three data sets were used to obtain vehicle age profiles for unrestrained drivers: an observational study from 2009 (belt use 98%), hospital admission data from 2008-2010 (belt use 89%), and Coroner's report data from 2008 (belt use 66%). A hypothetical scenario was considered in which seat belt interlocks were made mandatory in all new vehicle models from 2015 onwards. Under this scenario, the vehicle age profiles from each dataset were used to examine the time it would take for seat belt interlocks to be a feature in vehicles driven by those who would otherwise not be wearing a seat belt. These results were used to calculate a 'best case' estimate of the potential effectiveness of seat belt interlocks: by 2030 there would be a potential 2% reduction in injuries requiring hospital admission, and a 7% reduction in fatalities. By 2050 these values would approach 5% and 16% respectively. These reductions would apply on top of any casualty savings already made through enhanced vehicle technologies, infrastructure and regulations. Despite the relatively long time required for interlocks to reach maximum effectiveness, their introduction would have low marginal costs.

Introduction

Seat belt interlocks are a vehicle safety technology that is designed to raise levels of seat belt compliance. They allow a vehicle to be started only when the vehicle's occupants have fastened their seat belts. Some systems restrict the vehicle in other ways, for example by restricting the speed or only allowing the lowest gear to be used. Currently, they exist only in certain vehicle types such as forklifts. Their use in passenger vehicles is controversial, mainly for historical reasons, but the fact remains that even in countries with high seat belt wearing rates, the residual of drivers and passengers not wearing a seat belt at the time of a crash leads to avoidable injury and death. In South Australia, seat belt usage is very high (around 97%), but up to one third of fatal crash victims are not wearing seat belts at the time of the crash (Raftery and Wundersitz, 2011).

Many modern vehicles are equipped with seat belt reminders that activate visual and auditory warning signals if the vehicle is started when occupants are seated and have not fastened their seat belts. Seat belt reminders are required to obtain a five-star rating under the European and Australasian New Car Assessment Programs (Euro NCAP and ANCAP). In vehicles with seat belt reminders, the additional cost of installing an interlock system ought to be very low, as all that is needed is additional logic that links the seat belt reminder sensors to the ignition system.

Seat belt interlocks do not exist in modern passenger vehicles. However, this technology rose to prominence (and infamy) in the USA roughly 40 years ago: in August 1973, a mandate was issued under federal law to have seat belt interlock systems installed in all model year 1974 vehicles sold in the US. The mandating of seat belt interlocks in the US was thought to be the next logical step from the 8-second 'buzzer light' reminder systems that had been made mandatory in the preceding year. However, despite surveys prior to introduction that indicated a positive attitude (Perel and Ziegler, 1971), the law was met with widespread public backlash and was repealed in the following year. Additionally, US Congress passed legislation prohibiting the reintroduction of mandatory seat belt interlocks or mandatory seat belt reminders that last longer than 8 seconds (Committee for the

Safety Belt Technology Study, 2004). Aside from the issues of public disapproval, mandatory interlocks were successful at encouraging greater seat belt usage in the US – belt usage rose from around 25% in vehicles built before interlocks became mandatory, to 59% in the 1974 interlock equipped vehicles (Robertson, 1975).

While the results of the US 1974 experience are interesting from an historical standpoint, they are unlikely to bear relevance to the present situation. In 1970s USA, the majority of vehicle occupants did not wear a seat belt; seat belt use was perhaps not accepted as being necessarily safer (anecdotal evidence suggests that many people believed that being ejected from the vehicle was safer), and seat belt use was perhaps not a social norm. This is in contrast to many motorised countries in the present-day; for example, wearing rates in Australia are very high. An observational study conducted in 2009 suggested seat belt usage of over 95%, despite much lower usage amongst fatally injured drivers (Wundersitz and Anderson, 2009). This difference in usage rates was examined by Raftery and Wundersitz (2011), who suggested that unrestrained occupants were likely to be engaging in other risky behaviours that would boost their chances of being involved in a crash.

There have been limited studies on the effectiveness of seat belt interlocks in the recent literature. Turbell et al. (1996) estimated a benefit-cost ratio of 100:1, based on an effectiveness in fatal crashes of 50%. They also presented results of a survey that indicated generally positive views towards seat belt interlocks. Van Houten et al. (2005) performed a study of five delivery van drivers who frequently drove unrestrained. Belt usage rose from 0-30% prior to interlock installation, to 80-95% when an interlock was installed that prevented the drivers from shifting into gear for a short time period after starting the vehicle if they did not fasten their seat belt.

