



Journal of the Australasian College of Road Safety

Formerly RoadWise — Australia's First Road Safety Journal



In this issue -

Peer-reviewed papers

- Can radar detectors and safety warning system (SWS) signals improve road safety?
- Connection without caution? The role of mobile phone involvement in young people's intentions to use a mobile phone while driving
- Road trauma, patterns of injury and mortality in an Australian trauma centre
- Factors affecting two- and five-year re-offence rates in Queensland drink drivers

Contributed articles

- Project RAPTAR: Reduce Accidents, Prevent Tragedy, Activate Resources
- Hoon club culture: A South Australian policing response
- Vulnerable road users: Characteristics of pedestrians
- Road lighting: A review of available technologies and appropriate systems for different situations

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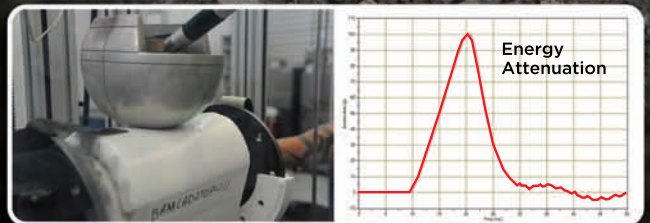
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Contents

From the President.	5
Letters to the Editor	5
College news	7
Diary	8

Peer-reviewed papers

Can radar detectors and safety warning system (SWS) signals improve road safety? – CM Rudin-Brown, M Cornelissen.	9
Connection without caution? The role of mobile phone involvement in young people's intentions to use a mobile phone while driving – KM White, SP Walsh, MK Hyde, BC Watson	16
Road trauma, patterns of injury and mortality in an Australian trauma centre – EM Frydenberg, K Curtis, S Chong, R Poulos, RH Grzebieta, TR Steel, T Nau	21
Factors affecting two- and five-year re-offence rates in Queensland drink drivers – V Siskind	29
Literature review.	37

Contributed articles

Project RAPTAR: Reduce Accidents, Prevent Tragedy, Activate Resources – M Musumeci	38
Hoon club culture: A South Australian policing response – P Newitt	40
Vulnerable road users: Characteristics of pedestrians – Z Bakovic	45
Road lighting: A review of available technologies and appropriate systems for different situations – S Kitsinelis and G Zissis	49



Cover photo:

by M Musumeci shows a confronting roadside display installed by community members in Ravenshoe, Queensland, as part of their RAPTAR Project. See article on page 38.

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From the President



Dear ACRS members,

The beginning of a new year is a good time to reflect and set some goals. The College is continuing to work to improve its relevance to members, both individual and corporate. The College is, of course, only as good as the members individually and the results of the collective activities.

We are already six months into the international Decade of Action on Road Safety, and of course our own Australian road safety strategy for the decade. Measuring progress, while difficult, is vital. The trends in injury and deaths from road crashes show some promising results with a 4.4% decrease in road crash deaths last year and a 17% decrease in deaths in the 17-25 age group. The annual results do show that there is more to do to achieve our reduction targets, and more importantly to reduce unnecessary road trauma.

The College's role, on behalf of its members, must be to assist by encouraging interaction between the various professions and academic interests, to build synergy of ideas and actions.

Our ACRS National Conference, later this year, will be a key part of that role, and I encourage you to plan now to attend. Details of the conference and information about how to register are included in this issue of the journal.

Also in this journal are papers and articles on what we might call behavioural adaptations to enforcement measures, such as those aimed at reducing speed. While we know that excessive behaviours are not the cause of most crashes, we also know that in many instances small average speed reductions reduce injury crash risk and severity. It seems to me that we do not yet have what the political commentators call a 'road safety

narrative' - a clear and compelling story of why a safe system is one everyone easily feels makes sense. One which does not need even to be written down. We have such a narrative in airline and rail travel and we are gaining one in workplace safety. When boarding a plane, we do not even contemplate not fastening our seatbelt or expecting the pilot to overtake another plane on the runway to land a couple of seconds earlier. We do not expect to buy an electric appliance and plug it into an unsafe circuit. There is an unspoken safety narrative, some of which relies on regulation and enforcement, but which largely depends on choices we make ourselves.

Perhaps in driving we have such an ingrained and personal experience that so many overlook the risks, not only to themselves but also to other road users. We apparently feel comfortable with risks being reduced by enforcement of rules and regulations, by transferring responsibility from ourselves to road builders, car manufacturers, legislators, police, trauma care specialists and other drivers.

Our 3M-ACRS Diamond Road Safety Award winner, Sergeant Michael Musumeci, reports in this issue on the positive outcomes of his RAPTAR community project and I know he is continuing to expand their activities. He is demonstrating the translation of strategies into action. Perhaps he is developing the 'narrative' we need nationally.

Finally, we were sorry to lose Jacki Percival as our Executive Assistant at the National Office at the end of last year. Jacki has been with us since 2004 and over the years has supported all our Executive Officers, Presidents and Executive Committees, and filled in between our EOs. Jacki has helped out in so many ways, including with Chapters and particularly with our conferences and events. We will miss her. Christine Bethwaite has joined the office as her replacement.

*Lauchlan McIntosh AM EACRS
President*

Letters to the Editor

Interaction between driving-related self-esteem and threat

Dear Editor,

Terror Management Theory (TMT) is interesting in providing a unified explanation of two things: that threat appeals can increase risky driving or risky driving intentions (i.e., produce an effect in the unexpected and undesirable direction), and that threat produces opposite effects in different people. Of course, contrary to this, it is often expected that threat appeals will reduce risky driving (and this expectation is sometimes realised). An effect in this direction is not incompatible with TMT, as it might occur (for example) because conforming with social norms is a psychological defence mechanism, and a means of conforming is by driving safely. TMT does, though, predict that in people for whom driving is linked to their self-esteem, threat appeals will increase risk-taking. Having in mind a clear falsifiable theory, such as TMT, helps greatly in both

planning an experimental program and interpreting the results. Even better would be to have several theories that make different predictions in different circumstances.

The key feature of TMT is the account it provides of the interaction between the mortality salience (MS) evoked by a threat appeal and driving-related self-esteem (DRS) in their effect on risky driving or risky driving intentions: this account is summarised early in the article by R Carey and K Sarma in the previous issue of the journal (Journal of the Australasian College of Road Safety, Vol. 22.4, 2011). The purpose of this letter is to point out that a straightforward way of generating an alternative explanation is as follows.

- In the absence of an interaction of DRS and MS, there would be no hesitation in saying these combine additively. We might even imagine someone's nervous system adding contributions from their personality (DRS) and the stimulus (the threat).

- To explain the interaction while preserving the simple idea of addition, it may be hypothesised that the total (T) is not directly observed, but instead the observed dependent variable is a nonlinear transformation of this. (For further discussion of this strategy of additivity plus nonlinearity for modelling and explaining interaction, see TP Hutchinson, *Interpretation of data showing something has one effect sometimes and a different effect in other circumstances: Theories of interaction of factors*. ASOR Bulletin 28(3), 25-29.)
- Specifically, the dependent variable (risky driving, or risky driving intentions) may be high when T is low, lower when T is intermediate, and high when T is high (i.e., a roughly U shaped function).

This mechanism is a step forward. A further step is to address the question, 'If the dependence on T is U-shaped, what might T be?' One possible suggestion is arousal. It might be that (a) in an experiment about driving, people with high DRS are more aroused than those with low DRS, (b) threat is arousing, and finally (c) both excessively low and excessively high arousal lead to increased risk-taking (possibly deliberately or possibly because of impaired judgement).

In the experiment of Carey and Sarma, DRS was measured and MS was dichotomous. That is better than having two dichotomous variables, but it is probably not sufficient for the data to support one theory rather than another, especially since no-one low in DRS was included in the experiment. To distinguish between one theory and another, some more complex experimental design seems necessary, e.g., 3 x 3 or 2 x 2 x 2.

TP Hutchinson

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The Centre for Automotive Safety Research is supported by both the South Australian Department for Transport, Energy and Infrastructure and the South Australian Motor Accident Commission. The views expressed are those of the author and do not necessarily represent those of the University of Adelaide or the funding organisations.

A single voice for rural road safety

Dear Editor,

Many rural Australians are blasé about the endemic risks associated with undivided rural roads. If they became aware of the full extent of the risks, would it not make a difference?

Undivided rural roads are lethal when a driver has a lapse or a miscalculation. Mountains of research on the dangers of rural roads should be spilling into the homes of rural Australians to help the people who drive these roads fully appreciate the dangers. Easy accessibility to quality research and the networking of ideas would surely help motivate rural residents to moderate their driving behaviour. Several European

countries have significantly lowered their rural road toll since 2001, including France, Portugal, Luxembourg, Germany, Belgium, Spain, the Netherlands and Ireland. These results stem mainly from huge investment in safer roads, better traffic design, lower speed limits and active and passive safety features.

Significant upgrading of the safety engineering of Australia's massive rural road network appears to be happening, but it will take a long time and a lot of money. Lowering the speed limit on select undivided rural roads in Australia would stand a better chance of succeeding if rural residents understood the reasons why. An effective conduit between the road safety research on rural roads and rural communities could be developed quite swiftly – a single voice for rural road safety in Australia.

One example is the US Center for Excellence in Rural Safety, administered by the University of Minnesota and funded by the Federal Highway Administration. Established in 2005, the centre provides all sorts of information for the benefit of rural drivers, including

- the Rural Highway Safety Clearinghouse, which links the user to useful research
- a Safe Road Maps section which uses Google maps and allows motorists access to accident data and 'blackspots' on their chosen route
- profiles of rural communities, groups and individuals who have had success in improving road safety
- information about upcoming safety events and new publications
- new technology
- subscription to a quarterly newsletter.

Rural Australians are very good at looking after their own. An initiative like the Center for Excellence in Rural Safety would provide them with a useful tool. Themes on rural road safety could be pursued for different states, different regions in different states and for different seasonal conditions.

Researchers could be on hand to answer questions raised by rural residents. Research reports could be summarised for rural people with limited reading time. Profiles could be done on average people who have had positive outcomes with road safety initiatives. Highly-experienced driver trainers could lend advice about driver behaviour and low-risk driving techniques. Police could provide information on accident causes, recurring trends and road safety campaigns. Specific links could be provided for teenagers and for use as school-based resources. Rural households could be sent email updates of ground-breaking research and trends in road safety initiatives. All this data could be accessible on one site, allowing rural communities to take more ownership of road safety and empowering them to take more care. Australians in rural areas are resilient and resourceful and should be given every opportunity to access the very best data available.

Andrew Scarce

**Owner/operator
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College News

Staff changes at national office

The College said goodbye to **Jacki Percival** at the end of 2011, after seven years in the role of Executive Assistant at the national office. Over the years, Jacki provided strong administrative support to ACRS staff and members, and in particular she worked diligently 'behind the scenes' to ensure the successful organisation of a number of national conferences. The Executive Committee, members and staff extend their thanks and appreciation to Jacki for her contribution during her time at ACRS. We wish her well for the future.

The College welcomes **Christine Bethwaite** who has taken over from Jacki, managing finance and administration.

Chapter reports

New South Wales

As a new year begins, I would like to thank the Sydney Chapter Executive Committee sincerely for their substantial efforts in 2011 and particularly acknowledge our outgoing members: Joanne Kemp, Doris Lee and especially Tom Gibson after years of commitment to the Committee. We all wish you well in your new and on-going endeavours.

To kick start 2012, we are planning a provocative first event, Media and Morality, in partnership with the St James Ethics Centre. A panel discussion, comprising high profile media, policy and academic representatives, will explore ways in which the media communicates information to the public on important social issues. The panel will debate where the line should be drawn in fair, honest and balanced media reporting on issues that can influence public policy to the detriment or benefit of the general community. This event is planned for March 1 (further details can be found on the Sydney Chapter page of the ACRS website). I hope you can join us.

I am also especially pleased to announce that we have secured the services of Ruth Lilian OAM, L & R Contact Business Services Pty Ltd as our Conference Manager for the 2012 Australasian Conference. Ruth has already proved invaluable in advancing conference preparations and we look forward to releasing the conference program soon following review of abstract submissions.

A/Prof Teresa Senserrick, NSW (Sydney) Chapter Chair and Representative on the National ACRS Executive Committee

South Australia

The SA Chapter continued with its successful program of Lunchtime Dialogues, with three presented between October and the end of the year.

The first was based on the Decade of Action in Road Safety, and the work of the RAA (the SA motoring organisation) in the Asia Pacific. The second was a presentation on why the Motor Accident Commission (the CTP insurer in SA, with an added responsibility for road safety marketing) chose to address motorcycling safety. The three highly acclaimed adverts, featuring Mick Doohan, were shown and discussed. Footage was also shown of the conflicts a motorcyclist faces, as revealed through a camera fitted to the motorcyclist helmet of an ACRS member who is a rider.

The year concluded with a presentation at the Royal Institute of Australia (RiAus). MAC had sponsored a special event the previous month on the science behind speed and road safety. Special guest speakers at that event included Raphael Grzebieta, Bruce Corbin, Jeremy Woolley and Jack McLean. That event involved a live audience, and streamed live on the internet. A dialogue that followed summarised the event and described the other work of RiAus to ACRS members.

Dr Jeremy Woolley, SA Chapter Representative

Victoria

A successful seminar was held in December 2011 with the focus on Community, alcohol and road trauma. The presenters were Geoff March, Director Policy of the Australian Drug Foundation, and Inspector Martin Bormann of the Alcohol and Drugs section of Victoria Police.

Plans for the first half of 2012 include a seminar on Parenting and role modelling and a 'hypothetical' dealing with a workplace crash and the safety and legal implications that flow from this event. Dates are yet to be set.

David Healy, ACRS Co-Vice President and Victorian Chapter Representative on the ACRS Executive Committee

Australian Capital Territory

Dr Stephen Jiggins has resigned as representative of the ACT Chapter. Steve's work on behalf of the Chapter during the last two years has been much appreciated. We thank him for his contributions and wish him well.

Other news

Australian Road Safety Awards 2011

The winners of the inaugural 2011 Australian Road Safety Awards were announced in late November. The Fatality Free Friday Road Safety Foundation (FFFRSF) Awards program, like our own 3M-ACRS Diamond Road Safety Award, recognises outstanding achievement and innovation in the area of road safety in Australia.

Nine winners were acknowledged from a field of 35 finalists across ten categories, representing a broad spectrum of community organisations, government, industry and individuals. Gold Coast City Council won the Local Government Award and the Founder's Award for Outstanding Achievement (Overall Award) for its SMART Motorcycle Training Program. SMART is a road safety initiative that offers professional instruction for licensed motorcycle riders to help improve rider skills and reduce riders' chances of crashing when faced with challenging road conditions. Across Australia, motorcyclists are 20 times more likely to be killed in a fatal road crash than a car driver or passenger; in Queensland, fatalities from crashes involving motorcycles increased by 71.4% between 2003 and 2008 with 72 fatalities resulting from crashes involving motorcycles in 2008.

The Australian Road Safety Awards judging panel included ACRS Executive Committee member and Chair of Road Safety at UNSW, Professor Raphael Grzebieta, international road safety expert Robert Klein and Senior Manager at the National Transport Commission, Dr Jeff Potter.

3M-ACRS Diamond Road Safety Award 2012

Entries for the 3M-ACRS Road Safety Award 2012 will be accepted from 1 April. Entries are sought from individuals or groups with stand-out road safety initiatives or programs which promote and enhance road safety. Entries must demonstrate the capacity to deliver significant road safety improvements. Visit www.acrs.org.au/award for more information. Entries close 15 June.

NRMA-ACT Road Safety Trust reports

The following reports supported by the Trust have been or will be published on the Trust website at <http://www.roadsafetytrust.org.au/c/rtrt?a=da&did=1004593>.

Two Canberra schools successfully undertook road safety projects at different stages in the secondary curriculum. Lake Ginninderra supported students with programs to help them develop a positive approach to road use and to make good decisions when they are driving or out with friends. The funding provided by the NRMA-ACT Road Safety Trust in 2010 made it possible to conduct a program which would provide greater depth and substance and would enable students to experience a whole range of activities which enhance their appreciation of road safety. Melba Copland Secondary College successfully developed and delivered a Safe Cycle program targeting Years 7-10, promoting safety when using multi-user paths, on roads and cycleways in the ACT. The program aimed to promote a culture of safety which could be transferred into future driving.

The Pedal Study conducted by ACRS Executive member and lead researcher, Liz de Rome of the George Institute, examined the characteristics of bicycle crashes in different cycling environments in the ACT and investigated the type and severity of injuries associated with the type of clothing worn. The objective was to inform strategies to reduce bicycle crashes and the severity of the associated injury.

The results of *A study of the effectiveness of driving medication warnings* by Tanya Smyth, Emeritus Professor Mary Sheehan and Professor Vic Siskind of CARRS-Q, Queensland University of Technology, are potentially important for the Australian approach to medication warnings about driving impairment. The research contributes both practical and theoretical findings that can be used to enhance the effectiveness of warnings and developing countermeasures in this area. The Therapeutic Goods Administration (TGA) has initiated a review of the labelling and packaging regulatory framework for prescription medicines, over-the-counter medicines and complementary medicines, and an external reference group has been established with representatives from key consumer, healthcare professional and industry stakeholders to inform this review. The Trust has drawn the attention of the TGA to the study and also forwarded a copy of the final report.

