A cohort study of drink-driving motor vehicle crashes and alcohol-related diseases

Abstract

Objectives: To elicit whether drivers involved in alcohol-related motor vehicle crashes are more likely to have future alcohol-related hospital admissions.

Method: A population-based cohort study of 3,286 drivers involved in a motor vehicle crash between 1988 and 1992 were followed over an eight to 13-year period.

Results: The findings from the study suggest a twofold increased risk associated with an alcohol-related motor vehicle crash and future alcohol-related hospital admission. The average time between an alcohol-related motor vehicle crash and future alcohol-related hospital admission was 12 years. Men and Indigenous Australian drivers were more likely to have a future alcohol-related hospital admission.

Conclusion: It is evident from this study that drink-driving resulting in a motor vehicle crash and hospitalisation could be considered an indicator of a less overt problem of alcohol dependency.

Implications: It is important that penalties for drink-driving go beyond merely punitive action and provide rehabilitation.

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The effect of alcohol-related disease on Australian health resources is large. Harmful use of alcohol in Australia has been estimated to have a direct health care cost of $145 million a year.[1] In 1986 alone, alcohol-related problems were the cause of 5,360 deaths and more than one million hospital bed-days in Australia.[2] In 1998, hazardous or harmful levels of alcohol consumption were responsible for an estimated 3,271 deaths and an estimated 71,422 hospitalisations in Australia.[3] Falls, alcohol dependence, assaults and road injuries are the most common reasons for hospitalisations due to excessive alcohol consumption.[4] Despite the apparent decrease in the number of alcohol-related deaths, alcohol misuse still remains one of the leading causes of preventable deaths.

In Western Australia between 1990-94, there were 1,607 alcohol-related deaths, and between 1991-95 there were 40,881 alcohol-related hospital episodes.[5] Alcohol was wholly attributable in an estimated 9,914 hospital admissions and 519 deaths over this period.[6]

The misuse of alcohol has been identified for many years as the single most significant contributing factor to road morbidity and mortality in Australia. In 1997, 28% of fatally injured motorists had a blood alcohol concentration (BAC) >0.05 g/100 mL, making alcohol the main cause of death on Australian roads.[7] However, over the past 20 years the percentage of alcohol-related road fatalities has decreased substantially; in Western Australia, the percentage of fatally injured drivers with a BAC >0.05 g/100 mL has fallen from 55% in 1983 to 31% in 1997.[7]

The reduction in the number of people killed on Australian roads as a result of alcohol is due to a combination of legislative change and public education. The introduction of random breath testing, the implementation of lower and nationally consistent BAC limits, adoption of zero BAC limits for certain groups of road users, tougher judicial penalties for drink-driving, and the introduction of compulsory blood testing on crash participants who attend hospital in some States[8] have contributed to the reduction.

The legislative changes appear to have had an impact on the risk-taking behaviour of Australians, reflected by the decrease in alcohol-related mortality on Australian roads. Recent figures from the 2001 National Drug Strategy Household Survey show that the proportion of Australians aged 14 years and older who, in the previous 12 months, drove a motor vehicle while under the influence of alcohol has fallen since 1998. Between 1998 and 2001, the reported prevalence fell from 18% to 13%. Among males, the proportion decreased from 24% to 18% and among females from 11% to 8%.[1] These results also highlight the fact that while there has been a significant reduction in the number of Australians who drive under the influence of alcohol, males are still more than twice as likely to do this as females.

Previous studies have shown that there is an increased risk of dying in alcohol-related motor vehicle crashes among repeat

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drink-drivers. Brewer et al. found that drivers between the age of 21 and 34 years who died in an alcohol-related crash were 4.3 times more likely to have been arrested previously for driving while intoxicated compared with drivers who died in non-alcohol related crashes.[9] For drivers 35 years or older, those killed in an alcohol-related crash were 11.7 times more likely to have had a previous arrest for drink-driving than drivers killed in non-alcohol-related crashes. While Brewer et al.'s research shows that repeat drink-drivers are at higher risk of dying in an alcohol-related crash, there has been a dearth of literature on whether drink-driving offenders actually have an alcohol dependency problem.