The Committee for the Safety Belt Technology Study (2004) report recommends the development of interlock systems to target particular applications, including motorists with poor driving offence records, teenage drivers and company fleets. A survey in the same report shows that drivers were divided on the acceptability of interlocks, with seat belt non-users less likely to approve. The report notes that the "pace and type of technology introduction continue to be affected by the interlock experience" (referring to the 1974 mandatory interlock law).

Seatbelt reminder systems on their own may provide large benefits: Lie et al. (2008) conducted an observational study in seven different countries of seat belt usage in cars equipped with and without seat belt reminders. Overall, the level of seat belt usage was 86% in cars without reminders, and 98% in cars with reminders. France had the highest level of belt usage (observations conducted in Paris), with a seat belt usage rate of 96.9% in cars without reminders, and 99.8% in cars with reminders.

Regan et al. (2006) conducted a field trial of 21 drivers in which seat belt reminders were not activated for the first 1500 km of driving, and were then activated for a further 15,000 km of driving. When the reminder system was inactive, the drivers were unbelted for about 5% of their total driving distance and took an average of around 30 seconds to fasten their seat belt. With the reminder system active, drivers spent 0.1-0.4% of their driving distance unbuckled, and fastened their seat belt within 5-10 seconds on average. Thus, the effectiveness of future interlock systems would need to account for the prevailing effectiveness of reminder systems.

Anderson et al. (2011) examined the potential benefits of seat belt interlock systems using crash data from New South Wales. They found an estimated benefit-cost ratio of 1.6 for passenger cars equipped with interlocks, and 3.3 for trucks equipped with interlocks.

At the very least, an estimate of the effectiveness of seat belt interlocks requires knowledge of (a) the effectiveness of seat belts at reducing the severity of injury in a given crash, (b) the proportion of casualties that are not wearing seat belts at present, and (c) the proportion of the those casualties that would have been likely to use a seat belt in the presence of an interlock. For (a), the average effectiveness of seat belts at preventing fatalities and serious injuries is approximately 50%, based on a review published by Elvik (2009, p. 603). For (b), such information can be obtained from routinely recorded police data, hospital records, or Coroner's data. For (c), little information exists, but the design of the technology and the experience of reminders would suggest that near universal use of seatbelts might result.

In estimating the benefits of any new vehicle technology, it is also necessary to account for the time taken for new vehicles to filter into the fleet and be driven by those who need to be exposed to that technology (i.e. those drivers who crash). For example, the relatively high age of the vehicle fleet in Australia generally means that new vehicle technologies take some time to filter through to the general fleet, and even longer again to that population of drivers and passengers who would directly benefit from them: Raftery and Wundersitz (2011) found that unrestrained occupants in fatal crashes in South Australia were more likely to be travelling in older vehicles (mean vehicle age of 14 years, compared with 11.4 years for restrained occupants).

The aim of this study was to estimate the benefit and timing of those benefits of introducing seat belt interlocks into the Australian passenger vehicle fleet.

Data and Methods

In this paper, the drivers of vehicles in three datasets were considered: observational study data from 2009 (to provide an estimate of current seat belt wearing rates), hospital admission data from 2008-2010 (to examine wearing rates amongst seriously injured drivers), and Coroner's data from 2008 (to examine wearing rates amongst fatally injured drivers). A hypothetical scenario was considered, where interlocks will be made mandatory in new vehicle models beginning in 2015, reaching 100% installation rate in 2020. (The choice of these dates is arbitrary and is intended only to be illustrative.) Vehicle age profiles were assembled from each population of vehicles mentioned above. It was then possible to estimate a profile of interlock prevalence that would result amongst those drivers that would otherwise be unrestrained in each population of vehicles, and this was used to construct a best-case estimate for the reduction in fatalities and serious injuries as a result of mandatory seat belt interlocks between 2015 and 2030.

Seat belt use data from police reports were not used in this study, due to concerns about the reliability and consistency of police-reported seatbelt use (particularly in lower severity cases). Coroner's data was preferred for fatal crashes (and police investigation was influential in the coroner's determination in each case). For non-fatal crashes requiring hospital admission, hospital records were considered; seat belt use is recorded by ambulance officers in order to ensure an accurate injury diagnosis, and emergency department medical staff also make an early determination for clinical purposes.