Diary

18-19 April 2012, Melbourne. Intelligent Transport Systems Conference 'Beyond 2012'.

9-10 August 2012, Sydney. 2012 ACRS National Conference 'A safe system – Expanding the reach'. www.acrs.org.au/activitiesandevents.

29-31 August 2012, Groningen, Netherlands. 5th International Conference on Traffic and Transport Psychology.

20-21 September 2012, Gold Coast, Queensland. Occupational Safety in Transport (OSIT) Conference. <http://ositconference.com>.

1-4 October 2012, Wellington, New Zealand. World Health Organisation Safety Conference. www.conference.co.nz/worldsafety2012.

4-6 October 2012, Wellington, New Zealand. Australasian Road Safety Research, Policing and Education Conference. <http://rsw2012.transport.govt.nz>.

Peer-reviewed papers

Can radar detectors and safety warning system (SWS) signals improve road safety?

by CM Rudin-Brown and M Cornelissen, Human Factors Team, Monash University Accident Research Centre (MUARC), Monash Injury Research Institute (MIRI)

Abstract

The relationship between speed, crash risk and crash severity is well documented. In-vehicle radar detectors are small, specialised radio receivers tuned to the frequency range used by police radar guns. These devices make it possible for drivers to detect police radar efforts and to alter their travel speed. Safety Warning Systems (SWS) emit pre-programmed radar signals that can be received by radar detectors up to one kilometre away, and can provide warnings to an equipped vehicle regarding potential road safety hazards. SWS have been promoted by some as inexpensive and practical warning devices that can be used within existing infrastructure; however, it is unclear whether any potential benefits would outweigh speeding-related costs. An independent review of the survey, observational and crash data literature pertaining to SWS and radar detectors was conducted. Collectively, the literature indicates that, because radar detectors are used predominantly by an already high-risk group of drivers, their application as receivers of SWS signals is unlikely to result in overall benefits to road safety.

Keywords

Crash risk, Drone radar, Road safety, Speed choice

Introduction

The relationship between speed and crash risk is well documented [1-6]. Each year in Australia over 1,400 people die as a result of road crashes. Speeding is a contributing factor in about 34 % of Australian road deaths and 13% of serious injuries [7]. The yearly economic cost to society of speeding-related crashes is high. In Australia in 2006, the Bureau of Transport Economics estimated that road trauma costs the Australian community almost \$18 billion annually [8]. In the United States in 2007, the annual cost was estimated to be \$40.4 billion [9]. Driving at high speeds reduces the available time margin for a driver to recognise and respond to hazards in the road environment and makes lateral control of the vehicle more difficult [1, 4]. In turn, crash severity is also highly affected by impact speed [10].

In-vehicle radar detectors - small, specialised radio receivers tuned to the frequency range used by police radar guns - make it possible for drivers to detect police radar efforts and to alter their travel speed to avoid penalties for speeding infractions [11]. Radar detectors are illegal in many jurisdictions around the world, including most European countries, Canadian provinces and territories, and American states. In Australia, the use of in-vehicle radar detectors is prohibited in all states except Western Australia. In keeping with Australian Road Rule 225 *Using radar detectors and similar devices*, the Government of Western Australia is drafting proposed amendments that will ban the fitment and use of radar detectors by drivers. There is opposition, however, from certain driver lobby groups that argue against the proposed ban and contend that radar detectors offer safety benefits by allowing drivers to be more aware of their speed and to slow down. More specifically, the primary benefit advanced by these lobby groups is the ability of some radar detector devices to detect warning signals emitted by Safety Warning Systems (SWS) and drone radar. SWS are pre-programmed devices that emit radar signals that can be received by radar detectors up to one km away. 'Smart' detectors can, in turn, provide an audible and/or visual warning to a driver regarding a potential road safety hazard [12]. Drone radar simulates the presence of law enforcement by transmitting signals using the same radar frequency, therefore activating radar detectors in passing vehicles. According to the Australia Drivers' Rights Association (ADRA), as of 1 June 2010, there were approximately 170 SWS transmitter locations in Western Australia.

The aims of the present review were to investigate the road safety impacts of radar detector use by drivers, and of SWS signals transmitted from roadworks sites, emergency vehicles and black spot locations being received by users of radar detectors.

Method

The relevant road safety literature pertaining to SWS and radar detectors was sourced through an extensive search of national and international road safety research, transport and road links websites and research databases using appropriate key words.

Literature review

Research has indicated that the presence of in-vehicle radar detectors contributes to drivers' non-compliance with highway speed limits. For example, in a random sampled telephone survey in the United States, 58% of radar detector users said they drove faster than they would without a radar detector and 75% of the users said that the apparatus saved them from at least one speeding ticket [11].

Besides those that only detect police radar emissions, there are also so-called 'smart' radar detectors that can also detect SWS messages. When activated, SWS emit pre-programmed messages that can warn a driver through the use of either an audible tone or a visual (on-screen) message. There are currently 64 standard messages that can warn drivers, amongst other things, of accidents, lane closings, severe weather conditions, road construction, and the presence of emergency vehicles. It has been asserted that other radar detectors, which are not SWS-compatible, can nevertheless detect SWS signals; however, they generally produce only a simple audible tone and do not display standard SWS messages [13].

One of the benefits of SWS is that they can be used immediately within existing infrastructure; this makes them inexpensive and practical to implement. Furthermore, it is possible to use SWS technology in a safety warning-only receiver system capacity that displays highway safety and information messages only, while not being able to detect and alert a motorist to the presence of police radar [14].

The question remains as to whether the proposed benefits of SWS signals on road safety are, in fact, accurate. Are radar detectors really a means of improving safety on our roads? To answer this question, available survey, observational (on-road), and crash (insurance) data studies were reviewed.

Surveys of radar detector owner/users

Three surveys of radar detector users were found to be prominent in the international discussion concerning banning of these detectors [15,16, 17]. Probably the most referred-to study in the debate is a study by Yankelovich, Clancy, and Schulman [15]. Unfortunately, the original, complete report is not publicly available; therefore, only highlights and abstracts as described by other sources are presented. The ostensible purpose of the study was to determine whether there was a significant difference in the accident rate per miles driven of users vs. non-users of radar detectors in the United States. Researchers selected two samples of participants for a telephone survey: one consisted of 1000 randomly drawn drivers, and the second consisted of 1000 recent purchasers of radar detectors (although only 805 reported having and using a radar detector at the time of the survey). Radar detector users were found to report driving, on average, twice the mileage of non-users. The authors of the study conclude that radar detector users are at least as safe as non-users because they drive more miles between collisions (233,933 miles for users vs. 174,554 miles for non-

users). A limitation of the survey, however, is that the two samples were not balanced across any other, possibly contributory, factors. This makes it difficult to conclude whether the difference in mileage driven is due to radar detector use or because of other reasons.

Users of radar detectors believe that they are safer drivers when using their radar detectors than when not using them [16]. A multi-method survey of radar detector users undertaken by the Australian Drivers' Rights Association (ADRA) revealed that 75% of drivers interviewed believed that they were safer drivers with their detector. Unfortunately, the original ADRA survey data is not publicly available; therefore, it was not possible to systematically review the survey methodology used. Three hundred radar detector owners in Australia were randomly selected for the survey that was conducted by telephone, fax and email. For an unknown reason, only the first 200 responses were analysed. Non-users of radar detectors were not included. Users reported driving between 12,500 and 25,000 miles (20,000 – 40,000 kms) annually. 93% of respondents were male and 37 %were aged between 26 and 35 years old. When asked about their driving behaviours when using radar detectors, 41% of the sample reported not slowing their average speed after fitting a radar detector. Those who reported that they drove faster than the posted speed limit reported that they only did so in rural areas and that they stayed with the flow of traffic. Almost 70% of respondents said they were more aware of enforcement while using a radar detector, and 86% reported being more aware of their speed, speed limits (71%) and driving conditions (82%). Two-thirds of the respondents reported that the use of radar detectors helped them combat fatigue. Interestingly, 4% of respondents reported having been involved in an accident, and 45% reported that they had received one or more speeding tickets since they purchased their radar detector.

Radar users and non-users appear to differ on a number of driving-related and demographic characteristics. A telephone-based survey of over one thousand radar detector users and non-users, conducted for the Drivers' Technology Association in the UK, was designed to gain insight into drivers' behaviour and attitudes towards in-vehicle radar detectors [17]. Results showed that users and non-users differ in characteristics including annual mileage driven, employment status, and type of vehicle model owned. In general, users of radar detectors were found to drive almost twice the annual mileage of non-users. Further, compared to non-users, a larger proportion of users were employed full-time, had higher incomes, and were more likely to driver a high performance vehicle (e.g. Audi, Volkswagen, BMW, Mercedes or Jaguar), which, in turn, were also more likely to be equipped with other in-vehicle technological features [17]. Users of radar detectors also reported travelling 50% further between collisions than did non-users. Interestingly, 75% of users reported that they had become more aware of the speed limit since purchasing a radar detector and that purchasing a radar detector had had a positive effect on their driving behaviour.

Because of limitations in methodology, it is difficult to draw conclusions from these studies regarding whether radar detector users are safer drivers than non-users. Radar detector users reported that they are more aware of speed limits and their speed than non-users. The data suggest, however, that non-users are naturally more aware of their own speed than users, as users only appear to gain this awareness after the purchase of their radar detector. Whether the awareness of speed results in corollary changes in driving behaviour is questionable; only 41% of users reported having slowed their average speed since beginning to use a radar detector and, despite having one, many (45%) report continuing to receive speeding tickets. The lack of objective performance data associated with the above surveys prevents reliable conclusions from being drawn regarding the safety of users vs. non-users. Observational (on-road) studies should provide more objective evidence of any differences between user vs. non-user groups.

Observational studies

Potentially, experimental and/or observational studies can provide objective evidence regarding the effect of radar detectors, and whether there are safety benefits associated with the use of these devices. Observational studies typically use a variety of methods to measure the speed of vehicles and whether they are equipped with radar detectors. For example, to measure the speed of passing traffic, typically non-detectable speed measuring devices (e.g. in-pavement loop detectors or retuned radars) are used to determine the normal mean traffic speeds. Following this first measure, regular police radar emissions, which can be received by radar detectors, are then activated. The resulting speed change (if effected) is then measured using the non-detectable speed measuring devices. Vehicles that change their speed by a certain threshold after the regular radar has been used are then presumed to be equipped with a radar detector. Studies may also use the observation of brake light activation following the discharge of regular radar to determine whether vehicles are fitted with a radar detector. Finally, radar-detector-detectors (devices that can detect the presence of a radar detector within vehicles) have been used by some researchers to provide a more reliable measure of radar detector usage [18].

Effects of SWS signals on vehicle speeds

Vehicles equipped with radar detectors slow down when in proximity to SWS signals. For example, an observational study conducted in work zones in the US measured speed in passing vehicles under three conditions: no transmitter activity, a drone radar signal, or SWS messages. Speeds were subsequently measured at three stations: road tube station, data collection vehicle station, and radar station. A radar-detector-detector was used to determine whether passing vehicles were equipped with radar detectors. Results showed no significant changes in speed, probably due to the low level of use of radar detectors in the traffic stream. When data of individual vehicles were analysed,

however, the majority of the vehicles with radar detectors were found to slow down, and to do so more when exposed to a SWS message than to a drone radar signal or no signal at all [10].

Studies in the US in which multiple devices, including a SWS, were evaluated revealed mixed results. Reports from Iowa [19] showed no significant change in measured vehicle speed. Speed was measured in a work zone involving a left lane closure with a crossover leading into two-way traffic. Data was collected two days prior to, and two days following, the installation of the SWS. None of the speed measures showed a significant difference. According to Robinson et al. [20], the lack of an effect might have been due to the small number of vehicles equipped with radar detectors in the traffic stream. In Kansas, however, researchers [21] also installed a SWS on a crossover point in a work zone. There they measured speed prior to reaching the crossover and half way through the crossover bend. The data of the prior measurements were not usable, but measurements taken in the curve were, and they showed a significant decrease in speed after installing the SWS.

Although there are indications that SWS might be more beneficial than the use of radar drones in reducing speeds of radar detector-equipped vehicles, this cannot be concluded based on the above studies. This is especially true since users of older detectors will receive the same signal in their vehicle regardless of whether the transmitter is an SWS or drone radar. The use of drone radars will be discussed next.

Effects of drone or police radar on vehicle speeds

Results from observational studies examining the ability of drone radar to reduce vehicle speed are generally inconclusive. Streff, Kostyniuk and Christoff [22] evaluated the effectiveness of drone radars in reducing speed (with and without police patrol car presence) on a US freeway (speed limit of 65 mph or 105 km/h) and in a construction zone (speed limit of 55 mph or 90 km/h). Measurement conditions varied. The radar drones were either on or off; police patrols were present or not; and speed was measured at three locations (upstream, at, and downstream of the drone radar). Different speed measures were used. Presence of radar detectors was measured using radar-detector-detectors. Results from the freeway and the work zones appeared to be consistent. Approximately five % of the traffic stream was equipped with a radar detector. The results show that the actual differences in mean speed were small (between 1 and 1.5 mph), but statistically significant. However, differences between measurements in the opposite directions showed that other factors influenced the speed of passing traffic. Surprisingly, the additional presence of police patrols did not cause practical reductions in the speed of the vehicles, which is contrary to findings of other studies (see next paragraph). Further, the speed reducing effect of drone radar was consistently found for commercial vehicles, which are generally more likely than other vehicle types to be equipped with radar detectors.

Roadwork zones

Observational studies find that vehicles equipped with radar detectors were generally speeding more before the radar detectors were activated [23]. Further, research by Ullman [24] has found that any safety benefits probably would not be observed by using SWS alone, but rather in combination with warning signs, for example.

Turochy [25] reports a study that found a speed control effect of drone radar in freeway working zones. On-site data were collected in several work zones. Speed measurements were conducted upstream as well as near the unmanned radars. The results showed significant reductions in mean speed and the percentage of traffic that was exceeding the speed limit. Interestingly, unmanned radar was most effective when police presence was expected by drivers. This has been confirmed by Benekohal [26] who, despite not obtaining consistent results, showed that speed reductions were not as effective when drivers knew the radar was a drone than when they did not.

A recent (2007) study of drone radars in South Carolina (US) work zones by Eckenrode and colleagues [23] used a radar-detector-detector to identify those vehicles equipped with active radar detectors. Results revealed a 10 km/h decrease in speed in those vehicles that were equipped with radar detectors although the sample size for these types of vehicles was insufficient to run a statistical test. While statistically significant, speed reductions were more conservative, however, in terms of reducing mean speeds of all traffic (reduction of ≈ 3 km/h), and in the percentage of vehicles that were exceeding the speed limit (reduction of 2 – 8 km/h). Further, observed speed reductions were of only brief duration. Of particular interest was the observation that, when the drone radar was turned off, major differences between the vehicle groups were observed. Radar detector-equipped vehicles travelled much faster than non-detector-equipped vehicles, which is the opposite of what happened when the drone radar was turned on. The researchers conclude that, due to the ease of installation and low costs involved, radar detector use might be effective to reduce speeds in certain radar-equipped vehicles.

Several studies have found interaction effects concerning vehicles equipped with radar detectors vs. those that are not. Ullman [24] found different effects for those vehicles observed to be exceeding the speed limit, and for trucks. Speed measurements were collected upstream from, and in, a work zone, and speed changes within the work zone as well as vehicle conflicts were recorded. Results showed that, across seven of eight sites tested, radar signals were associated with minimal (0.3 to 2.5 km/h) speed reduction effects on average speeds within the work zone, and this effect was only statistically significant at two of the eight sites. The greatest effect, however, was demonstrated by those who were approaching the work zone with a speed greater than 105 km/h (the speed limit), and by trucks. Ullman notes that this coincides with the observation that those target vehicles (speeding and commercial

vehicles) are generally more likely to be equipped with a radar detector than other vehicles. Interestingly, these researchers also looked at vehicle conflicts during their study and found that crashes due to severe braking may increase in the presence of radar signals.

As part of a larger research project, Carlson, Fontaine and Hawkins [27] tested the effect of drone radar on speed reduction in a work zone and found an interaction with the use of other devices. Speed reductions as a result of the drone radar were marginal (≈ 3.2 km/h) and were not statistically significant. Radar drones were also tested alongside other devices, like warning signs. Together with advisory signs of the temporary speed limit, speed of cars was reduced significantly (≈ 4.8 km/h) and it reduced the number of vehicles exceeding the maximum speed limit. These researchers note that, in previous research, it has been noted that commuters and truck drivers who drive the road regularly become suspicious if no obvious enforcement is in place.