Few studies have investigated the relationship between alcohol-related medical conditions (defined as one or more of the diagnoses listed in Table 2) and road crashes. A study of Western Australian drivers investigated alcohol-related medical conditions as a risk factor for future alcohol-related motor vehicle crashes.[10] Results indicated that only 3% of patients admitted to hospital for an alcohol-related condition would be involved in a future alcohol-related motor vehicle crash. A limitation of that study, however, is people with alcohol dependency are unlikely to require hospitalisation for an alcohol-related medical condition until later in their 'alcohol career'. Consequently, an alcohol-related motor vehicle crash is likely to occur before, rather than after, hospitalisation for such conditions.

The aim of this study is to investigate the association between involvement in an alcohol-related motor vehicle crash requiring hospitalisation and subsequent admission to hospital for alcohol-related medical conditions.

Methods

A population-based prospective cohort study was undertaken involving all drivers or riders of motor vehicles who were hospitalised in Western Australia during the period 1988 to 1992. Motor vehicle crashes were identified through the Western Australian Road Injury Database, which links police crash reports obtained from the Traffic Accident System of the Main Roads Department of Western Australia with hospital discharge records for the State of Western Australia. To determine whether the driver involved in a motor vehicle crash had a BAC exceeding 0.05gm/100ml only police-attended motor vehicle crashes were included in the cohort (n=3,286). A BAC exceeding 0.05gm/100ml was defined using a calibrated breath test by a police officer. This equipment is used to provide evidence in court.

The outcome of interest was a subsequent alcohol-related hospital admission. An alcohol-related hospital admission was defined as a medical diagnosis that could only have resulted from excessive alcohol consumption. These medical diagnoses were defined as having an aetiologic fraction of 1.0 (100% attribution)[5] and were identified using the ICD-9-CM (prior to 1 July 1999) and ICD-10-AM (from 1 July 1999 onwards) codes as alcohol psychosis, alcohol dependence, alcohol abuse, alcohol polyneuropathy, alcohol cardiomyopathy, alcoholic gastritis, alcoholic liver cirrhosis, ethanol toxicity, methanol toxicity, external cause of injury by ethanol or methanol poisoning, and external cause of injury by alcohol aspiration.

It was necessary to link those drivers or riders identified in our cohort to their hospital records. This was achieved by accessing the Health Services Linked Database. All hospital admissions and death records for each cohort member admitted to hospital for an alcohol-related medical condition between 1 January 1988 and 31 December 1992 (the cohort recruitment period) and 31 December 2000 were extracted from the database. This ensured there was a follow-up period of between 8 and 13 years from the date of hospitalisation following a police-reported motor vehicle crash. Details (including name, gender and date of birth) of individuals involved in a crash were linked using probabilistic techniques to the hospital data. The specific techniques used for linking (or matching) the records are outlined in the paper by Rosman.[11] It is important to note that each individual presenting to a hospital in Western Australia is allocated a unique identifier, which minimises the likelihood of counting an individual twice. Therefore, all drivers or riders in the cohort were followed-up using their unique identifier.

The survival time for this study was calculated from the date of hospitalisation following a police-reported motor vehicle crash through to the date of first alcohol admission (as outlined above), loss to follow-up, or censoring.

A description of the demographic characteristics of the cohort was undertaken using SPSS software. Comparison of the means for continuous variables was undertaken using independent *t*-tests. Tests of association were undertaken using the chi-square test with continuity correction where appropriate. Survival times (alcohol versus non alcohol-related motor vehicle crash) were calculated and the significance of any difference was determined by the log-rank test. To determine the factors associated with alcohol-related hospital admission (including time to first alcohol-related hospital admission), both logistic regression and Cox's proportional hazards analyses were undertaken. Factors included in the models were gender, age, Indigenous status and whether the driver was involved in an alcohol-related motor vehicle crash. All *p*-values were two-sided and were considered significant at 0.05 and 95% confidence intervals were calculated using the standard errors from the analysis.