The data were limited to drivers of cars and car derivatives (including passenger cars, SUVs, station wagons, utilities and vans). Trucks and other heavy vehicles were not recorded in the observational study data, and were excluded from the hospital admission and Coroner's data.

Observational study

The observational study was conducted in March 2009, in rural and metropolitan South Australia. Observers stood at selected intersections during daytime hours and recorded the seat belt use of vehicle occupants by seating position, age and sex (Wundersitz and Anderson, 2009).

The complete dataset from the observational study consisted of 16,890 observations of occupant seat belt use, occupying 10,954 vehicles. Of those, 16,304 occupants were wearing a seat belt, 353 were not and so the overall seat belt use in the study was 97.9%. The remainder had an unknown seat belt use status due to difficulty in observation.

For each vehicle in the study, the number plate was recorded by the observers. The initial intent of recording number plates was to ensure that the same vehicle did not get counted more than once at each survey location. The number plate recordings were used in the present study to identify registration data associated with each vehicle, including the vehicles' years of manufacture. This was obtained from the South Australian Department of Planning, Transport and Infrastructure, with the data backdated to March 2009 to include number plates that have since been retired, and to eliminate errors caused by number plates that may have been reassigned to new vehicles.

When the observational data were limited to drivers only, in vehicles that could be matched to registration data, there were a total of 10,848 records. Of those 10,625 were wearing a seat belt and 201 were not wearing a seat belt. The remainder had an unknown seat belt use status. Hence, the overall seat belt usage rate was 98.1% for drivers with a known vehicle age and seat belt use. This was consistent with the rate for all observations (drivers and passengers combined, all vehicles) in the study.

Hospital admissions

Hospital admission data were previously collected as part of a study on medical conditions and crash causation (Lindsay and Ryan, 2011). The database compiled for that study contains details of every active crash participant admitted to the Royal Adelaide Hospital (RAH) as a result of a crash on a public roadway in South Australia between 1/1/2008 and 31/12/2010. The RAH is one of two major trauma centres in the State and receives patients from metropolitan and rural locations. An 'active' participant was one who had some level of control over the accident occurring, including vehicle drivers, pedestrians, pedal cyclists and motorcycle riders. Hospital admission data were not collected for non-driver passengers of vehicles. Any hospital stay of over 4 hours qualified as admission (in line with current definitions used in official hospital separation data). Patients who were admitted to hospital and later died as a result of their injuries were included in the original dataset, but for the purposes of the present study, these records were not included.

The resulting dataset contains records for 811 drivers of cars or car derivatives. Of those, 599 had a known seat belt use status and of those, 69 were not wearing a seat belt. Seat belt use was generally recorded by ambulance personnel or had been determined by medical staff. Hence, an estimate of seat belt usage amongst these drivers was 88.5%.

For each driver, vehicle information was obtained using the South Australian Traffic Accident Reporting System (TARS). TARS contains police recorded information on vehicle crashes that result in medical treatment, or property damage of at least $3000. Part of the information contained is the vehicles' year of manufacture (and this is based on registration data held by the same department). The TARS relevant to each admission was identified manually by any note of the vehicle registration number recorded in the hospital admission data, and by the date of the crash and other details common to both records.

After matching, there were a total of 702 drivers for whom vehicle age was known (the remainder could not be matched to a TARS record or had an unknown vehicle year). Of those, 470 were recorded as restrained, 56 unrestrained, and the remainder had an unknown seat belt use. This gave a seat belt usage of 89.4% for the drivers with a known vehicle age and seat belt use status.

Coroner's reports

The database of the coroner's records consisted of road fatalities that occurred in South Australian for the year 2008. Records existed for 217 people (fatally or non fatally injured) involved in 90 fatal crashes (crashes in which at least one person died as a result of the crash). Vehicle age was recorded in the database.

Of all the car occupants in the dataset for whom seat belt use was known, 74 were wearing a seat belt, 38 were not (66% wearing rate). Additionally, 5 occupants were classed as "probably not" wearing a seat belt, and 18 as "probably yes" to wearing a seat belt. Taking these numbers into account gives a seat belt wearing rate of 68%.