The effectiveness of drone radars appears to depend on several factors. On the basis of their literature review, Eckenrode and colleagues [23] concluded that effectiveness depends on three factors: the number of radar detectors in the traffic stream, the frequency used (as some bands have more false alarms than others), and whether drivers are actually deceived that there is police presence. It was also suggested that, with advancements in the sophistication of radar detector technology, drone radars were becoming less effective at reducing speeds. The review also concluded that only a limited number of studies have been conducted in the United States since 1995, the year in which radar detectors became illegal, and thus the number of radar detectors in the traffic stream is reduced [23].

Blackspots/high accident zones

A study by Pigman et al. [28], undertaken in a high accident zone in the US state of Kentucky, involved the assessment of unmanned radars as well as the diversion of trucks onto a bypass route. Speed-related data were collected over time and a survey on radar detector use was undertaken. Differences in mean speed following installation of the unmanned radars were small; however, the individual speed of vehicles with radar detectors decreased significantly, while those of vehicles that were not equipped with radar detectors was not affected.

Long-term effects

Although research has found that speed is reduced when police radars are activated, direct empirical evidence regarding the duration of speed reduction is lacking [11]. Two separate studies were conducted to determine the duration of speed reductions caused by radar detector exposure. In the first study, speed of ambient traffic was measured using an inductance loop. Speed measurements were made in five different conditions: a) no police radar present, b) police radar at

inductance loop, c) police radar one mile before the loop, d) police radar 2 miles before the loop, and e) police radar 5 miles before the loop. Results showed that when speed was measured directly after exposure to the police radar, the vehicles exceeding the speed limit by 10 mph decreased from 42% to 28%. Measurements taken one mile after police radar activation showed that 38% of vehicles were travelling more than 10 mph above the speed limit again. By two or five miles after exposure to the police radar, 40 % of vehicles were exceeding the speed limit by more than 10 mph [11].

In a second study (reported in [11]), only speeding vehicles were included in the analysis. Speed of a vehicle was measured at five different locations. First, a non-detectable speed measurement device was used. If this device indicated that a vehicle was speeding, a detectable radar was then directed towards the vehicle, and speed was re-measured (1, 3 and 4 miles after activation of the detectable radar) and potential lane changes and brake light activation were observed. Results revealed that, of those vehicles speeding (more than 10 mph above the speed limit, which was 65 mph on this particular stretch of road), 39% reduced their speed by at least five mph after activation of the detectable radar. In total, 44% of the vehicles reduced their speeds by at least five mph or activated their brake lights (without receiving obvious traffic obstructions), which suggests that 44% of the speeding vehicles passing the study zone were using active radar detectors [11]. Speed measurements also revealed that speed prior to detectable radar activation was, on average, higher for those assumed to be using radar detectors than for those assumed not to be using radar detectors. After activation of the detectable radar, the vehicles assumed to use radar detectors slowed down by more than 10 mph, while other vehicles only slowed down by 1 mph, on average. The speed of the vehicles with assumed radar detectors was equivalent to the other speeding vehicles again four miles after radar activation; however, it did not return to the speed level recorded before activation within those four miles. The authors of the study therefore conclude that radar detectors do not induce long-term compliance with speed limits, and view the results as supporting their contention that the motivation for buying a radar detector is to avoid speeding-related infractions.

To conclude, results from observational studies reveal that radar detector users generally seem to drive faster than non-users. Upon detecting radar signals, however, users decrease their speed more than non-users. Whether this has an effect on the flow of the general traffic stream remains to be determined. Furthermore, the speed reduction related to radar detectors is greatest directly after exposure to a detectable radar. By approximately three to five kilometres after the exposure, effects are largely nonexistent. This effect may be similar in nature to the 'halo' effects (lasting effects over time or distance from a speed enforcement treatment) observed upstream and downstream of other speed enforcement approaches, including speed cameras and police presence [29-31].

Analysis of crash data of radar users vs. non-users

There is no conclusive research evidence regarding whether higher speeds are an expected outcome resulting from the protection offered by radar detectors, or whether those who own (and use) such devices would be faster drivers than others regardless of radar detector use. While radar detector manufacturers and lobby groups claim that those who use detectors are actually better drivers and have fewer accidents per kilometre driven than those drivers who do not use radar detectors, such claims are difficult to evaluate without more solid data concerning the safety impact of radar detectors [32].

In an effort to provide an objective answer to the question of whether radar detector users are less safe than non-users, researchers in Canada used records of an insurer -Insurance Cooperation of British Columbia (ICBC) - to sample participants [33]. Radar detector users were identified by categorising claims and policies in which radar detectors were listed. The researchers acknowledged that the group of users that took out the extra insurance probably was not representative of the general population, and this was confirmed as this group were more likely to be younger, male, owners of expensive cars, and they were more likely to drive either to/from work or as part of their work than the general population. As a consequence, the researchers controlled the sample for exposure. However, because of the non-representativeness of the sample, conclusions based on the results can only be extended to the subgroup of male drivers between ages of 21 and 42 who drive for business purposes or to/from work, typically in medium- or higher-priced vehicles. For that group, and controlled for exposure, radar detector ownership was associated with significantly higher rates of collision claims per year in general as well as for those where the driver was at-fault or for those occurring on weekends with only a single vehicle involved. The radar detector users in this subgroup were also convicted of speeding more often than were non-users.

Based on these results, and the attempt to control for as many factors as possible, it was concluded that radar detector users in the subgroup under study were less safe than non-users. However, a cause-and-effect relationship between owning a radar detector and driving less safely could not be concluded. Rather, ownership of a radar detector was put forth as being indicative of a predisposition toward more risky driving behaviour in the first place [33].

Discussion

The main question guiding this review was: 'Will radar detectors and, specifically, those that can receive SWS messages, increase safety on our roads?' This is a very broad and complex question; however, it can be answered on the basis of the literature reviewed above.

It seems that, based on the literature reviewed, the use of radar detectors is more prevalent in large commercial trucks than in cars. Furthermore, radar detector use seems to be largely restricted to a particular subgroup of the population: young men, with good jobs and high performing cars, who drive long distances [24]. Claims regarding the effects of radar detector use can therefore only be made regarding this subgroup of drivers. This subgroup generally seems to speed more often than the general population, which may be either because they feel protected by the radar detector, or because they are more predisposed to speeding in the first place—the available data does not allow for determination of cause and effect.

When radar emissions are received by vehicles equipped with radar detectors, drivers of those vehicles appear to reduce their speed more than non-users (as non-users do not detect the signal of the radar detector), and will then show slower speeds than non-users [24]. After a few miles, though, the effect seems to diminish and the users are either back to their previous speed or to the speed of the traffic flow locally [23]. These transient effects of speed enforcement treatments are often referred to as ‘halo effects’ and have been observed as a consequence of other speed reduction techniques including speed cameras and visible police presence [29-31].

Based on the literature, the transmission of radar or SWS messages seems to be associated with reduced average speeds for the high-risk driver subgroup described above. These speed reductions appear to last only for a short distance within a local area. The effect is only temporary; the literature suggests that it would not result in reduced average speeds of the entire traffic stream, and vehicle collisions due to the braking of those drivers responding to the radar signal have been reported [24].

Whether the use of radar detectors makes drivers safer is difficult to determine. The research is inconsistent. Surveys find that people report that they are safer drivers when using a radar detector and that radar users report driving more kilometres in between collisions than non-users. However, samples are non-representative and, therefore, user and non-user groups are not comparable. Furthermore, the surveys are based on self-reported data, which is recognised as being limited methodologically [34]. Interestingly, a crash data evaluation study that controlled for exposure within its sample found that radar detector users were actually found to be less safe than non-users [33]. One further issue regarding the research literature in the area of SWS and radar detectors is that it is relatively old—most likely because the use of radar detectors has been prohibited in much of the western world since the mid-1990s.

Whether the results should encourage or discourage the use of radar detectors should be subject to more in-depth research. For example, controlled or driving simulator experiments could be used to investigate the effect of radar detector use on a wider group of the general population and under different circumstances. This would overcome some of the limitations within the current literature described above, for example, the

non-representativeness of samples. Also, the question remains as to whether the benefits of speed reduction locally due to the use of radar detectors outweigh the costs of speed increases in areas that are not under radar transmission by those same drivers. That is a question that is impossible to answer based on the reviewed research.

Finally, the effects of prolonged exposure to radar warning transmissions by radar detector users are not known. Research suggests that, if vehicles are exposed to drone radars without obvious enforcement for long periods, they will be less likely to decrease their speed; however, there is, at present, no objective research available to confirm this contention.

Conclusions

The literature review identified a number of survey, observational and crash data studies that have been undertaken in the area of radar detectors, owner characteristics, and driver speed choice. Limitations associated with some of these research methodologies, in particular with surveys and observational studies, limit the extent to which the findings can be used to inform definitive conclusions. Despite these limitations, the available literature revealed several reliable findings. These include:

- In-vehicle radar detectors are associated with non-compliance of highway speed limits.
- Drivers of vehicles equipped with radar detectors tend to be predominantly young, employed males, who own expensive, high-performance vehicles.
- Compared to others, drivers of vehicles equipped with radar detectors tend to drive greater distances and be involved in more collisions (make more insurance claims).
- Collectively, results from observational studies indicate that the presence of SWS or drone radar signals results in small (3 to 10 km/h) but significant reductions in the speed of radar detector-equipped vehicles in their vicinity.
- The speed reduction effects of radar detectors are limited to vehicles that are equipped with an active device.
- The speed reduction effects of radar detectors are limited to a small area (approximately 3 km) around the location of a SWS/drone radar.
- Some research has found an increase in crashes in areas surrounding drone radar emissions. This may be due to increases in speed variability between those vehicles equipped with radar detectors vs. those that are not.
- There are currently a limited number (approximately 170) of SWS transmitters in use in WA.

To conclude, because radar detectors are used predominantly by an already high-risk group of drivers (young, affluent males who own high performance vehicles and drive long distances), the application of radar detectors as receivers of SWS and drone radar signals is unlikely to result in overall benefits to road safety. Such a system would only be of benefit to *temporarily*

and *locally* reduce the speed of those target vehicles equipped with radar detectors, which are already likely to be exceeding the speed limit (possibly due to the pre-existing presence of an active radar detector). A focus by jurisdictions on more recently developed, in-vehicle advanced driver assistance systems (ADAS), such as Intelligent Speed Adaptation (ISA), would be more likely to result in significant gains in overall road safety.

References

- Davis, G.A., Davuluri, S., & Pei, J. P. (2006). Speed as a Risk Factor in Serious Run-off-Road Crashes: Bayesian Case-Control Analysis with Case Speed Uncertainty. *Journal of Transportation and Statistics*. 9(1): p. 17-28.
- Kloeden, C., & McLean, J. (1998). How traveling speed relates to the risk of crash involvement. *ITE Journal*. 68(9): p. 16-17.
- Kloeden, C.N., & McLean, A. J. Rural speed and crash risk in Road Safety Research, Policing and Education conference. 2001. Melbourne.
- Liu, G.X., & Popoff, A. (1997). Provincial-wide travel speed and traffic safety study in Saskatchewan. *Transportation Research Record*. 1595(8-13).
- TRB (1998). Managing speed: review of current practice for setting and enforcing speed limits. SR254: Transportation Research Board
- Vorko-Jovic, A., Kern, J., & Biloglav, Z. (2006). Risk Factors in Urban Road Traffic Accidents. *Journal of Safety Research*. 37(1): p. 93-98.
- Dept. of Infrastructure Transport Regional Development and Local Government (2011). Road deaths Australia: May 2011 summary. Canberra.
- Bureau of Infrastructure Transport and Regional Economics (BITRE) (2009). Cost of road crashes in Australia in 2006. Research Report 118: November: Canberra.
- NHTSA (2007). Traffic safety facts: 2007 data. Speeding. Report number DOT HS 810 998: Washington, DC.
- OECD (2006). Speed Management Summary Document. European Conference of Ministers of Transport/OECD Joint Transport Research Centre
- Teed, N., A.K. Lund, and R. Knoblauch (1993). The duration of speed reductions attributable to radar detectors. *Accident Analysis and Prevention*. 25(2): p. 131-137.
- Australian Drivers Rights Association. (2011). ADRA. [cited 5 July 2011]; Available from: www.adrawa.com.au/sws.htm.
- Scaduto, T. (1996). Driving intelligence: now radar detectors can alert you to road hazards, approaching emergency vehicles and a lot more than just speed traps. *Popular Mechanics*. October: p. 66-68.
- Greneker, E.F. The safety warning system: An in-vehicle signing system using an existing infrastructure of 10 to 20 million vehicular receivers. in *Proceedings of 7th Annual Meeting and Exposition of Merging the Transportation and Communications Revolutions*. 1997. Washington, DC.
- Yankelovich. (1987). Yankelovich Clancy Schulman Radar Detector Survey Highlights. [cited 6 July 2011]; Available from: www.carr.org.au/d-yankelovich.pdf.
- Safety Warning System (2001). Speed, radar detectors and safety: New Australian survey validates concept behind SWS [Electronic version]. *SWS Monitor*. p. 1-2.
- Leaman, J. and J. Down (2001). Radar Detector Survey. MORI.
- Freedman, M., A.F. Williams, N. Teed, and A.K. Lund (1990). Radar detector use and speeds in Maryland and Virginia. Insurance Institute for Highway Safety: Arlington.
- Kamyab, A., T.H. Maze, S. Gent, and C. Poole. Evaluation of speed reduction techniques at work zones. in *Proceedings of the Mid-Continent Transportation Symposium*. 2000. Ames, Iowa.
- Robinson, M., P. McGowen, A. Habets, and C. Strong (2002). Safety applications of ITS in rural areas. DTFH61-98-C-00073, Science Applications International Corporation: McLean, Va.
- Meyer, E. Midwest smart work zone deployment initiative: Kansas' results. in *Proceedings of the Mid-Continent Transportation Symposium*. 2000. Ames, Iowa.
- Streff, F.J., L.P. Kostyniuk, and C. Christoff (1995). Effects of drone radar and police enforcement on travel speeds: Test on a 65 mph freeway and 55 mph construction zone. Report number UMTRI-95-22: The University of Michigan Transportation Research Institute: Ann Arbor.
- Eckenrode, R.T., W.A. Sarasua, J.H. Mattox, J.H. Ogle, and M. Chowdhury. Revisiting the use of drone radar to reduce speed in work zones: South Carolina's experience. in *Proceedings of the Transportation Research Board Annual Meeting*. 2007. Washington, DC.
- Ullman, G.L. (1991). Effect of radar transmissions on traffic operations at highway work zones. *Transportation Research Record*. 1304.
- Turochy, R.E., A study of the effectiveness of unmanned radar as a speed control technique in freeway work zones, in *Civil Engineering*. 1997, Virginia Polytechnic Institute and State University: Blacksburg.
- Benekahal, R.F. (1993). Temporal speed reduction effects of drone radar in work zones. *Transportation Research Record*. 1409: p. 32 - 41.
- Carlson, P.J., M.D. Fontaine, and H.G.H. Jr. (2000). Evaluation of traffic control devices for rural high-speed maintenance work zones. FHWA/TX-00/1879-1, Texas Transportation Institute: College Station.
- Pigman, J.G., K.R. Agent, J.A. Deacon, and R.J. Kryscio (1989). Evaluation of unmanned radar installations. *Transportation Research Record*. 1244: p. 7 - 16.
- Hajbabaie, A., M.-H. Wang, J. Medina, M. Chitturi, and R. Benekahal. Sustained and Halo Effects of Various Speed Reduction Treatments in Highway Work Zones. In *Proceedings of the 90th Annual Meeting of the Transportation Research Board*. 2011. Washington, DC: TRB.
- Anderson, R. Introducing speed cameras in the ACT: How to win friends and influence people. In *Proceedings of the Road Safety Research, Policing, and Education Conference*. 2000. Brisbane, Qld: Queensland University of Technology.
- Sisiopiku, V.P. and H. Patel (1999). Study of the impact of police enforcement on motorists' speed. *Transportation Research Record*. 1693: p. 31-36.
- Cooper, P.J. (1992). Speed safety and radar detectors. *ITE journal*. 62(10): p. 17-20.
- Cooper, P.J., Y. Zuo, and M. Pinili (1992). Are radar detector users less safe than nonusers? *Accident Analysis and Prevention*. 24(4): p. 329 - 338.
- Rudin-Brown, C.M., R.W. Jenkins, T. Whitehead, and P.C. Burns (2009). Could ESC (Electronic Stability Control) change the way we drive? *Traffic Injury Prevention*. 10(4): p. 340-347.

Connection without caution? The role of mobile phone involvement in predicting young people's intentions to use a mobile phone while driving

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Abstract

The present study examined the predictors of the intentions of young people aged between 17 and 24 years (N = 196) to use their mobile phone while driving. Using convenience sampling, drivers were recruited at petrol station travel centres to complete a cross-sectional survey. The Theory of Planned Behaviour constructs of attitude, subjective norm, and perceived behavioural control (PBC) were measured, as well as mobile phone involvement - a construct based on behavioural addiction components to reflect people's cognitive and behavioural interaction with their mobile phone. Attitudes, PBC, and mobile phone involvement predicted young people's intentions to use their mobile phone while driving, highlighting the need for interventions to address the perceived rewards and costs of the behaviour and to challenge the potentially powerful need to be constantly connected with others by technology irrespective of the associated dangers.