Results

There were 3,286 drivers or riders of a motor vehicle admitted to hospital following a police-attended motor vehicle crash between 1988 and 1992 in Western Australia. The number of observations was equally distributed across the five-year recruitment period, namely 20% per year (χ^2=4.27, *df*=4, *p*=0.371). Seven per cent (n=217) of the cohort was classified as an alcohol-related (had a BAC ≥0.05 as reported by the attending police officer) motor vehicle crash. The average age of the cohort was 32 years (range=15-88 years) with significantly more males (71%, n=2,345, χ^2=7.94, *df*=1, *p*=0.005). Three per cent (n=95) of the cohort were Indigenous Australians. Descriptive statistics for alcohol and

Table 1: Demographic features of the cohort.

Variables	Alcohol-related motor vehicle crash related	Non alcohol-related motor vehicle crash related
Number	217	3,069
Mean number of admissions	1.12	1.06
(SD)	0.78	0.85
Mean age of drivers	30.07	32.44
(SD)	14.23	15.88
Sex of the driver		
Male	163	2,183
Female	54	886
(male proportion)	75.12%	71.13
Indigenous Australian	10	86
(proportion)	4.61%	2.80%
Alcohol-related hospital admissions	13	91
(proportion)	5.99%	2.99%

Table 2: Distribution of alcohol-related medical conditions (n=104).

Alcohol-related ICD code combinations[a]	Frequency	Per cent
ICD-9-CM		
Other and unspecified alcohol dependence (303.9)	25	24.04
Toxic effects of alcohol (980)	12	11.54
Alcohol dependence syndrome (303)	8	7.69
Other and unspecified alcohol dependence, continuous (303.91)	7	6.73
Other specified alcoholic psychosis (291.8), alcohol abuse, continuous (305.01)	3	2.88
Other alcohol-related conditions	21	20.19
ICD-10-AM		
Harmful alcohol use (F10.1)	11	10.58
Acute alcohol intoxication (F10.0)	9	8.65
Alcohol dependence syndrome (F10.2)	5	4.81
Acute alcohol intoxication (F10.0), harmful alcohol use (F10.1)	1	0.96
Acute alcohol intoxication (F10.0), external cause – severe alcohol intoxication (Y91.2)	1	0.96
Alcoholic cirrhosis of the liver (K70.3), alcohol dependence syndrome (F10.2)	1	0.96

Note:
(a) Codes include diagnosis and external cause of morbidity codes.

Table 3: Predictors of alcohol-related hospital admissions.

Variable	Odds ratio	95% CI
Alcohol-related motor vehicle crash		
No	1.00	–
Yes	1.96	1.06-3.61
Sex of driver		
Female	1.00	–
Male	2.18	1.28-3.73
Indigenous Australian		
No	1.00	–
Yes	8.07	4.53-14.3

Note:
Model adjusted for age.

non-alcohol-related motor vehicle crashes are presented in Table 1.

A total of 104 (3%) of the cohort members had at least one alcohol-related hospital admission over the observational period, with the number of alcohol-related admissions ranging from one to 36 admissions. The percentage of various medical diagnoses for alcohol-related hospital admission is presented in Table 2. There was a significant association between an alcohol-related motor vehicle crash and future alcohol-related hospital admission (χ^2=6.05, *df*=1, *p*=0.014). There was also a significant association between Indigenous and non-Indigenous Australians and future alcohol-related hospital admissions. Eighteen per cent (n=17) of Indigenous Australians in the cohort had a future alcohol-related hospital admission compared with 2% (n=87) of non-Indigenous Australians (χ^2=69.3, *df*=1, *p*<0.001).