For this study, the records were limited to drivers, and to those who died as a result of the crash. This left 14 unrestrained drivers, and 27 restrained drivers, for a seat belt usage of 65.9%. There was 1 driver with unknown seat belt use. There were also 2 drivers recorded as "probably yes" to wearing a seat belt, and 1 driver as "probably not". Taking this into account gives the same seat belt usage of 65.9%.

Effectiveness estimate

The vehicle age profiles determined by the three data sources were used to estimate the potential future effectiveness of seat belt interlocks on a yearly basis. However, it should be noted that the estimate incorporates unrealised benefits of seatbelt reminder systems. At this stage, no attempt has been made to examine the marginal benefits of the interlocks over that of audible reminders.

The first step was to determine the time it would take for seat belt interlocks to penetrate the fleet such that typically unrestrained drivers would be driving interlock equipped vehicles. It was assumed that the vehicle age profile for unrestrained drivers would remain constant with time without any intervention from interlocks. Drivers who habitually travel unrestrained may be less likely to upgrade to an interlock equipped vehicle, but it was assumed that this effect would be minimal. The vehicle age profiles were taken from each dataset, and a Weibull statistical distribution was fitted to each.

A hypothetical interlock introduction rate was also assumed. The hypothetical introduction rate was based on interlocks becoming mandatory on new vehicle models from 2015 onwards. Assuming a five-year model turnaround, it was assumed that all new vehicles would have interlocks installed by 2020, with a linear rate of introduction between 2015 and 2020.

Using these two assumptions, for each future year it was possible to estimate the proportion of vehicle drivers that would otherwise be unrestrained, who would then be in vehicles equipped with interlocks.

The second step was to link the presence of interlocks to a reduction in injury occurrence. For this step, only the Coroner's and hospital admission data were used, as they were representative of fatally and seriously injured drivers. It was assumed that without any intervention from seat belt interlocks the proportion of unrestrained drivers in each dataset would remain constant with time.

Two effectiveness values were assumed:

- The seat belt interlock effectiveness was assumed to be 95%. That is, of those drivers who would otherwise be unrestrained, 95% would wear a seat belt in the presence of a seat belt interlock. (The remaining 5% would find some way to circumvent the interlock or would remove their belt after starting the vehicle.) This assumption is speculative, but in line with the results reported by Van Houten et al. (2005), and a slightly stronger effectiveness than what has been reported for seat belt reminder systems.

- The injury reduction effectiveness of the seat belt was assumed to be 50% for both datasets. Elvik et al. (2009, p. 603) reviewed many reports of seat belt effectiveness, and suggest an effectiveness of around 50% for fatal injuries, and close to this for serious injuries. Since the Coroner's data corresponds to fatal injuries, and the hospital admission data to injuries that were generally 'serious', this estimate seems reasonable. Turbell et al. (1996) and Anderson et al. (2011) also used an injury reduction effectiveness of 50%. Elvik et al. suggest lower levels of effectiveness for minor injuries in front seat passengers (20-25%) and for rear seat occupants at all levels of injury (20-25%). Thus, if these effectiveness estimates were extended to rear seat passengers, they should be reduced by half. Note also that the hospital admission criteria of a four hour stay means that some casualties in the hospital admission data set might fit the definition of a 'minor' injury rather than a 'serious' injury in these effectiveness estimates.

In each future year, the potential reduction in injury was calculated by the following:

$$\textit{Percentage injury reduction} = I \times P \times E(\textit{interlock}) \times E(\textit{seat belt}) \times 100\% \qquad (1)$$

The value of *I* was the proportion of otherwise unrestrained drivers that would be in interlock equipped vehicles. This was calculated for each future year in the first step described above. For example, if this value were 30% for a certain year, then we could say that of all the vehicle occupants that would otherwise be travelling unrestrained in that year, 30% would be in vehicles that have seat belt interlocks installed.

The value of *P* was the proportion of all vehicle drivers that travel unrestrained. This was based on the value obtained from the relevant dataset.

The values of *E(interlock)* and *E(seat belt)* were the assumed effectiveness values described above, and were 0.95 and 0.50, respectively.

Thus, for each future year, a percentage reduction in injuries was calculated due to the effect of mandatory seat belt interlocks.

Results

Vehicle age distributions by seat belt use

Error! Reference source not found. lists the mean vehicle age for all drivers, restrained drivers and unrestrained drivers in each dataset. The median vehicle ages are listed in **Error! Reference source not found.**. The original vehicle age data were rounded to the nearest year. On average:

- In all datasets the unrestrained drivers were in older vehicles than the restrained drivers.