Keywords

Attitudes, Driver distraction, Mobile phone, Road safety, Theory of Planned Behaviour

Introduction

Within the communication field, new technologies have allowed instant connection to information and other people in an unprecedented manner. At the same time, they have created the potential for risky situations involving use of the technologies. One of these contexts is using mobile technologies while driving, where the incorporation of some new applications now available on these devices (e.g., assisted navigation) can serve to aid drivers. In contrast, other functions (e.g., access to email and social networking sites via mobile devices) can provide a distraction from the main purpose of safe driving.

Mobile phone use

In Australia, mobile phone use while driving is a fairly common behaviour but is illegal in the case of hand-held phones [1]. Mobile phone use while driving has been associated with risks of crashing due to reduced driver attention on road conditions and driving tasks [2, 3]. It is likely that people use their mobile phones while driving due to the identified benefits of mobile phone use in general such as remaining in contact with others [4], and allowing instant access to information especially via the

increasing number of available applications (e.g., social networking sites). Although these functions may be beneficial in many contexts, when driving, the potential for drivers to respond to contact from others rather than focusing on the task at hand presents a safety risk.

The focus in the present study is the mobile phone use of young people (for the purpose of this study, young people are defined as persons aged between 17 and 24 years), given (i) the general over-involvement of young drivers in road crashes in Australia and internationally and (ii) the greater use of mobile phones among young drivers while driving. First, road crash statistics consistently reveal that young drivers are over-represented in both fatalities and injuries in Australia and many other countries around the world. For instance, within Australia, although road crash fatality rates have steadily declined over recent decades, young drivers continue to be killed at rates that far exceed those of older, more experienced drivers [5]. Second, in Australia, in addition to young adults having the highest level of general mobile phone use [6], they are also more likely to use a mobile phone while driving than older drivers [1].

There is evidence that many young people believe the benefits of mobile phone use while driving outweigh any costs, in particular, the increased risk of crashing [4, 7]. Researchers have examined the predictors of mobile phone use in general, and specifically in the case of risky or problematic behaviours such as while driving [8, 9]. A number of researchers have drawn on well-validated models, such as the Theory of Planned Behaviour (TPB) [10], to understand the determinants of decisions made by drivers, including those of young drivers, in this context.

Theory of Planned Behaviour

The TPB is a model of decision-making where behaviour is determined by the individual's intentions to perform the behaviour [10]. Intentions, in turn, are influenced by an individual's attitude, subjective norm, and perceived behavioural control (PBC). Attitude reflects a person's favourable or unfavourable evaluation of performing the behaviour; subjective norm is how much the person feels social pressure to perform or not perform the behaviour; and PBC describes how easy or difficult a person perceives performing the behaviour to be (and may influence behaviour directly). In addition to meta-analytic results across a wide range of behaviours [11], there is some limited evidence for the model in predicting intentions and behaviour for mobile phone use in general [12], and intentions

for mobile phone use while driving among community populations [13]. For younger drivers, there is some support for the utility of the standard TPB constructs in examining road safety behaviours such as drink driving [14] and some emerging evidence related to mobile phone use while driving [15, 16]. Although TPB constructs are usually measured by multiple items, single item measures for TPB constructs have been used in a variety of studies [11, 17, 18] and can provide an initial indication of the utility of the model for predicting a target behaviour.

Recently, researchers have identified that some people develop such a dependent relationship with the functions and connections a mobile phone provides that it can lead to an over-reliance on the medium, even when use is socially inappropriate (e.g., cinemas, lecture theatres) or dangerous (such as whilst driving) [19, 20]. Based on qualitative research [21], Walsh, White, and Young [22] developed their mobile phone involvement questionnaire (MPIQ) which drew on the framework of Brown's [23, 24] behavioural addiction components as the basis for measuring mobile phone involvement. The MPIQ includes symptoms such as cognitive and behavioural salience (the activity dominating thoughts or behaviour), withdrawal (negative physiological or psychological response to not engaging in the behaviour), and loss of control (being unable to control one's desire to perform the behaviour). Factor analytic results supported a unidimensional construct and, based on the criterion of a reliability coefficient of .70 or higher being considered acceptable [25], the MPIQ possessed adequate reliability ($\alpha = .78$). It may be that the more involved people are with their mobile phone, the more likely they will use it in environments even if risky or illegal due to the priority of mobile phone use in their lives.

Aims and objectives

The aim of the present study, then, was to provide a preliminary examination of the utility of the TPB, incorporating mobile phone involvement, to predict young people's intentions to use their mobile phone while driving. The study focused on young adults aged between 17 and 24 years, given the general over-representation of young drivers in road crashes in Australia and internationally [5] and because they comprise the group with the greatest mobile phone usage while driving [1].

First, it was expected that the more young people reported a favourable attitude towards using their mobile phone while driving, the stronger their intentions to use their mobile phone while driving. In addition, it was expected that the more participants reported that they perceived social approval to use their mobile phone while driving, the stronger their intentions to do so. Further, it was expected that the more participants believed that they have control over using their phone while driving, the stronger their intentions to use their mobile phone while driving. Finally, in addition to the impact of the standard TPB constructs, it was expected that young people who reported greater involvement with their phones would report stronger intentions to engage in mobile phone use while driving.

Materials and Methods

Participants

This study was conducted as part of a larger survey examining the mobile phone use while driving patterns of the general public with participants recruited at petrol station travel centres in South-East Queensland, Australia [13]. The travel centre managers imposed a maximum time per customer interaction limit of 10 minutes for the study. Potential participants were screened to determine if they held a current driver's licence and if they used a mobile phone at least once a day to ensure that all participants engaged in some form of mobile phone use. After receiving university ethics approval and permission of the travel centres, patrons who were utilising the eating areas of the centres were invited by one of the research assistants to complete a survey about mobile phone use while driving, and were compensated (\$10) for their time. Participants were provided with writing utensils if needed and completed hard copies of the surveys in the eating areas, indicating to the researchers when they were ready to return their questionnaires. Some participants completed the questionnaires while seated alone and other participants completed their surveys individually but in the pairs and groups in which they were sitting when approached. Of the total sample, there were 196 (105 males, 91 females) participants aged between 17 and 24 years ($M = 20.02$, $SD = 2.05$) and most (87%) of the participants in this age group reported using a hand-held mobile phone for texting and calling more frequently than a hands-free phone while driving. Among a number of other survey measures, participants responded to TPB items about their intentions to use a mobile phone while driving and items assessing the level of involvement with their mobile phone. Participants were asked also about the frequency of previous use of their mobile phone while driving.

Measures

TPB constructs

The TPB constructs were based on standard measures [8] and were assessed with one item each, all scored on a scale from 1 (*extremely unlikely*) to 7 (*extremely likely*), with the starting prompt 'If you were driving in the next week, do you agree that...?'

- *Attitude* was measured with the item 'Using my mobile phone while driving would be good'.
- *Subjective norm* was measured with the item 'Those people who are important to me would want me to use my mobile phone while driving'.
- *Perceived behavioural control* was measured with the item 'I have complete control over whether I use my mobile phone while driving'.
- *Intention* was measured with the item: 'It is likely that I will use my mobile phone while driving'.

Mobile phone involvement questionnaire (MPIQ)

Walsh et al.'s [22] mobile phone involvement questionnaire comprised the following eight items: 'I interrupt whatever else I am doing when I am contacted on my mobile phone'; 'I often use my mobile phone for no particular reason'; 'I feel connected to others when I am using my mobile phone'; 'Arguments have arisen with others because of my mobile phone use'; 'I lose track of how much I am using my mobile phone'; 'I often think about my mobile phone when I am not using it'; 'I have been unable to reduce my mobile phone use'; 'The thought of being without my mobile phone makes me feel distressed'. All items were measured on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Based on the criterion of a reliability coefficient of .70 or higher being considered acceptable [25], the scale was reliable ($\alpha = .78$).

Data analysis

The TPB constructs, mobile phone involvement, and the demographic factor of age were all measured on continuous scales, with sex (1 = *male*, 2 = *female*) and type of phone use (1 = *predominantly hands-free*, 2 = *predominantly hand-held*) measured as dichotomous variables. Correlational analyses were conducted to assess the inter-relationships between the predictors and outcome variable of intentions. A three-step hierarchical regression was then performed with the background factors entered on Step 1, the TPB predictors entered on Step 2, and mobile phone involvement entered on Step 3. This analysis enabled a calculation of the proportion of variance each step accounted for in the prediction of intentions (and whether or not the step was significant) as well as identification of the significant factors that predicted intentions once all of the variables had been entered into the equation.

Results

Descriptive statistics

Most of the young people in the sample reported using their mobile phone while driving at least once or twice a week for sending texts (53%), reading texts (65%), making calls (60%) and answering calls (69%), with about a third of participants reporting that they performed one of these behaviours at least daily. Means, standard deviations, and correlations among the constructs used in the present study are provided in Table 1 (Appendix 1). Of the predictor variables, attitude, subjective norm, PBC and mobile phone involvement were significantly correlated with behavioural intentions, with attitude as the strongest correlate.

Regression analysis predicting intention

A hierarchical multiple regression was performed to examine the impact of the standard TPB constructs (attitude, subjective norm, PBC) and mobile phone involvement on young people's intentions to use a mobile phone while driving. The

background variables of age, sex and type of phone use (predominantly hands-free versus predominantly hand-held) were entered into the equation at step 1. The TPB constructs were entered on step 2 and mobile phone involvement was entered on step 3 – see Table 2 (Appendix 2). As a group, the step 1 background variables did not significantly predict participants' intentions ($R^2 = .02$), $F(3, 192) = 1.36$, $p = .256$. Entry of the step 2 variables (standard TPB constructs) accounted for a significant portion of the variance in intentions ($\Delta R^2 = .43$), $F(3, 189) = 49.19$, $p < .001$. At the final step, entry of mobile phone involvement added an additional, significant proportion of the variance in people's intentions ($\Delta R^2 = .02$), $F(1, 188) = 6.327$, $p = .013$. In the final equation, the model accounted for a total of 47% of the variance and the significant predictors of intentions were attitude, PBC and mobile phone involvement.

Discussion

This study comprised a preliminary investigation to explore whether the TPB constructs of attitude, subjective norm, and PBC predicted the intentions of young people to use their mobile phone while driving. Additionally, the study gauged whether the level of mobile phone involvement was a significant predictor of intentions.

The TPB constructs of attitude and PBC predicted young people's intentions, suggesting that young people who are more favourable towards the idea of using a mobile phone while driving and who perceive that doing so is within their control are more likely to intend to use their mobile phone while driving. As subjective norm did not emerge as a significant predictor, others' approval (or disapproval) did not impact on young people's intentions to use their mobile phone while driving. Although there is evidence for the role of subjective norm influencing young people's intentions to use a mobile phone while driving in some studies [15, 26], there is also mixed evidence in other studies with some support for the role of subjective norm in the case of intentions to send texts, but not read texts while driving [16].

It is possible that, similar to other TPB research in general [11], it may not be the approval or disapproval from others that is important; instead, other sources of social influence should be considered either instead of or in addition to subjective norm. In the case of young people specifically, it may be the norms of their referent group such as their immediate friendship group and whether their friends actually use their phone while driving that has a more direct impact on their decisions (i.e., group norms) than perceptions of explicit approval from others [27] and there is support for the influence of group norms on intentions to text while driving [16]. Further, researchers have found support for the impact of other types of norms on young people's intentions to use their mobile phone while driving and these types of social influence may be important to consider in future examinations. These norms include moral norms

(perception of the socially-derived moral correctness or incorrectness of performing particular behaviours - see [16]) and both verbal and behavioural norms (direct and overt attempts by actors in the environment, such as law enforcers, to encourage individuals to behave in a certain way - see [26]).

The level of mobile phone involvement influenced young people's intentions to use a mobile phone while driving, after accounting for the influence of the standard TPB constructs. Those participants reporting greater involvement with their mobile phone were more likely to intend to use their mobile phone while driving. These results highlight the emerging role that mobile communication technologies have assumed in people's lives and that, for some people, the ease and convenience of use of these technologies leads to an excessive attachment that impairs their decision-making. Other researchers [e.g., 15] have examined the perceived importance of the call on people's decisions to use a mobile phone while driving and it is possible that those who are highly involved with their mobile phone consider most calls to be important.

The finding that attitude and PBC emerged as significant predictors of young people's intentions to use their mobile phone while driving can inform efforts to curb this risky behaviour. Other studies examining younger people's road safety decision-making also have identified attitudes as an important component to influence actions [14, 15, 16], highlighting their role as possible catalysts of change. For instance, as a suggestion in the present context, strategies to curb young people's mobile phone use while driving could focus on minimising the benefits of using a mobile phone while driving and emphasising the costs (e.g., communicating with others and retrieving information via a mobile phone are risky while driving and are better performed and more efficient with one's full attention). In addition, given that the importance of control perceptions has been highlighted in other studies examining younger adults' performance of unsafe driving behaviours [14, 15], strategies to reduce mobile phone use while driving potentially could highlight that the decision to use the phone is one's own choice and that everyone has the right to exercise the option not to respond to texts or calls from others while driving. For mobile phone involvement, it may be beneficial to examine explicitly people's relationships with their phone and direct efforts toward any excessive attachment with the technology that may result in poor decision-making such as choosing to use one's mobile phone while driving. One possibility is that strategies could be employed to challenge and manage some people's need to be constantly connected to others irrespective of context or location.

This study had several limitations. The study examined intentions only and did not assess whether or not participants used their mobile phone while driving (i.e., reported behaviour) at a follow-up time point. Although intentions are the strongest predictor of subsequent behaviour [11], a prospective study with a follow-up data collection period may allow for a more

in-depth understanding of the relationship between TPB constructs and behavioural performance. Also, given that the items were part of a larger survey where there were time constraints per customer imposed by the management of the travel centres, the TPB measures were one-item scales only. As such, the study provides only preliminary evidence as to the relationship among the TPB predictors and young people's intentions to use a mobile phone while driving. Future research should confirm the current pattern of results with multi-item scales and employ a prospective design to assess behaviour.

Given the potentially fatal consequences of interacting with mobile phone technology on the roads, it is imperative that researchers continue to identify the psychological factors that influence this commonly performed behaviour. The results of this study suggest it would be worthwhile to focus on young people's attitudes and control perceptions about using a mobile phone while driving, as well as acknowledging the dependent relationship some develop with their phones which allows for constant access between themselves and others. This knowledge could be used to inform efforts that help reduce the prevalence of young adults using mobile phones while driving, and to enable strategies to be implemented that foster alternative means for young people to connect with important others in a safer way.

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References

1. Pennay D. Community attitudes to road safety: Community attitudes survey wave 20. Road Safety Report 3. Canberra: Australian Transport Safety Bureau; 2008.
2. McEvoy SP, Stevenson MR, Woodward M. Phone use and crashes while driving: A representative survey of drivers in two Australian states. *The Medical Journal of Australia*. 2006; 185:630-634.
3. McEvoy SP, Stevenson MR, Woodward M. The contribution of passengers versus mobile phone use to motor vehicle crashes resulting in hospital attendance by the driver. *Accident Analysis and Prevention*. 2007; 39:1170-1176.
4. Walsh SP, White KM. Ring, ring, why did I make that call? Mobile phone beliefs and behaviour amongst Australian university students. *Youth Studies Australia*. 2006; 25:49-57.
5. Department of Infrastructure, Transport, Regional Development and Local Government. Road deaths Australia: 2008 statistical summary. Canberra, Australia: Department of Infrastructure, Transport, Regional Development and Local Government, Canberra; 2009.