It is evident from the logistic regression results in Table 3 that an alcohol-related motor vehicle crash is a significant predictor of future alcohol-related hospital admissions. In fact, the likelihood of an alcohol-related hospital admission is almost twofold greater (OR=1.96, 95% CI 1.06-3.61) if, at the time of recruitment, the driver was involved in an alcohol-related motor vehicle crash. This finding applies when the age, sex and Indigenous status of the driver or rider of the motor vehicle is taken into account.

It is also interesting to note that Indigenous Australians had an eightfold (OR=8.07, 95% CI 4.53-14.3) increased risk of a future alcohol-related hospital admission following an alcohol-related motor vehicle crash resulting in hospitalisation. However, due to the small sample size, this estimate is unstable.

There was a significant difference between alcohol and non-alcohol-related motor vehicle crashes and time to first alcohol-related hospital admission (Log Rank Test 7.64, *df*=1, *p*=0.005). The average time it took for a driver involved in an alcohol-related motor vehicle crash to be re-admitted for an alcohol-related condition (other than a motor vehicle crash) was 12 years (95% CI 11.7-12.2) compared with 12 years 7 months (95% CI 12.7-12.8) for drivers involved in a non-alcohol-related motor vehicle crash.

Table 4 reports the key predictors of time to first alcohol-related hospital admission. The Cox's regression findings are similar to those reported in Table 3, namely that drivers involved in an alcohol-related motor vehicle crash are twice as likely (Hazard Ratio 2.05, 95% CI 1.14-3.67) to be admitted, in the future, for an alcohol-related condition compared with drivers not involved in an alcohol-related motor vehicle crash. Figure 1 contrasts the cumulative hazard function for the time to first alcohol-related hospital admission between cohort members defined at recruitment as an alcohol- or non-alcohol-related motor vehicle crash, after adjusting for age, sex and Indigenous status of the drivers (factors found to be important from the multivariate modelling).

Discussion

The aim of this study was to investigate the association between involvement in an alcohol-related motor vehicle crash requiring hospitalisation and future admission(s) to hospital for alcohol-

Table 4: Predictors of time to first alcohol-related hospital admission.

Variable	Hazard ratio	95% CI
Alcohol-related motor vehicle crash		
No	1.00	–
Yes	2.05	1.14-3.67
Sex of driver		
Female	1.00	–
Male	2.16	1.28-3.65
Indigenous Australian		
No	1.00	–
Yes	7.46	4.41-12.6

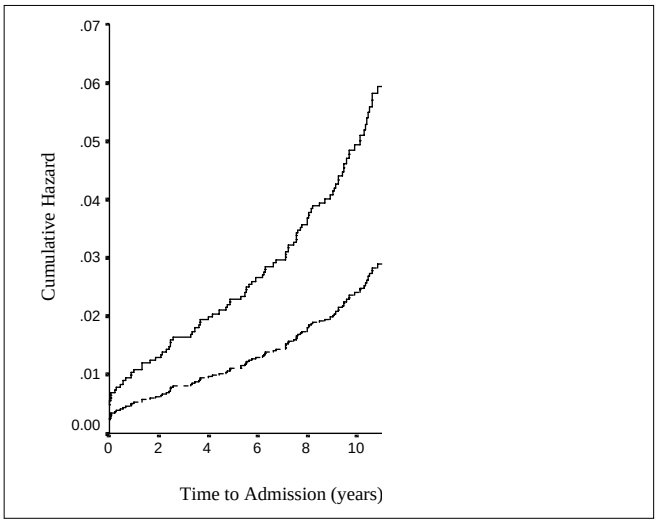
Note:
Model adjusted for age

related medical conditions. The study proposed that people involved in alcohol-related motor vehicle crashes were more likely to be admitted for an alcohol-related disease in the future. Moreover, there might be the potential, if the association was true, that drivers involved in serious alcohol-related motor vehicle crashes could be candidates for prevention programs focused on alcohol dependence.