- The drivers in the observational study were in newer vehicles than those in the hospital admission or Coroner's data.

The results suggest that for drivers being seriously injured or killed while unrestrained, around half are driving vehicles that are at least 15 years old. This implies that if interlocks were introduced in all new vehicles, it may take at least 15 years for half of the otherwise unrestrained drivers involved in crashes to be driving vehicles with interlocks.

Table 1. Mean vehicle age by seat belt use in each dataset

	Mean vehicle age		
Dataset	**All drivers**	**Restrained drivers**	**Unrestrained drivers**
Observational study (2009)	9.99	9.94	12.62
Hospital admissions (2008-2010)	12.66	12.05	16.32
Coroner's data (2008)	13.09	11.93	15.50

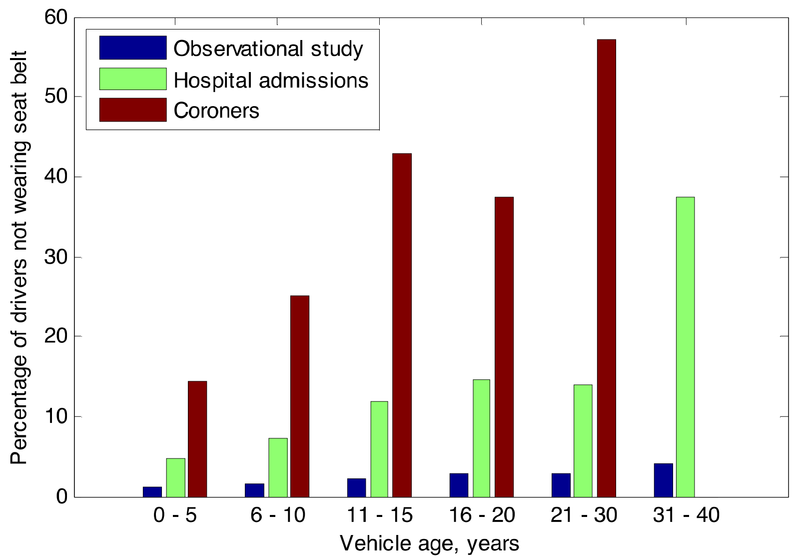
Table 2. Median vehicle age by seat belt use in each dataset

	Median vehicle age		
Dataset	**All drivers**	**Restrained drivers**	**Unrestrained drivers**
Observational study (2009)	9	9	11
Hospital admissions (2008-2010)	12	11	15.5
Coroner's data (2008)	11	10	16

Figure 1 illustrates seat belt use by age of vehicle. Due to the limited data for older vehicles, the data were grouped into increments of 5 years up until 20 years old, then in two 10 year increments to 40 years old. The Coroner's data did not include any vehicles in the 30-40 age group.

This plot indicates that seat belt non-usage increased with vehicle age in all three datasets. The Coroner's data consistently has the highest level of non-use, followed by the hospital admissions, then the observational study. This is expected – if lack of seat belt use leads to a higher chance of serious injury or death, then we would expect to see higher levels of non-usage in these datasets. In vehicles aged over 20 years old, over half of the drivers in the Coroner's data were not wearing seat belts. (Note that these vehicles are very unlikely to be equipped with reminder systems.)