6. Department of Broadband Communications and Digital Economy. Online statistics. Retrieved 17 July 2009, http://www.archive.dbcde.gov.au/2008/01/statistical_benchmarking/online_statistics; 2008.
7. Nelson E, Atchley P, Little TD. The effects of perception of risk and importance of answering and initiating a cellular phone call while driving. *Accident Analysis and Prevention*. 2009; 41:438-444.
8. Brusque C, Alauzet A. Analysis of the individual factors affecting mobile phone use while driving in France: Socio-demographic characteristics, car and phone use in professional and private contexts. *Accident Analysis and Prevention*. 2008; 40:35-44.
9. Foss RD, Goodwin AH, McCart AT, Hellinga LA. Short-term effects of a teenage driver cell phone restriction. *Accident Analysis and Prevention*. 2009; 41:419-424.
10. Ajzen I. The theory of planned behavior. *Organizational Behavior and Human Decision Processes*. 1991; 50:179-211.
11. Armitage CJ, Conner M. Efficacy of the theory of planned behaviour: A meta-analytic review. *British Journal of Social Psychology*. 2001; 40:471-499.
12. Walsh SP, White KM. Me, my mobile, and I: The role of self- and prototypical identity influences in the prediction of mobile phone behavior. *Journal of Applied Social Psychology*. 2007; 37:2405-2434.
13. Walsh SP, White KM, Hyde MK, Watson BC. Dialling and driving: Factors influencing intentions to use a mobile phone while driving. *Accident Analysis and Prevention*. 2008; 40:1893-1900.
14. Aberg L, Haglund M. Young people, drinking habits, transportation and peer relations. A questionnaire study. 14th ICTCT workshop. Retrieved 15 April 2011, from www.ictct.org/dlObject.php?document_nr=236&/Aberg.pdf; 2001.
15. Zhou R, Wu C, Rau P-LP, Zhang W. Young driving learners' intention to use a handheld or hands-free mobile phone when driving. *Transportation Research Part F: Traffic Psychology and Behaviour*. 2009; 12:208-217.
16. Nemme HE, White KM. Texting while driving: Psychosocial influences on young people's texting intentions and behaviour. *Accident Analysis and Prevention*. 2008; 42:1257-1265.
17. Payne N, Jones F, Harris P. The impact of working life on health behavior: The effect of job strain on the cognitive predictors of exercise. *Journal of Occupational Health Psychology*. 2002; 7:342-353.
18. Paisley CM, Sparks P. Expectations of reducing fat intake: The role of perceived need within the theory of planned behavior. *Psychology & Health*. 1998; 13:341-353.
19. Bianchi A, Phillips JG. Psychological predictors of problem mobile phone use. *CyberPsychology & Behavior*. 2005; 8:39-51.
20. Jenaro C, Flores N, Gomez-Vela M, Gonzalez-Gil F, Caballo C. Problematic internet and cell-phone use: Psychological, behavioral, and health correlates. *Addiction Research and Theory*. 2007; 15:309-320.
21. Walsh SP, White KM, Young RM. Over-connected? A qualitative exploration of the relationship between Australian youth and their mobile phones. *Journal of Adolescence*. 2008; 31:77-92.
22. Walsh SP, White KM, Young RM. Needing to connect: The effect of self and others on young people's involvement with their mobile phones. *Australian Journal of Psychology*. 2010; 62:194-203.
23. Brown R. Some contributions of the study of gambling to the study of other addictions. In: Eadington W, Cornelius J, editors. *Gambling behavior and problem gambling*. Reno: Institute for the study of gambling and commercial gaming: University of Nevada; 1993. p. 241-272.
24. Brown RIF. A theoretical model of the behavioural addictions: Applied to offending. In: Hodge JE, McMurran M, Hollin CR, editors. *Addicted to crime*. Chichester, UK: John Wiley; 1997. p. 13-65.
25. Tabachnick BG, Fidell LS. *Using multivariate statistics*. New York: Harper & Row; 2007.
26. Riquelme, HE, Al-Sammak F, Rios, RE. Social influences among young drivers on talking on the mobile phone while driving. *Traffic Injury Prevention*. 2010; 11:127-132.
27. Terry DJ, Hogg MA. Group norms and the attitude-behavior relationship: A role for group identification. *Personality and Social Psychology Bulletin*. 1996; 22:776-793.

Appendix 1

Table 1. Means, standard deviations, and bi-variate correlations for the predictor variables

Variable	M	SD	1	2	3	4	5	6	7	8
1. Age	20.02	2.05	-							
2. Sex	1.46	.500	-.08	-						
3. Type of phone use	1.87	.34	-.07	.03	-					
4. Attitude	3.17	1.96	.06	-.16*	-.04	-				
5. Subjective norm	2.64	1.81	.06	-.10	.04	.64***	-			
6. PBC	5.13	2.07	.09	.10	-.09	.24***	.23**	-		
7. Intention	4.43	2.25	.05**	-.11	-.09	.64***	.37***	.31***	-	
8. Mobile phone involvement	3.53	1.18	-.21	.23**	.04	.16*	.11	-.02	.21**	-

* $p < .05$. ** $p < .01$. *** $p < .001$.

Note. For Sex, 1 = male, 2 = female; For Type of phone use, 1 = predominantly hands-free, 2 = predominantly hand-held

Note. PBC refers to perceived behavioural control

Appendix 2

Table 2. Multiple regression analysis for variables predicting intentions to use a mobile phone while driving (N = 196)

Variable	B	B	R ²	ΔR ²
Step 1			.02	.02
Age	.02	.02		
Sex	-.33	-.07		
Type of phone use	-.31	-.05		
Step 2			.45	.43***
Attitude	.71	.62***		
Subjective norm	-.12	-.09		
Perceived behavioural control	.21	.19***		
Step 3			.47	.02**
Mobile phone involvement	.27	.14**		

* $p < .05$. ** $p < .01$. *** $p < .001$.

Note. Weights provided are at the final step of the analysis.

Road trauma, patterns of injury and mortality in an Australian trauma centre

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Abstract

Introduction: Road trauma remains a leading cause of death and permanent disability. The authors investigated differences between road user groups, mortality rates and pattern of injuries. **Methods:** Data were prospectively collected on trauma presentations to the St George Public Hospital (SGH) from January 2002 to June 2008 (n=5118). Injury severity and patterns were evaluated using the Injury Severity Score (ISS), the New Injury Severity Score (NISS) and the Abbreviated Injury Score (AIS). Multiple regression analysis was used to analyse data. **Results:** Risk of death was 5 times higher for injured pedestrians than drivers (OR=5.0 95% C.I 2.97-8.57, $p < 0.001$). Patients with head injuries had an increased risk of death compared to patients without head injuries (adjusted OR=6.04, 95% C.I. 3.79-9.64, $p < 0.0001$).

Conclusion: Vulnerable road users had a significantly higher mortality rate than other road users. These findings highlight the need for further research into factors contributing to pedestrian injury such as road design and pedestrian crossings.

Keywords

AIS, Car occupant, ISS, Mortality, NISS, Pedestrian, Road trauma, Trauma

Introduction

Despite a decrease in the mortality rate of multi-trauma patients over the past two decades, road trauma remains a leading cause of death and long-term morbidity [1]. The decrease is partly due to increased occupant crashworthiness of new vehicle models and safer road design, but is also due to road safety campaigns increasing public awareness of the importance of wearing a seatbelt, avoiding drink driving and speed enforcement legislation [2, 3].

The Crash Injury Research and Engineering Network (CIREN) was developed by the National Highway Traffic Safety Administration (NHTSA) in the United States in 1996. It is a multicentric research collaboration between clinicians and engineers looking at traffic-related injuries presenting to eight 'level 1' trauma centres in the United States. The mission of the

CIREN studies is to improve the prevention, treatment, and rehabilitation of motor vehicle injuries and to reduce death, disability, and human and economic costs [4]. The CIREN research has chosen to focus on individual factors that may affect mortality/outcome such as mortality rates in severely injured patients according to vehicle make [5] and the patient's position in the car (near- vs. far-side car occupants) [6].

There have been limited publications correlating the type of injuries sustained by road user groups - pedestrians, bicyclists, motorcyclists, car-occupants - and outcome indicators, such as death, injury severity or length of stay (LOS). Eid et al. investigated 1070 trauma patients divided into road user types [7]. They focused on ethnicity of patients as well as death, severity of injury (ISS) and injury pattern, and found that predictors for mortality included low GCS, high ISS and low systolic blood pressure on admission [7]. Road user groups were not found to be significant in predicting mortality [7].

Markogiannakis et al. studied 730 consecutive road trauma patients and found that there was an association between road user groups and outcomes and injury profiles [8]. Car occupants were the group with the highest injury severity score (ISS) but pedestrians were the group with the highest mortality [8]. Further, Markogiannakis found that craniocerebral injuries were significantly more frequent in motorcyclists and pedestrians than in the other road user groups [8]. Large autopsy studies of road trauma also indicate head injuries as a leading cause of death [9, 10].

The authors of this study investigated patterns of injury in road trauma to identify differences in mortality rate and pattern of injuries. A better understanding of the mechanisms behind road trauma and its effects on a variety of road user groups may allow us to be better equipped to predict and prevent future road injuries.

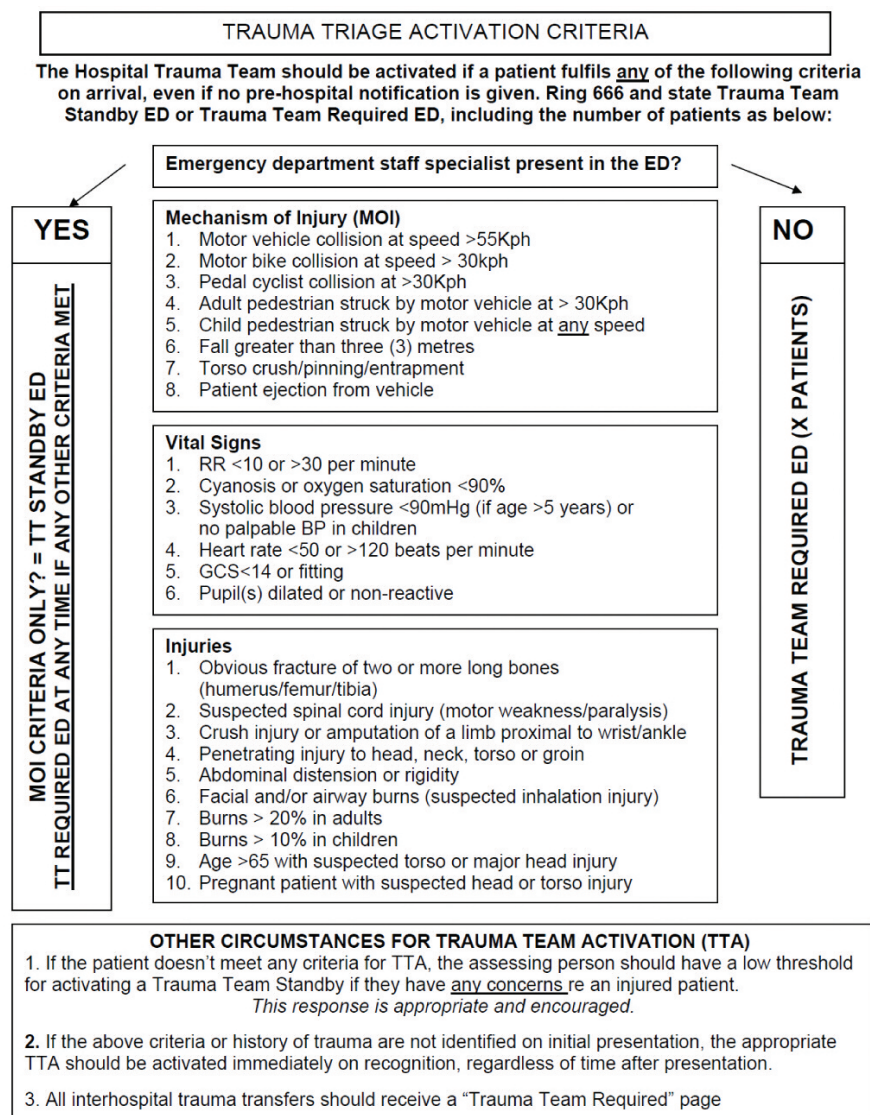


Figure 1. Trauma team activation criteria

Materials and Methods

Analysis of prospectively collected data on patients presenting to St George Public Hospital (SGH) from January 2002 to June 2008 meeting Trauma Team activation criteria was performed (Figure 1). Data is collected prospectively by trauma nurses at the patient bedside. Each trauma nurse has undergone injury coding training. A purpose-built trauma data registry is continuously kept up to date. This data includes patient demographics, mechanism of injury, physiological data, length of stay (LOS), ISS and in-hospital complications. Logarithmic values were used to remove skewness in the LOS data. Patients were assigned to various road user groups: pedestrian, bicyclist, motorcyclist or car occupant. Patient injury severity and injury pattern were evaluated using the Injury Severity Score (ISS), the New Injury Severity Score (NISS) and the Abbreviated Injury Score (AIS)[11].

Statistical analyses were performed using SAS version 9.1.3 (SAS Institute, Inc., Cary, NC). The association between two categorical variables was assessed through Chi-square tests. One-way ANOVA was used to test the equality of means among groups. Adjusted odds ratios controlling for age and sex, derived from multiple logistic regression were used for pairwise comparisons of binary outcome variables. To evaluate length of stay, a continuous variable, multiple regression was used to control for age and sex. In the presence of numerous post-hoc comparisons, Bonferroni-adjusted p-values, used to control for the experimentwise error rate (EWER), is overly conservative. For this study, the level of significance after a Bonferroni adjustment would be $0.05/15 \approx 0.0033$. As a compromise between controlling for EWER and conservatism, p-values from post-hoc comparisons less than $\alpha=0.005$ are deemed statistically significant. Deviance Goodness of Fit Statistics was used to measure goodness-of-fit for logistic regression.

Results

Between January 2002 and June 2008, 5118 road-related trauma patients meeting trauma triage activation criteria presented to the emergency department (ED), about 1.6% of all ED presentations. 3119 (60.9%) patients were male. The majority of patients in each group were male except front-seat

(39%) and rear-seat passengers (43.1%) where the majority of patients were female (Table 1).

There was a significant association between age group and road user type as shown in Table 1. Of the 620 patients less than 17 years of age, 35.7% (221) were rear-seat passengers, 26.5% (164) pedestrians and 20.2% (125) pedal-cyclists. In the 17-49 year age group 49.6% (1607 of 3241) were drivers, 16.1% (522) motorcyclists and 13.2% (428) front-seat passengers. In the 50-65 year group, 57% (403 of 707) were drivers, 13.4% (95) front-seat passengers and 11.6% (82) pedestrians. In the >65 year group, 45.1% (248 of 550) were drivers, 28.2% (155) pedestrians and 17.8% (98) front-seat passengers.

5.6% (288) of the 5118 patients required admission to the high-dependency unit (HDU) meaning they required closer observation and monitoring than what was possible on the ward (Table 2). 3.7% of patients (188) required admission to intensive care (ICU) meaning they were so unwell that they required assistance with airway, ventilation and/or circulation (Table 2). Pedestrians had the highest admission rate to ICU (5.8%), and motorcyclists had the highest admission rate to HDU (8.1%). The association between road user group and admission to HDU was statistically significant (Table 2).

The patients staying longest in critical care units were motorcyclists in ICU (1.77 days) and front-seat passengers in HDU (1.18 days). There was a significant association between road user groups, injury and overall length of stay (LOS) in hospital (Table 2).

After controlling for variables such as sex and age, individual linear regression models found that for each unit increase in NISS, LOS in hospital increased by 1.044 days (95% CI 1.003-1.038, $p<0.0001$). For each unit increase in ISS, the LOS increased by 1.057 days (95% CI 1.049 – 1.063, $p<0.0001$). Patients having more than one severe injury ($\text{AIS} \geq 3$) had an increased LOS of 2.208 days (95% CI 1.578 – 3.089, $p<0.0001$) compared to patients only sustaining one severe injury ($\text{AIS} \geq 3$).

Table 3 demonstrates the incidence of severe injury ($\text{AIS} \geq 3$). Drivers and front-seat passengers had a similar pattern of injury, with more severe injuries to thorax (33.7% and 35.6%

Table 1. Age, sex, admission and survival by type of road user - indicative of different rates of exposure and risk across different demographic groups

Cause of injury	Male (%)	Age <17 (%)	Age 17-49 (%)	Age 50-65 (%)	Age >65 (%)	Deaths (%)	Admitted (%)	Total (%)
Driver	1342 (59.12)	12 (1.94)	1607 (49.58)	403 (57.00)	248 (45.09)	25 (1.10)	111(4.89)	2270 (44.35)
Front seat passenger	274 (39.03)	81 (13.06)	428 (13.21)	95 (13.44)	98 (17.82)	8 (1.14)	31(4.42)	702(13.72)
Rear seat passenger	188 (43.12)	221 (35.64)	162 (5.00)	25 (3.54)	28 (5.09)	4 (0.92)	21(4.82)	436 (8.52)
Pedal cyclist	356 (85.58)	125 (20.16)	234 (7.22)	42 (5.94)	15 (2.73)	3 (0.72)	37(8.89)	416 (8.13)
Motor cyclist	543 (89.75)	17 (2.74)	522 (16.11)	60 (8.49)	6 (1.09)	7 (1.16)	47(7.77)	605 (11.82)
Pedestrians	416 (60.38)	164 (26.45)	288 (8.89)	82 (11.60)	155 (28.18)	39 (5.66)	123(17.85)	689 (13.46)
Total	3119 (60.94)	620 (100)	3241 (100)	707 (100)	550 (100)	86(1.68)	370 (7.23)	5118 (100)

Table 2. Length of stay in critical care and hospital according to road user group for admitted trauma patients

	Length of stay (log value)		Days in ICU (log value)		Days in HDU (log value)	
	n	Mean (SD)	n (%)	Mean (SD)	n (%)	Mean (SD)
Driver	111	2.83 (1.19)	79 (3.48%)	1.49 (0.94)	109 (4.80%)	0.95 (0.64)
Front seat Passenger	31	2.69 (1.44)	19 (2.71%)	1.58 (1.02)	36 (5.13%)	1.18 (0.68)
Rear seat Passenger	21	1.54 (1.56)	7 (1.61%)	1.71 (0.51)	15 (3.44%)	1.07 (0.83)
Pedal cyclist	37	1.40 (1.48)	15 (3.61%)	1.19 (0.90)	30 (7.21%)	1.01 (0.65)
Motor cyclist	47	2.38 (1.17)	28 (4.63%)	1.77 (0.83)	49 (8.10%)	1.01 (0.64)
Pedestrians	123	2.04 (1.63)	40 (5.81%)	1.63 (0.91)	49 (7.11%)	1.17 (0.78)
Total	370		188 (3.67%)		288 (5.63%)	

NB Some patients were admitted both to ICU and HDU during their admission and therefore appear in both columns.