The findings suggest a twofold increased risk associated with an alcohol-related motor vehicle crash and future alcohol-related hospital admission. In fact, the average time between an alcohol-related motor vehicle crash and future alcohol-related hospital admission was 12 years. This finding, however, does not discriminate between the time from alcohol-related crash and a specific diagnostic alcohol-related disease. Unfortunately, due to insufficient numbers, we could not estimate this relationship but it is possible that with a longer observational period this could be determined.

This is the first population-based study to investigate the association, prospectively, and provides preliminary evidence that prevention programs targeting drink-drivers involved in motor vehicle crashes resulting in hospitalisation may be beneficial.

Figure 1: Time to first alcohol-related hospital admission by alcohol- and non-alcohol-related motor vehicle crash.



Various Australian studies have found that age, sex, employment, education and marital status are associated with patterns of problem drinking.[12] This study clearly highlights that being male and Indigenous status are key determinants of future alcohol-related hospital admissions.

A limitation of the study is the relatively short follow-up period (8-13 years) and, consequently, the small number of subjects admitted to hospital for an alcohol-related disease during the observational period. While diseases such as alcoholic psychosis, alcohol abuse, acute alcohol gastritis, ethanol or methanol toxicity, and injury caused by alcohol poisoning or aspiration tend to have short aetiologic periods, diseases such as alcohol polyneuropathy, alcohol cardiomyopathy and alcoholic liver disease usually take many years to develop. Clearly a greater follow-up period, beyond the current study, is necessary to capture cases that become serious enough to require hospitalisation. We were limited to the study's observational period as prior to 1988 the classification of an alcohol-related motor vehicle crash was not reliable.

Another issue that should be considered is the fact that hospitalisation represents one of the most severe outcomes of alcohol-related diseases under investigation. Without question, a number of patients within the cohort would have developed these diseases during the follow-up period, but would not have required hospitalisation. Furthermore, a classification that the alcohol-related disease must have an aetiologic fraction of one was very rigorous. For these reasons, it is likely that our estimate underrepresents the true value.

The issue of whether drink-drivers are actually 'driving drinkers' has been raised numerous times over the past 30 years in Australia. As far back as 1973, a Law Reform Commission report on *Alcohol, Drugs and Driving*[13] found that a significant proportion of drivers who had died in alcohol-related crashes were likely to be chronic alcoholics. The report also discussed appropriate penalties and countermeasures for drink-driving. It recommended greater fines and licence disqualification, with the latter seen as a greater deterrent and a powerful factor for the individual not to repeat the offence, although this is complicated by high rates of driving under suspension, especially for long disqualifications. Furthermore, while it is known that more than one drink-driving offence is predictive of alcohol dependence,[9] it is important to recognise that most alcohol-related injuries involve high-risk but non-dependent drinking.

More recently, alternative countermeasures for drink-drivers have been considered. Several United States (US) experiments have shown that the main thrust of countermeasures should be rehabilitation therapy and treatment programs, especially in the group of people with a drinking problem serious enough to cause them to break the law. The US uniform vehicle code includes a provision for the treatment of alcoholics and drug addicts as an alternative to the imposition of conventional penalties and such programs have been reported to reduce recidivism by up to 9%.[14] Likewise, under Tasmania's Road Safety (Alcohol and Drugs) Act 1970, it allows a court to order an offender into treatment with

respect to alcohol and drink-driving. The act also provides that a second offender will not be reissued with a driver's licence after disqualification unless the court is satisfied that they are not suffering from alcohol or drug dependency. To our knowledge, however, there is no provision of a treatment or rehabilitation program for drink-driving in Western Australia specifically targeting repeat drink-drivers.

It is evident from this study that drink-driving resulting in a motor vehicle crash could be considered an indicator of a less overt problem of alcohol dependency. It is important, therefore, that penalties for drink-driving must recognise the basis of this critical issue. There is a need (particularly in Western Australia) to establish a flexible range of penalties using both conventional and alternative countermeasures to successfully treat drink-driving.

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