Figure 1. Seat belt non-usage by vehicle age for each dataset

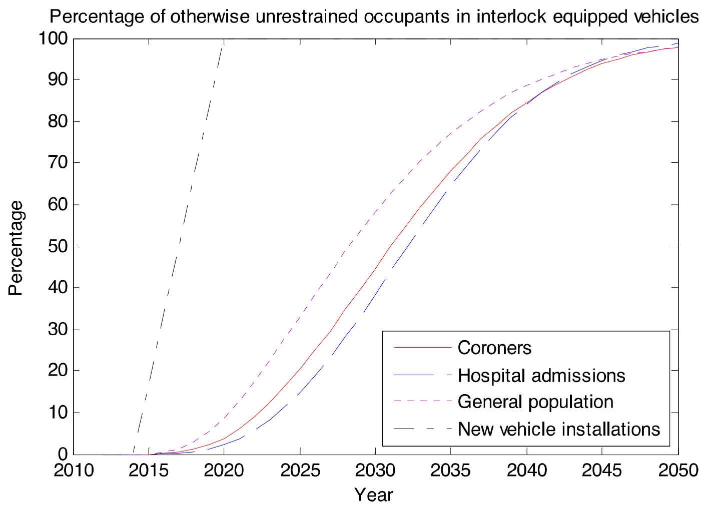


Effectiveness estimates for seat belt interlocks

For this effectiveness estimate, we assumed that without any intervention from seat belt interlocks, the proportion of unrestrained drivers in each dataset would remain the same, and that the unrestrained drivers would be driving vehicles of a similar age profile from year-to-year. We have also assumed that the seat belt effectiveness would remain constant from year-to-year, although this may change with improvements in crashworthiness.

We have assumed a linear rate of introduction of seat belt interlocks from 2015 to 2020. Figure 2 shows the percentage of drivers that would otherwise be unrestrained, who would be driving interlock equipped vehicles in each year. This is split by dataset. Thus, the line corresponding to the Coroner's data implies that by 2030, approximately 45% of fatally injured drivers that would have otherwise been driving unrestrained would be in interlock equipped vehicles. The introduction of interlocks is most rapid for the unrestrained 'general population' (based on observational study data), due to this population being in the newest vehicles. This is followed by the population of unrestrained occupants implied by the Coroner's data, and then the population of unrestrained occupants implied by the hospital admission data. For all three populations, 95% interlock usage is achieved by 2045. In the nearer future, we see that by 2025 we would expect 33% of the general unrestrained population in interlock equipped vehicles, and 20% and 15% for the Coroner's data and hospital admission data, respectively.

Figure 2. Percentage of otherwise unrestrained drivers who would be in interlock equipped vehicles, given a linear introduction of interlocks installations in new vehicles from 2015-2020

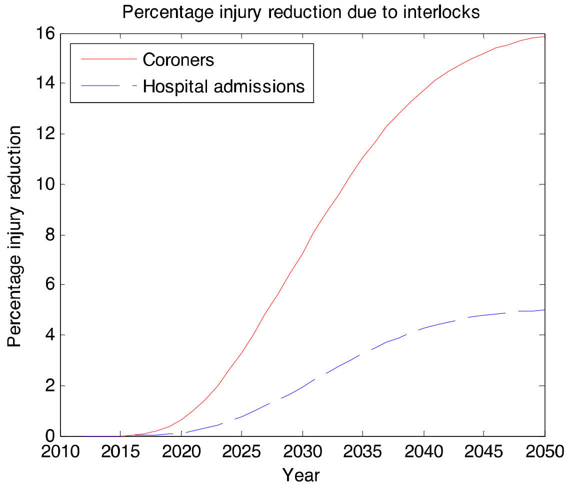


Equation (1) was used to calculate the potential casualty reduction each year due to introduction of seat belt interlocks, for the Coroner's data and hospital admission data. This is shown in Figure 3. The Coroner's data implies a reduction in fatalities, and the hospital admission data implies a reduction in casualties with injuries requiring hospital admission.

Figure 3 implies that by 2050, the presence of seat belt interlocks would reduce fatalities by around 16% and casualties requiring hospital admission by 5%. At this point the otherwise unrestrained population is almost entirely driving vehicles equipped with interlocks (see Figure 2), and so the percentage reduction in casualties is driven by the proportion of the population driving unrestrained (around 34% for fatalities and 11% for hospital admissions), multiplied by the assumed effectiveness values of 95% and 50%.

It is important to note that Figure 3 gives a percentage reduction in the casualties that would have occurred in those years without the presence of interlocks, but that the number of casualties is likely to decrease even without the presence of interlocks due to the effects of other vehicle safety technologies currently rolling through the fleet, infrastructure improvements and enhanced road safety regulations.

Figure 3. Potential injury reductions per year given a linear introduction of interlock installations in new vehicles from 2015-2020



Discussion

Seat belt interlocks have not received a lot of attention in recent literature and the US 1970s experience remains the only large-scale deployment of this technology. The results of that experience are interesting from an historical standpoint, but do not give an indication of what might occur if interlocks were made mandatory in the current setting, as restraint use was much lower in the USA in 1973 (around 25%).