Table 3. Incidence of severe injury (AIS \geq 3) per anatomical region for each road user group

n (%)	Driver	Front - seat passenger	Rear- seat passenger	Pedal Cyclist	Motorcyclist	Pedestrian
Head	96 (26.52)	33 (24.44)	11 (16.92)	33 (33.67)	31 (15.90)	95 (32.87)
Face	10 (2.76)	2 (1.48)	1 (1.54)	1 (1.02)	0 (0.0)	6 (2.08)
Neck	2 (0.55)	1 (0.74)	0 (0.0)	1 (1.02)	3 (1.54)	1 (0.35)
Thorax	122 (33.70)	48 (35.56)	23 (35.38)	13 (13.27)	68 (34.87)	80 (27.68)
Abdomen	29 (8.01)	16 (11.85)	11 (16.92)	9 (9.18)	18 (9.23)	22 (7.61)
Spine	33 (9.12)	16 (11.85)	8 (12.31)	13 (13.27)	13 (6.67)	14 (4.84)
Upper Extreme	39 (10.77)	7 (5.19)	4 (6.15)	9 (9.18)	32 (16.41)	25 (8.65)
Lower Extreme	31 (8.56)	12 (8.89)	7 (10.77)	19 (19.39)	30 (15.38)	46 (15.92)
Skin	0	0	0	0	0	0
Total	362	135	65	98	195	289

NB The number in () signifies what % per road user group had severe injuries to one particular body region; each patient may have more than one injury with AIS \geq 3

respectively), head (26.5% and 24.4%), and to a lesser extent abdomen (8% and 11.9%) and spine (9.1% and 11.9%). Rear-seat passengers also had a high frequency of severe thoracic injuries (35.4%), but sustained a higher incidence of severe abdominal injuries (16.9%). Rear-seat passengers had fewer severe head injuries (16.9%) compared with other groups.

Pedal cyclists had the highest overall frequency of head (33.7%), spine (13.3%) and lower limb injuries (19.4%) but sustained severe thoracic (13.3%) injuries less often than other groups. Pedal cyclists had a modest proportion of abdominal injuries (9.2%) compared to the other groups. Abdominal injuries ranged from 7.6% for pedestrians to 16.9% for rear-seat passengers. The most frequent area of severe injury sustained by motorcyclists was the thorax (34.9%). They also sustained severe injuries to the head (15.9%) and both upper (16.4%) and lower limbs (15.4%). Pedestrians most frequently sustained severe trauma to the head (32.9%), followed by thorax (27.7%) and lower limb (15.9%). Pedestrians had the highest proportion of severely injured patients with 23.8% having an Injury Severity Score (ISS) >15 . 17% of motorcyclists and 12% of pedal

cyclists had an ISS >15 . Less than 10% of car occupants had an ISS >15 (Table 4). There was a significant association between road user type and ISS ($p<0.0001$).

Pedestrians were significantly more likely to have an AIS \geq 3 than drivers. When statistically adjusted for the difference in ISS score between groups, the OR for pedestrians was OR=3.36 (95% C.I 2.68-4.19, $p<0.001$), front-seat passengers OR=2.66 (95% C.I 1.99 – 3.55, $p<0.001$) or rear-seat passengers OR=2.33 (95% C.I 1.63 – 3.34, $p<0.0001$). The odds ratios were slightly lower for motorcyclists and pedal cyclists, but they remained significantly higher than those of motor vehicle occupants (Table 5). The odds of having an AIS \geq 3 were over 4 times greater in patients with more than one body region injured, compared to patients with a single body region injured (adjusted OR=4.68, 95% C.I 3.58-6.11, $p<0.0001$). Multiple high AIS scores in different body regions are required for a high ISS score, and the findings are reflective of that. However, in all patient groups, not just in the group with ISS >15 , the odds of having an AIS \geq 3 were higher for patients with more than one body region injured.

Table 4. Injury severity according to road user type for all trauma presentations

Cause of injury	ISS <9 n (%)	ISS 9-15 n (%)	All ISS >15 n (%)	Mean (SD)	
				Log(ISS)	Log(NISS)
Driver	1855 (81.72)	206 (9.07)	209 (9.21)	1.21 (0.96)	1.31 (1.010)
Front-seat Passenger	570 (81.20)	66 (9.40)	66 (9.40)	1.20 (0.98)	1.30 (1.02)
Rear-seat Passenger	368 (84.40)	29 (6.65)	39 (8.94)	0.93 (0.99)	1.02 (1.05)
Pedal cyclist	264 (63.46)	104 (25.00)	48 (11.54)	1.74 (0.85)	1.94 (0.89)
Motorcyclist	352 (58.18)	150 (24.79)	103 (17.02)	1.79 (0.97)	2.01 (1.04)
Pedestrians	361 (52.39)	164 (23.80)	164 (23.80)	1.94 (1.05)	2.14 (1.05)
Test statistics	$\chi^2(10)=411.6$, $P<0.0001$			$F=116.81$ $P<0.0001$	$F=137.60$ $P<0.0001$

The overall risk of death was 1.7% (Table 1). The risk of death was greater for pedestrians than other groups (5.7%) (Table 1). The odds of death in pedestrians compared to that of drivers and pedal cyclists were more than five times higher (odds ratios 5.0 and 5.6 respectively), and 4 times higher than those of front-seat passengers and motorcyclists after controlling for age and gender (Table 5).

Using logistic regression, the association between death and NISS, ISS or multiple injured anatomical areas was found to be significant. The odds of death were increased by 14% with each unit increase in NISS, adjusted OR of death 1.14 (95% C.I. 1.12-1.16, $p<0.0001$), and by 16% with each unit increase in ISS, adjusted OR of death 1.16 (95% C.I. 1.13-1.18, $p<0.0001$). The odds of death in those with multiple AIS \geq 3 injuries were over 6 times those of patients with a single injury with an adjusted OR of death of 6.64 (95% C.I. 2.42-18.21, $p<0.001$).

The study found that 59 patients (1.2%) were admitted with severe head injuries (AIS \geq 3). There is a higher pre-dominance of male patients in the head-injured group compared to the non-head-injured group for all road user groups (67.6% vs. 56.7% for drivers, 48.1% vs. 36.9% for front-seat passengers, 53.8% vs. 40.7% for rear-seat passengers, 86.2% vs. 85.1% for bicyclists, 90.5% vs. 89.5% for motorcyclists, 63.7% vs. 57.5% of pedestrians). The risk of death is higher in the head-injured group with 3.7% vs. 0.3% for drivers, 5.3% vs. 0.2% for front-seat passengers, 1.3% vs. 0.8% for rear-seat passengers, 1.1% vs. 0.4% for bicyclists, 1.4% vs. 1.1% for motorcyclists and 8.8% vs. 3% for pedestrians (Table 6).

After controlling for age and sex in a logistic regression model, patients with head injuries have a statistically significant increased risk of death compared to patients without head injuries (adjusted OR=6.04, 95% C.I. 3.79-9.64, $p<0.0001$) (Table 5). Among patients sustaining head injuries, the risk of death was greater for pedestrians compared to drivers (adjusted OR=2.40, 95% C.I. 1.27-4.54, $p=0.007$), motorcyclists (adjusted OR=6.02, 95% C.I. 1.36-26.73, $p=0.0182$) and pedal cyclists (adjusted OR=6.14, 95% C.I. 1.41-26.75, $p=0.0157$) (Table 4).

Discussion

It was found that the most vulnerable road users are pedestrians, followed by motorcyclists, cyclists and then vehicle occupants who are provided the most protection during impact. The probability of death amongst patients with trauma presentations to the emergency department in the study period was five times higher for pedestrians than that for drivers and pedal cyclists and four times higher for pedestrians than for front-seat passengers and motorcyclists. Vulnerable (minimally protected) road users – pedestrians, pedal cyclists and motorcyclists – were significantly more likely to have an AIS \geq 3 than car occupants. The risk was greatest for pedestrians. A larger proportion of pedestrians were severely injured in comparison with other road users.

There have been a large number of studies investigating how injuries occur to pedestrians struck by cars, buses and bicyclists as a result of crash investigation, reconstruction of real world crashes and computer simulation studies [12-19], yet the type and severity of injuries sustained by each road user group have been less well investigated. For sedans and small vehicles, the pedestrian is usually struck at the legs first. This causes the body to rotate towards the vehicle's bonnet and windscreen leading to the pedestrian's unprotected head hitting either the bonnet or windscreen. The pedestrian is then thrown forward and usually strikes the ground headfirst. In the case of buses and trucks, the head is struck either by the vehicle or when the pedestrian is struck in the chest and thrown backwards striking the back of their head on the pavement[19]. All studies show that greatest risk of injury is to the pedestrian's head as a result of such an impact.

Head injured pedestrians had a significantly higher mortality rate than other vulnerable road users. This could be explained by helmet use in other groups. Cyclists and motorcyclists have a high rate of helmet wearing, reducing impact severity to the head during a crash. Occupants in motor vehicles, have protection in terms of crumple zones, airbags, seatbelts and air curtains. Head injuries to vehicle occupants usually occur as a result of lateral impacts. The occupant's head is struck by an incoming vehicle or strikes an internal surface of the vehicle

Table 5. Odds ratios (with 95% confidence intervals) for outcome (AIS≥3, death, hospital admission, admission to HDU, admission to ICU) for each pairwise comparison of road user groups, after adjusting for sex and age groups

Adjusted OR 95% C.I p-value (sample size)	Driver	Front-seat passenger	Rear-seat passenger	Motor cyclist	Pedal cyclist
AIS≥3 (n=807)^a	Driver	1			
	Front seat passenger	1.26 (0.97, 1.65) 0.088	1		
	Rear seat passenger	1.44 (1.01, 2.04) 0.043	1.14 (0.77, 1.68) 0.517	1	
	Motor cyclist	2.69 (2.12, 3.41) <0.001	2.13 (1.56, 2.90) <0.0001	1.87 (1.28, 2.74) 0.001	1
	Pedal cyclist	2.50 (1.88, 3.32) <0.001	1.98 (1.41, 2.79) <0.0001	1.74 (1.17, 2.59) 0.006	0.93 (0.68, 1.27) 0.648
	Pedestrian	3.36 (2.68, 4.19) <0.0001	2.66 (1.99, 3.55) <0.0001	2.33 (1.63, 3.34) <0.0001	1.25 (0.95, 1.63) 0.107
					1.34 (0.99, 1.81) 0.055
Death (n=86)^a	Driver	1			
	Front seat passenger	1.26 (0.55, 2.85) 0.586	1		
	Rear seat passenger	1.72 (0.58, 5.11) 0.332	1.37 (0.40, 4.65) 0.617	1	
	Motor cyclist	1.25 (0.53, 2.97) 0.610	1.00 (0.34, 2.89) 0.996	0.73 (0.20, 2.62) 0.629	1
	Pedal cyclist	0.90 (0.27, 3.03) 0.866	0.72 (0.18, 2.80) 0.632	0.52 (0.11, 2.42) 0.409	0.72 (0.18, 2.82) 0.637
	Pedestrian	5.04 (2.97, 8.57) <0.001	4.02 (1.82, 8.85) <0.001	2.94 (1.01, 8.53) 0.047	4.03 (1.70, 9.57) <0.01
					5.60 (1.68, 18.69) 0.005
Admitted to ICU (n=188)^a	Driver	1			
	Front seat passenger	0.98 (0.59, 1.64) 0.9401	1		
	Rear seat passenger	0.92 (0.42, 2.06) 0.8467	0.94 (0.39, 2.29) 0.896	1	
	Motor cyclist	1.22 (0.77, 1.91) 0.3980	1.24 (0.67, 2.30) 0.4945	1.32 (0.55, 3.12) 0.5351	1
	Pedal cyclist	1.24 (0.70, 2.20) 0.4588	1.27 (0.62, 2.57) 0.5124	1.34 (0.53, 3.39) 0.5316	1.02 (0.54, 1.95) 0.9477
	Pedestrian	2.04 (1.36, 3.06) 0.0005	2.08 (1.18, 3.68) 0.0115	2.21 (0.96, 5.06) 0.0610	1.68 (0.99, 2.84) 0.0524
					1.64 (0.88, 3.07) 0.1183
Admitted to HDU (n=288)^a	Driver	1			
	Front seat passenger	1.20 (0.81, 1.79) 0.3663	1		
	Rear seat passenger	1.30 (0.73, 2.31) 0.3772	1.08 (0.57, 2.03) 0.8144	1	
	Motorcyclist	2.06 (1.43, 2.98) 0.0001	1.72 (1.06, 2.77) 0.0269	1.59 (0.85, 2.99) 0.1481	1
	Pedal cyclist	2.16 (1.40, 3.35) 0.0005	1.80 (1.06, 3.06) 0.0295	1.67 (0.86, 3.23) 0.1284	1.05 (0.65, 1.70) 0.8481
	Pedestrian	1.48 (1.03, 2.13) 0.0357	1.22 (0.78, 1.95) 0.3789	1.14 (0.62, 2.11) 0.6777	0.72 (0.46, 1.12) 0.1443
					0.68 (0.41, 1.12) 0.1328

Head injuries and died (n=59) ^b	Driver	1						
	Front seat passenger	1.76 (0.71, 4.34) 0.2278	1					
	Rear seat passenger	0.54 (0.07, 4.20) 0.5576	0.31 (0.04, 2.61)	0.2813	1			
	Motor cyclist	0.40 (0.09, 1.76) 0.2241	0.23 (0.05, 1.15) 0.07	0.74 (0.06, 8.43) 0.8054	1			
	Pedal cyclist	0.39 (0.09, 1.73) 0.2152	0.22 (0.04, 1.13) 0.0695	0.72 (0.06, 8.21) 0.7927	0.98 (0.13, 7.14) 0.9847	1		
	Pedestrian	2.40 (1.27, 4.54) 0.0070	1.37 (0.56, 3.37) 0.4882	4.43 (0.58, 33.91) 0.1516	6.02 (1.36, 26.73) 0.0182	6.14 (1.41, 26.75) 0.0157		

^aAll trauma patient presentations ^bTrauma patient presentations with head injuries

Table 6. Demographics grouped by non-head injured and head injured patient

n (%)	Cause of injury	Male	Age<17	Age 17-49	Age 50-65	Age >65	Deaths	Total
Non-head injuries	Driver	998 (56.67)	11 (0.62)	1233 (70.02)	324 (18.40)	193 (10.96)	6 (0.34)	1761
	Front seat passenger	210 (36.91)	69 (12.13)	334 (58.70)	81 (14.24)	85 (14.94)	1 (0.18)	569
	Rear seat passenger	145 (40.73)	188 (52.81)	121 (33.99)	23 (6.46)	24 (6.74)	3 (0.84)	356
	Pedal cyclist	200 (85.11)	62 (26.38)	140 (59.57)	26 (11.06)	7 (2.98)	1 (0.43)	235
	Motor cyclist	409 (89.50)	12 (2.63)	391 (85.56)	50 (10.94)	4 (0.88)	5 (1.09)	457
	Pedestrians	214 (57.53)	89 (23.92)	163 (43.82)	45 (12.10)	75 (20.16)	11 (2.96)	372
Head injuries	Driver	344 (67.58)	1 (0.20)	374 (73.48)	79 (15.52)	55 (10.81)	19 (3.73)	509
	Front seat passenger	64 (48.12)	12 (9.02)	94 (70.68)	14 (10.53)	13 (9.77)	7 (5.26)	133
	Rear seat passenger	43 (53.75)	33 (41.25)	41 (51.25)	2 (2.50)	4 (5.00)	1 (1.25)	80
	Pedal cyclist	156 (86.19)	63 (34.81)	94 (51.93)	16 (8.84)	8 (4.42)	2 (1.10)	181
	Motor cyclist	134 (90.54)	5 (3.38)	131 (88.51)	10 (6.76)	2 (1.35)	2 (1.35)	148
	Pedestrians	202 (63.72)	75 (23.66)	125 (39.43)	37 (11.67)	80 (25.24)	28 (8.83)	317

during impact [18, 20, 21]. Side impact crashes into poles and trees also result in serious head injuries when the occupant's head strikes the intruding tree or pole as a result of body inertia [16, 22]. Similarly, chest injuries are dominant in side impact pole and tree crashes.

Patients with head injuries have a higher mortality rate than non-head injured patients. This is consistent with previous epidemiological studies that have looked at cause of death and trauma scores [9, 10, 17, 23-27]. These studies report Central Nervous System (CNS)-related causes of death in 21.6-71.5% of all trauma-deaths. In 2009 Pfeifer found the majority of deaths were due to CNS-injury (21.6-71.5%) followed by exsanguination (12.5 – 26.6%) and sepsis (3.1 – 17%) [27].

Pfeifer compared mortality rates reported in the 1980s, 1990s and 2000s and an overall decrease in mortality was found. When broken down an increase was found in deaths from injuries to the Central Nervous System (CNS) (50.1% - 44.2% - 63.5%), a

small change was found in deaths from sepsis (7.3% - 3% - 5.2%), and a significant decrease was found in deaths from exsanguination (27.6 % - 25% - 15%)[27]. Pfeifer's study included pre-hospital deaths and was partly designed to assess the effect of Advanced Trauma Life Support (ATLS) training on mortality[28]. ATLS was first introduced in 1978 but only became common in the developed world as part of surgical training in the late 1990s and 2000. The decrease in overall mortality and mortality due to exsanguination over the three decades Pfeifer looked at is probably related to the wider implementation of trauma systems and better management of severely injured patients as outlined in the ATLS guidelines [29]. Van Olden et al. demonstrated that the introduction of ATLS training programs significantly reduced overall mortality rates (24.3% pre-ATLS, 0% post-ATLS) [29, 30].

Several factors may be responsible for the rate of CNS-related deaths not having changed over the last three decades. Both Pfeifer and Van Olden looked at mortality rates only; it is

possible that the majority of patients recorded as CNS-related deaths were too severely injured for the introduction of ATLS guidelines to make a difference in their outcome. In this study population, however, ISS, NISS, having multiple injuries with AIS ≥ 3 , or having a head injury were all statistically significantly associated with increased chance of dying in all road user groups.

The data was collected prospectively on patients brought into hospital. In 1996, Hill et al. performed a population-based study showing that 67% of car occupants in their population died at the scene, frequently from blood loss due to aortic rupture. This was in contrast to pedestrians, where 67% died in hospital predominantly from head injuries[13]. Trauma victims who died at the scene were not included in this study. This may alter the results slightly, as some trauma groups may be more likely to sustain injuries resulting in immediate and 'at the scene' death than others.

Conclusion

Vulnerable road users, in particular pedestrians, had a significantly higher mortality rate than other road users with 5.7% mortality rate. Patients with head injuries had an increased risk of death compared to patients without head injuries, particularly pedestrians, with an 8.8% mortality rate. These findings highlight the need for further research into factors contributing to pedestrian injury, such as road design and pedestrian crossings.

References

- Regel G, Lobenhoffer P, Grotz M. Treatment results of patients with multiple trauma: an analysis of 3406 cases treated between 1972 and 1991 at German Level 1 trauma centre. *J Trauma*. 1995;38:70-79.
- Sakashita C, Graham A, Roos MD, Croft S, Elliott M, editors. Comparing provisional and unrestricted license holders on speeding offenses and crash rates. Australasian Road Safety Research policing and education conference; Melbourne, 2007
- Shuey R, editor. The key to Road Safety. Australasian Road Safety Research Policing and Education Conference; Melbourne, 2007.
- CIREN. Crash Injury Research and Engineering Network. Viewed August 2011. <http://www.nhtsa.gov/CIREN>.
- Ryb G, Burch C, Kerns T, Dischinger P, Ho S. Crash Test Ratings and Real-World Frontal Crash Outcomes: A CIREN Study. *J Trauma*. 2010;68:1099-1105.
- Tencer A, Kaufman R, Mack C, Mock C. Factors affecting pelvic and thoracic forces in near-side impact crashes: a study of US-NCAP, NASS, and CIREN data. *Accid Anal Prev*. 2005;37:287-293.
- Eid H, Barss P, Adam S, Torab F, Lunsjo K, Grivna M, et al. Factors affecting anatomical region of injury, severity, and mortality for road trauma in high-income developing country: Lessons for prevention. *Injury*. 2009;40(7):703-7.
- Markogiannakis H, Sanidas E, Messaris E, Koutentakis D, Alpantaki K, Kafetzakis A, et al. Motor vehicle trauma: analysis of injury profiles by road user category. *Emerg Med J*. 2006;23(1):27-31.
- Hossack D. The pattern of injuries in 470 pedestrians killed in road accidents. *Med J Aust*. 1975;1(22):678-9.
- Sevitt S. Fatal road accidents, injuries, complications and causes of death in 250 subjects. *Br J Surg*. 1968;55(7):481-95.
- AAMA. Abbreviated Injury Scale. Des Plaines, Illinois, USA1990.
- Dischinger P, Cushing B, Kerns T. Injury patterns associated with direction of impact. Drivers admitted to trauma centres. *J Trauma*. 1993;35(3):454-8.
- Hill D, Delaney L, Duflou J. A population-based study of outcome after injury to car occupants and to pedestrians. *J Trauma*. 1996;40(3):351-5.
- Nast-Kolb D, Aufmkolk M, Ruchholtz S. Multiple organ failure still a major cause of morbidity but not mortality in blunt trauma. *J Trauma*. 2001;51(5):835-41.
- Vestrup J, Reid J. A profile of Urban Adult Pedestrian Trauma. *J Trauma*. 1989;29(6):741-5.
- Rogers C, Pagliarello G, McLellan B, Nelson W. Mechanism of injury influences the pattern of injuries sustained by patients involved in vehicular trauma. *Can J Surg*. 1991;34(3):283-6.
- Rooij LV, Bhalla K, Meissner M, Ivarsson J, Crandall J, Longhitano D, et al. Pedestrian Crash Reconstruction using Multi-Body Modeling with Geometrically detailed, validated vehicle models and advanced pedestrian injury criteria. 18th Enhanced Safety Vehicle Conference; Nagoya, 2003.
- Grzebieta R, Rehnitz G. Crashworthy Systems - a paradigm shift in road safety design (part II). *Transport Engineering in Australia*. 2001;7(1&2).
- Short A, Grzebieta R, Arndt N. Estimating bicyclists into pedestrian collision speed. *International Journal of Crashworthiness*. 2007;12(2):127-35.
- Grzebieta R, Tingvall C, Rehnitz G. Geometric compatibility in Near Side Impact Crashes. 17th International Technical Conference on the Enhanced Safety of Vehicles; June; Amsterdam, Netherlands2001.
- Stolinski R, Grzebieta R, Fildes B, Judd R, Wawrzynczak J, Gray I, et al. Response of Far-side occupants in car-to-car impacts with standard and modified restraint systems using Hybrid III and US-SID. Occupant Protection, 1999.
- Richardson S, Jiang T, Grzebieta R, Rehnitz G. Simulation of Vehicle Lateral Side Impacts With Poles to Estimate Crush and Impact Speed Characteristics. *Journal of the Australasian College of Road Safety*. 2006;17(4):22-9.
- Richardson S, Jian T, Grzebieta R, Rehnitz G, editors. Vehicle Lateral Side Impacts with Poles - A Review and Analysis. 4th International Crashworthiness Conference ICRASH2004; San Francisco, 2004
- Stephenson S, Henley G, Harrison J, Langley J. Diagnosis based Injury Severity Scaling: investigation of a method using Australian and New Zealand hospitalizations. *Inj Prev*. 2004;10(6):379-83.
- Soreide K, Kruger A, Vardal A. Epidemiology and contemporary patterns of Trauma Deaths: Changan Place, Similar Pace, Older Face? *World J Surg*. 2007;31(11):2092-2103.
- Small T, Sheedy J, Grabs A. Cost, demographics and injury profile of adult pedestrian trauma in inner sydney. *Aust N Z J Surg*. 2006;76(1-2):43-7.
- Pfeifer R, Tarkin I, Rocos B, Pape H. Patterns of mortality and causes of death in polytrauma patients - has anything changed? *Injury*. 2009;40(9):907-11.
- Collicott P. Advanced trauma life support course, an improvement in rural trauma care. *Nebr Med J*. 1979;64:279-80.
- VanOlden G, Meeuwis J, Bolhuis H. Clinical impact of advanced trauma life support. *J Emerg Med*. 2004;22:522-5.
- VanOlden G, Meeuwis J, Bolhuis H. Advanced trauma life support study: quality of diagnostic and therapeutic procedures. *J Trauma*. 2004;57:381-4.

Factors affecting two- and five-year re-offence rates in Queensland drink drivers

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Abstract

Risk factors for repeat drink driving, an important road safety issue, are well known. However, apart from the findings of a recent New South Wales study, estimates of Australian recidivism rates by risk factors are not well known.

The driving records of a cohort of Queensland drink drivers participating in a drink driving rehabilitation program were matched by age, region, blood alcohol concentration (BAC) level and prior offence and used to estimate sex-specific two- and five-year re-offence rates overall. Estimates of the proportion of Queensland drink drivers with a prior drink driving (DD) offence in 2004 were used to standardise rates to the Queensland drink driving population. Rates were higher in remote areas, as were rates in males, young drivers, drivers with high BAC levels and drivers with prior DD convictions (this was especially true of drivers with at least two prior DD convictions). Five-year rates for Queensland were estimated as 21.8% in males and 16.4% in females, appreciably higher than in New South Wales.

Keywords

Drink driving, Drink driving risk factors, Recidivism, Repeat offenders

Introduction

Drink driving continues to be a major problem for law enforcement, frequently leading to death and injury among drivers, their passengers and other road users. Predictors of recidivist drink driving, defined usually as repeat apprehension for drink driving (DD), have been extensively studied; the results have been summarised in a recent paper from New South Wales, which also reported on the proportions of convicted drink drivers reconvicted for a DD offence within five years, by a number of characteristics [1]. These included demographic variables, characteristics of the index offence (including penalties), and number of prior traffic and DD offences, all from the database maintained by NSW Bureau of Crime Statistics and Research. The index year was 2002. Predictors identified in that study and in previous research were being young, male or indigenous; prior drink driving offences; a previous criminal conviction; an alcohol or other substance abuse problem; certain mental health disorders; and residence in a disadvantaged area [1, 2].

Unidentified data supplied by Queensland Transport on the characteristics of a cohort of drink drivers have provided the

opportunity to estimate drink driving recidivism rates in Queensland and identify its predictors. The resulting estimates constitute a baseline from which to assess impacts on drink driving recidivism which may arise from targeted interventions. Members of the Queensland magistracy have expressed interest in these results as an indication of the magnitude of the problem and to inform their sentencing policies. In general, understanding the extent and antecedents of a problem such as repeat drink driving is a prerequisite to devising strategies to combat it.

Method

Participants

As part of an outcome evaluation of a drink driving rehabilitation program undertaken by Queensland Transport and the Centre for Accident Research and Road Safety - Queensland (CARRS-Q), a comparison series of drink drivers who had not undertaken the program was selected. These were matched to those assigned to the program on a number of factors present at the index offence, i.e. the drink driving offence which occasioned their selection into the comparison sample: sex; age in five categories; a history of prior drink driving conviction(s) (within three years before the index offence); BAC level categorised less than 0.15 mg/100 ml, at least 0.15 mg/100 ml, failure to supply a specimen and other, as indicated by the offence code; and police division of residence, presented in the data file supplied only as a region classified into the five categories of the Accessibility/Remoteness Index of Australia (ARIA) [3]. For details see Table 2. Information on prior and subsequent DD offences, including BAC level if recorded and time since index offence, was provided. The period covered is 2001 to 2006, with some comparison drivers convicted in 2007 and 2008. These data have been edited to remove duplications and multiple offence codes and correct discrepancies between blood alcohol concentration and offence code.

Because of the matching process, the controls are not a representative sample of Queensland drink drivers as a whole, nor are they a random sample even within the categories of each matching variable. However, they were selected at random from the pool of drivers classified by the combination of these factors. With appropriate adjustment they can be used to estimate recidivism rates within these categories and for Queensland overall, in the present instance at two and five years. Cross-sectional information on the distribution of most of the matching variables in drink drivers in Queensland in 2004 is available for use in calculating the estimates of the recidivism rates in Queensland drink drivers as a whole [4].

Males and females are considered separately, since they differ markedly in their propensity to offend and re-offend. There were 20,681 drivers in the analysis, 87% male and 13% female. Median follow-up intervals were just over four years for males, slightly shorter for females.

Data analysis

Estimates were calculated by the Kaplan-Meier procedure, the failure-time variable being the number of days from the index offence to the first subsequent drink driving conviction, or to the end of follow-up if no subsequent drink driving conviction was reported. Two and five year re-offence rates were estimated, the latter interval chosen to be comparable to that used in the NSW study[1]. In practice, the estimates used were those given by the algorithm at 730 and 1825 days, or, if no estimate was provided at these points, the estimate at the closest prior point, provided this was no more than 50 days earlier. In that case, which occurred usually in categories containing relatively few drivers, linear interpolation was used to estimate the appropriate rate. Differences in recidivism rates between factor categories are assessed by the logrank test. Confidence intervals - the measure of variation employed when weighted estimates for Queensland drink drivers are calculated - are derived by assuming that the logarithms of the rates are approximately normally distributed.

Results for each matching factor are presented individually below. To apply to the Queensland population, each should in theory be adjusted for all the other matching factors. However, the necessary degree of cross-sectional distributional detail is unsurprisingly not available for the Queensland drink driving population. This level of adjustment turns out not to be needed, since as is shown below only one factor (number of prior drink driving offences) has sufficient between-category variability and a large enough difference in distribution from the Queensland drink driving population to affect the results.

Results

As expected, rates for males were considerably higher than for females (Table 1).

For individual factors, among males there is little difference in re-offence rates at two and five years between Brisbane and the Inner and Outer Regional areas, but rates are higher in Remote and Very Remote areas. Younger drivers have somewhat higher rates while drivers aged 50 years and over have markedly lower

rates, with those between 25 and 49 years of age intermediate at both time periods. Re-offence rates on a univariate basis by index offence code show little difference at two years where blood alcohol concentration is known, and are somewhat higher among the more serious offenders at five years; drivers without a reading, often because of failure to supply, have lower levels of re-offence. Where an actual BAC reading was available, five-year rates for (predominantly young) drivers in the lowest category (< 0.05 mg/100 mil.) are slightly higher than average, particularly at five years, but from the next category (0.05 – 0.99 mg/100 mil.) five year rates trend upward. In conformity with the results for offence code, drivers without a reading have the lowest rates at both time points. By far the largest differences are seen for the variable, number of prior offences, with drivers with two or more drink driving offences prior to their index offence having very high rates at both two and five years, despite the probable driving suspensions which most or all will have received (Table 2).

Rates for female drivers are far less stable in many of the categories due to much lower numbers. On the whole, results are in conformity with those for males with a few possible discrepancies, which could be largely due to the instability alluded to above (Table 3).

There is no evidence of effect modification on any of the other factors considered by the most influential factor on re-offence rates, namely prior offence history, at least among males. That is, within categories the ratios of five year rates among those with a prior offence history to those with no such history vary relatively little, and non-significantly, over categories of age, region, BAC level or index offence code (data not shown). These ratios fluctuate around 1.65, which is the ratio of the five-year re-offence rate among those with a prior offence history to that among those without (Table 2).

In order to obtain estimates of re-offence rates for all drink drivers in Queensland, it would- strictly speaking - be necessary to weight sample estimates to reflect the distribution in the population of Queensland drink drivers of the factors considered here. Distributions of some of these are found in the report mentioned previously which analysed records of all convicted drink drivers in Queensland for the year 2004, which is near the mid-point of the period studied here [4]. This report indicates that the age distributions in the 2004 cohort and the current sample are similar, with medians of 31.0 and 31.7 years respectively. There are a higher proportion of males, high level BAC offences and repeat offenders in the current sample, while

Table 1. Estimated two- and five-year re-offence rates and standard errors (s.e.), by sex.