In present day South Australia, seat belt use is very high (around 97% according to observational study data from 2009), but unrestrained occupants are overrepresented in crashes, particularly those that are fatal. Seat belt use amongst fatally injured vehicle drivers was just 65% for the Coroner's data used in this study. This is expected as unrestrained occupants are more likely to be injured or killed; however, even if its assumed that unrestrained occupants are four times more likely to die, Wundersitz and Anderson (2009) show that the measured seat belt use of 97% in the general population would suggest 89% seat belt use in fatal occupants (which is much higher than the true figure of 65%). For seat belt use to be 65% for fatal crash occupants, using an odds ratio of 4, we would expect to see a seat belt use of around 88% in the general population, if all other things were equal. Even the propensity of drivers of older vehicles in the general population to be unrestrained (Figure 1), and the propensity of older vehicles to be involved in crashes cannot explain the discrepancy.

A previous CASR report by Raftery and Wundersitz (2011) discussed this discrepancy, and the findings of that report suggest that unrestrained fatal crash victims are more likely to be engaging in other risky behaviours, or to be part of at-risk segments of the population. Thus, if the level of seat belt use is much lower in the segment of the population that are involved in fatal crashes, seat belt interlocks would have benefits, even if seat belt use is very high in the general population.

The results of this study show that unrestrained occupants are generally found in older vehicles, particularly those that are involved in crashes, but also those in the general population. This has also been found in other studies of seat belt use and vehicle age (McCartt and Northrup, 2004; Preusser et al. 1991).

The presence of seat belt reminders in newer vehicles may be having an effect on the distribution of vehicle ages amongst unrestrained drivers. Lie et al. (2008) and Regan et al. (2006) suggest a strong effect of seat belt reminders on restraint use. If newer cars are more likely to have reminder systems, then we would expect to see fewer occupants of newer vehicles travelling unrestrained, shifting the vehicle age distribution for unrestrained drivers towards older vehicles.

For this study, we essentially assumed a ‘strongest case’ scenario – in other words, assumptions were made that would give the strongest case for seat belt interlocks. It was assumed that seat belt interlocks would be the only factor that would affect future seat belt use (in reality, the increased prevalence of reminder systems and other factors would most likely continue to increase overall seat belt use). It was also assumed that the vehicle age profile of otherwise unrestrained drivers would not change over time. A fairly rapid introduction of interlocks was assumed, beginning in 2015 and reaching 100% installation in new vehicles by the end of 2020. This was on the basis of a five-year design cycle for new vehicle models.

Under this ‘strongest case’ scenario, it was estimated that it would take until 2050 for the unrestrained driver populations to approach 100% interlock installations, with a 16% reduction in fatalities and 5% reduction in hospital admitted casualties. Since it is difficult to predict with accuracy everything that will be happening 40 years into the future, it is perhaps more realistic to examine the graph for the nearer future: in 2030 (10 years after all new vehicles would come with interlocks installed under this hypothetical scenario), there would be a 7% reduction in fatalities and 2% reduction in casualties requiring hospital admission.

The greatest advantage to seat belt interlocks is the small, almost negligible cost of their inclusion in new vehicles. Due to seat belt reminder systems becoming very common, most new vehicles are already equipped with sensors to detect the presence of occupants in each seating position, and whether or not each seat belt is fastened. In this case, the installation of an interlock simply requires linking these sensor measurements to prevention of the vehicle from starting. Under these circumstances, it is reasonable to argue that benefits will easily outweigh the costs and the ‘inconvenience’ to a very small minority of drivers who currently drive unrestrained (in contradiction to the road rules).

The results in this paper demonstrate that even if a technology promises strong benefits, it may take a long time for vehicles equipped with that technology to pass through the fleet and affect those who need to be exposed to it. This is particularly the case when the people who need to be exposed to the technology are driving older vehicles than the general population. This is the case for seat belt interlocks – a large proportion of crash victims are travelling unrestrained, so there is a large benefit available if technology can be used to enforce seat belt use in this population. However, because that unrestrained population are in older vehicles, it would take longer for benefits to be fully realised than would be indicated by average prevalence in the registered fleet.

This brief analysis suggested that it is arguable that the introduction of interlocks should be encouraged – they delay between introduction and benefit only underscores the desirability of accelerating such technologies into the fleet. Other means of ‘fast-tracking’ seat belt interlocks to those who are at high risk could also be considered, as after-market installation may be an option for many cars currently on the road.

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