Sex	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
Males	17,962	10.8	0.24	25.8	0.40
Females	2,719	7.8	0.52	18.2	0.91

Logrank χ^2 (1 d.f.) = 54.3, $p < 0.0001$

Table 2. Estimated two and five-year re-offence rates and standard errors (s.e.), by region, age, index offence code, BAC at index offence and number of prior drink driving offences - males

Region (ARIA classification)	N	Rate (%)	Two year s.e.	Rate (%)	Five year s.e.
Major City (Brisbane)	7776	10.8	0.36	26.3	0.60
Inner regional	5042	9.7	0.43	24.8	0.79
Outer regional	4155	10.8	0.49	25.3	0.78
Remote	517	12.4	1.47	29.7	2.38
Very remote	472	18.0	1.78	31.0	2.36
Logrank χ^2 (4 d.f.) = 18.1, p = 0.001					
Age (years)	N	Rate (%)	Two year s.e.	Rate (%)	Five year s.e.
17 – 24	5395	12.0	0.46	29.8	0.78
25 – 29	3130	10.3	0.56	25.6	0.95
30 – 39	4881	10.8	0.45	25.6	0.75
40 – 49	2989	10.6	0.57	24.6	0.94
≥ 50	1567	7.5	0.67	16.9	1.12
Logrank χ^2 (4 d.f.) = 85.7, p < 0.0001					
Index Offence Code	N	Rate (%)	Two year s.e.	Rate (%)	Five year s.e.
67 (Under influence liquor UIL)	488	7.6	1.19	18.7	2.07
2383 (Fail to supply specimen)	344	10.1	1.65	23.2	2.66
2381 (UIL PCA < 0.150)	8063	10.8	0.35	25.0	0.59
2380 (UIL PCA ≥ 0.150)	9067	10.9	0.34	27.2	0.57
Logrank χ^2 (3 d.f.) = 11.4, p = 0.010					
B.A.C. at Index Offence	N	Rate (%)	Two year s.e.	Rate (%)	Five year s.e.
< 0.05	537	11.3	1.39	29.3	2.43
0.05 – 0.099	4243	10.8	0.48	23.9	0.81
0.10 – 0.149	3297	10.9	0.55	25.8	0.92
0.150 – 0.199	6380	10.6	0.40	26.9	0.68
0.200 – 0.249	2129	10.8	0.69	27.1	1.15
≥ 0.250	544	13.4	1.48	29.6	2.28
No reading	832	8.7	0.98	20.4	1.61
Logrank χ^2 (6 d.f.) = 17.1, p = 0.009					
Number of Prior Offences	N	Rate (%)	Two year s.e.	Rate (%)	Five year s.e.
None	9167	7.9	0.29	19.8	0.50
1	7234	11.9	0.39	30.0	0.67
≥ 2	1561	23.2	1.12	44.6	1.67
Logrank χ^2 (2 d.f.) = 483, p < 0.0001					

Table 3. Estimated two- and five-year re-offence rates and standard errors (s.e.), by region, age, index offence code, BAC at index offence and number of prior drink driving offences - females

Region (ARIA classification)	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
Major City (Brisbane)	1073	7.0	0.79	17.8	1.46
Inner regional	711	8.1	1.05	22.9	2.02
Outer regional	808	7.3	0.93	14.2	1.39
Remote	67	11.9	3.98	27.5	6.83
Very remote	60	9.7	3.88	23.4	13.0
Logrank χ^2 (4 d.f.) = 10.6, p = 0.031					
Age (years)	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
17 – 24	568	8.0	1.15	17.0	1.92
25 – 29	337	9.4	1.63	17.9	2.51
30 – 39	940	8.0	0.90	21.0	1.65
40 – 49	679	6.6	0.97	16.1	1.70
≥ 50	195	8.0	2.02	17.0	4.19
Logrank χ^2 (4 d.f.) = 9.4, p = 0.053					
Index Offence Code	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
67 (Under influence liquor)	71	4.3	2.44	15.1	6.36
2383 (Fail to supply specimen)	77	12.4	4.06	31.3	7.37
2381 (UIL PCA < 0.150)	963	8.1	0.89	15.7	1.39
2380 (UIL PCA ≥ 0.150)	1608	7.5	0.67	19.3	1.22
Logrank χ^2 (3 d.f.) = 10.3, p = 0.016					
B.A.C. at Index Offence	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
< 0.05*	52	9.8	4.18	9.8	4.18
0.05 – 0.099	560	7.3	1.11	14.3	1.77
0.10 – 0.149	351	9.5	1.60	19.7	2.63
0.150 – 0.199	1090	7.4	0.81	18.9	1.48
0.200 – 0.249	413	7.9	1.35	21.3	2.49
≥ 0.250	105	8.8	2.82	16.6	4.33
No reading	148	8.3	2.29	22.3	4.65
Logrank χ^2 (6 d.f.) = 10.8, p = 0.096. *no re-offences beyond 16 months					
Number of Prior Offences	N	Two year		Five year	
		Rate (%)	s.e.	Rate (%)	s.e.
None	1884	5.5	0.53	14.7	1.01
1	787	12.8	1.23	25.8	1.91
≥ 2	48	20.5	6.25	37.9	9.79
Logrank χ^2 (2 d.f.) = 55.3, p < 0.0001					

Table 4. Estimates of two and five year re-offence rates with 95% confidence intervals (95% CI) for Queensland drink drivers derived by aggregating rates for those with and without prior offences with weights based on 2004 proportions - males

Region (ARIA classification)	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
Major City (Brisbane)	9.0	8.1 – 10.0	21.9	20.4 – 23.5
Inner regional	8.2	7.2 – 9.3	21.8	19.9 – 23.8
Outer regional	8.5	7.4 – 9.8	20.9	19.1 – 23.0
Remote	9.8	6.9 – 13.9	25.9	20.5 – 32.9
Very remote	14.7	10.9 – 19.7	25.9	20.7 – 32.4
Age (years)	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
17 – 24	9.5	8.4 – 10.8	24.4	22.3 – 26.7
25 – 29	9.2	7.8 – 10.8	21.9	19.6 – 24.4
30 – 39	9.0	7.9 – 10.1	21.8	20.0 – 23.8
40 – 49	8.0	7.1 – 9.8	21.6	19.4 – 24.1
≥ 50	6.8	5.3 – 8.7	15.3	12.8 – 18.3
Index Offence Code	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
67 (Under influence liquor)	7.2	4.8 – 11.0	18.6	14.1 – 24.7
2383 (Fail to supply specimen)	7.3	4.4 – 11.9	19.9	14.4 – 27.5
2381 (UIL PCA < 0.150)	8.4	7.5 – 9.4	18.6	17.1 – 20.3
2380 (UIL PCA ≥ 0.150)	9.3	8.5 – 10.1	24.0	22.6 – 25.4
B.A.C. at Index Offence	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
< 0.05	9.6	6.2 – 14.8	20.2	14.3 – 28.4
0.05 – 0.099	9.0	7.8 – 10.4	18.4	16.4 – 20.6
0.10 – 0.149	7.6	6.3 – 9.2	18.8	16.4 – 21.5
0.150 – 0.199	9.2	8.3 – 10.2	24.1	22.5 – 25.8
0.200 – 0.249	9.1	7.1 – 11.0	23.3	20.6 – 26.3
≥ 0.250	10.9	7.9 – 15.2	25.8	20.5 – 32.4
No reading	7.4	5.4 – 10.2	19.1	15.4 – 23.6

the regional distributions use different definitions and hence are not comparable. In addition, the report contains no detailed breakdown of BAC level.

Since in the current sample the re-offence rates at two and five years differ relatively little between drivers with offence codes defined by low and high BAC levels, the only two factors that have been used in the re-weighting are gender and offence history, dichotomised as none or at least one. (Reweight using regional population estimates in ARIA categories hardly alters the overall sample estimates for either males or females.) In the report on the 2004 cohort, the proportion of females was 20%; 15.5% of males and 13% of females had a prior offence within the previous three years, so that 84.5% of males

and 87% of females were first offenders according to our definition. Population estimates overall and within categories of each factor are given by multiplying the applicable re-offence rate among male drivers with no prior offence by 0.845 and those among male drivers with at least one prior offence by 0.155 and summing. The same is done for females, using weights of 0.87 and 0.13 respectively. The resulting estimates of overall re-offence rate for males were 8.8% at two years with a 95% confidence interval (95% CI) of 8.3% to 9.4%, and 21.8 (95% CI 20.8% - 22.8%) at five years. Among females the estimates were 6.5% (95% CI 5.4% - 7.9%) and 16.4% (95% CI 14.4% - 18.8%) respectively. For Queensland as a whole the estimates are 8.4% (95% CI 7.7% - 9.2%) and 20.7% (95% CI 19.5% - 22.0%) respectively.

Table 5. Estimates of two and five year re-offence rates with 95% confidence intervals (95% CI) for Queensland drink drivers derived by aggregating rates for those with and without prior offences with weights based on 2004 proportions - females

Region (A.R.I.A. classification)	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
Major City (Brisbane)	5.7	4.1 – 7.9	16.7	13.3 – 21.0
Inner regional	8.1	5.8 – 11.3	21.2	16.8 – 26.8
Outer regional	5.8	4.0 – 8.3	12.4	9.5 – 16.3
Remote & very remote	10.3	5.2	18.6	10.6 – 32.8

Age (years)	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
17 – 24	6.5	4.3 – 10.0	14.7	10.7 – 20.4
25 – 29	8.3	5.2 – 13.4	17.3	11.8 – 25.3
30 – 39	6.3	4.6 – 8.7	18.1	14.6 – 22.6
≥ 40	6.2	4.4 – 8.7	15.4	12.1 – 19.7

Index Offence Code	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
2381 (UIL PCA < 0.150)	4.9	3.4 – 7.1	9.7	7.1 – 13.2
2380 (UIL PCA ≥ 0.150)	6.9	5.5 – 8.8	18.4	15.7 – 21.7

B.A.C. at Index Offence	Two year		Five year	
	Rate (%)	95% CI	Rate (%)	95% CI
0.05 – 0.099	4.7	2.8 – 7.7	9.5	6.1 – 15.0
0.10 – 0.149	6.3	3.6 – 11.1	13.7	8.6 – 21.8
0.150 – 0.199	7.0	5.2 – 9.3	17.9	14.7 – 21.9
≥ 0.200	6.9	4.5 – 10.4	19.3	14.7 – 25.5

The same sex-specific reweighting can be applied to re-offence rates by category for region, age, index offence code and BAC level after stratification by prior drink driving offence history. These are provided in Table 4, in all categories for males. Relativities between categories are on the whole unaltered, with the exception of the variable, index offence code, where rates in the more serious offence range (BAC ≥ 0.150) are now appreciably and significantly higher than those in the other categories, particularly at five years. In addition, the trend previously evident across the categories of index BAC is now essentially reduced to the dichotomy represented by the index offence code. Multivariate analysis using Cox proportional hazard modelling with all factors included confirms these relativities.

Weighted estimates are also provided for females for completeness, but only in selected or aggregated categories, depending on numbers (Table 5). In view of the much reduced sample size for women, the results - in particular those at five years - should be treated with caution.

Discussion

The above results indicate that almost 9% of Queensland male drivers and 6.5% of Queensland female drivers will have been convicted of a second drink driving offence within two years of a randomly chosen ('index') drink driving offence, despite the driving suspensions or disqualifications almost all will have received at a court hearing within a few months of that offence. At five years, the proportion re-offending will have increased to almost 22% in males and over 16% in females. Drivers of either sex with a history of previous drink driving within three years prior to the index offence have far higher re-offence rates at both two and five years, notably those who had more than one prior drink driving offence. Re-offence rates at both time periods tended to be higher in males living in remote or very remote regions of Queensland, and in male and female drivers with high-range blood alcohol concentrations (0.15 mg/100 ml or more) at the index offence. On the other hand, male drivers of at least 50 years of age had markedly lower re-offence rates at both two and five years. Young male drivers had the highest re-offence rates. The pattern in females was less clear, probably because they were far fewer in number.

Residence in remote and very remote areas has apparently not been recognised specifically as a risk factor for drink driving recidivism. However, levels of alcohol consumption are known to be very high in rural Queensland. [5]

The five-year re-offence estimates from the NSW series are 16.6% in males and 9.7% in females, compared with the higher rates in Queensland of 21.8% and 16.4% in males and females respectively [1]. In terms of the individual factors common to both datasets, rates in NSW are shown for both sexes combined as against the sex-specific results presented here, which complicates direct comparison. However, in both states females comprise a small %age of drink drivers. Ignoring this complication, the relativities are similar in the case of age, with highest rates among younger drivers and lowest in the oldest group. On the other hand, the NSW data do not show the striking difference in re-offence rates of Queensland male and female drivers with BAC level of 0.15 mg/100 ml or higher compared to those with lower levels greater than or equal to 0.05 mg/100 ml. Both sets of results show higher rates in drivers with BAC levels below 0.05 mg/100 ml, who are in Queensland at least mainly in the youngest age group. Nor do the NSW results indicate as large a difference among both males and females between Queensland drivers with no prior drink driving offences and those with at least one.

It should be noted that the follow-up intervals New South Wales start from the date of court appearance whereas the Queensland intervals start at the date of offence. However, the mean and median intervals from offence to court hearing in Queensland in a series of over 1000 drink driving offenders assigned to the rehabilitation program in 2009 were only 71 and 42 days, respectively. Although the intervals in Queensland could be over two years in a few instances, as a whole this difference between the study intervals in NSW and Queensland is inconsequential.

Imperfect re-weighting of the Queensland estimates is an unlikely explanation of these differences. Even the drivers in the joint category of risk factors with lowest re-offence rates (urban residence, no prior drink driving offences, low range BAC at index offence and aged between 25 and 49 years) have five year re-offence rates of 16.4% in males and 11.7% in females. Only 11% of the male sample and 16% of the female sample fall into this group, and re-offence rates among the remainder will in the main be much higher. Two-year recidivism rates are available for the entire 1993 Queensland cohort of convicted drink drivers with a follow-up interval of three years or less. These rates are, at 13.2% in males and 7.9% in females, appreciably larger than the estimates provided here [6]. A possible cause is the difference in overall drink driving offence rates in the two states as measured by the ratio of annual drink driving conviction to licensed drivers. In Queensland, these were 1.39% in males and 0.39% in females in 2004 [4], whereas in New South Wales they were 0.88% and 0.19% respectively in 2002 [1].

Comparable figures on police enforcement or court outcomes

in the two states are difficult to obtain, so the difference awaits explication.

Comparable rates for other jurisdictions both in Australia and abroad are difficult to come by. As Trimboli and Smith point out, previous estimates vary widely with differing lengths of follow-up periods.[1] Furthermore, policing methods and definitions of drink-driving vary across and within countries. A European Union report from 2008 claims that 'research has demonstrated that between 20% and 30% of convicted drink drivers re-offend' without specifying the interval between offences [7]. A report of an interlock trial in Alberta, Canada, suggests a five year re-offence rate among control drink drivers of 17% [8], while control drink drivers from an interlock trial in Indiana, USA, appear to have had a 24% rate among first offenders and 32% among repeat offenders over a somewhat longer period [9].

Thus it is impossible to decide whether the Queensland estimates are unusually high or the NSW rates unusually low. What seems clear, however, is that greater efforts need to be made to reduce the prevalence of re-offence in Queensland drink drivers, particularly among repeat offenders.

As remarked earlier, the sample, while randomly selected, is not representative of all drink drivers in Queensland over the study period even within the categories of single factors on which the reference sample of drivers was matched. However, with appropriate adjustment, credible estimates of recidivism rates can be obtained based in most cases on large numbers, at least among males. These estimates are subject to the recognised imperfection of data collected for administrative rather than research purposes, but this is unlikely to have influenced the results to any appreciable degree. Since the sample contained far fewer females, estimates of their re-offence rates are not as reliable.

Conclusion

In practical terms, the results suggest several possible countermeasures. More severe or focused sanctions for multiple repeat drink driving offenders could be considered; these might include installation of alcohol ignition interlocks or an equivalent device, or even vehicle impoundment where no other users would be affected. Programs for beginning young drivers are in place and it is hard to imagine what further measures could be implemented. Better enforcement in remote areas is perhaps called for; however, given the sparseness of the population and the distances involved, this would be costly in terms of police resources. More fundamentally, the drinking culture of these regions needs changing, but the means to do so do not seem available as yet.

References

1. Trimboli L, Smith N. Drink driving and recidivism in NSW. Crime and Justice Bulletin No. 135. NSW Bureau of Crime Statistics and Research, September 2009.

2. Siskind V, Schonfeld C, Sheehan M. Predictors of Re-offence among Australian Drink Drivers. In 15th International Conference on Alcohol, Drugs and Traffic Safety (T2000), 21-26 May 2000, Stockholm, Sweden; <http://eprints.qut.edu.au/9995/>.
3. Commonwealth Department of Health and Ageing. Measuring Remoteness: Accessibility/Remoteness Index of Australia (ARIA). Occasional Papers: New Series number 14.
4. Leal NL, King MJ and Lewis, IM. Profiling Drink Driving Offenders in Queensland. Journal of the Australasian College of Road Safety 2008 19(2): 47-54.
5. Sheehan MC, Siskind V, Turner R, Veitch C, O'Connor T, Steinhardt D, Blackman R, Edmonston CJ, Sticher G, 2008. Rural and Remote Road Safety Study: Final Report. Queensland University of Technology, available from <http://eprints.qut.edu.au/26539/>.
6. Buchanan DA. Recidivism rates of a cohort of drink-drivers in Queensland – A basis for comparison. Unpublished Masters Thesis, University of Queensland 1999.
7. European Transport Safety Council. ETSC Fact Sheet 2008. http://www.etsc.eu/documents/Fact_Sheet_Drink%20Driving%20Recidivism.pdf
8. Voas RB, Marques PR, Tippetts AS, Beirness DJ. The Alberta Interlock Program: the evaluation of a province-wide program on DUI recidivism. Addiction 1999.
9. Voas RB, Blackman KO, Tippetts AS, Marques PR. Evaluation of a program to motivate impaired driving offenders to install ignition interlocks. Accident Analysis and Prevention 2002 34:449-455.

Pavement markings should be visible in all driving conditions, not just during dry daytime conditions.

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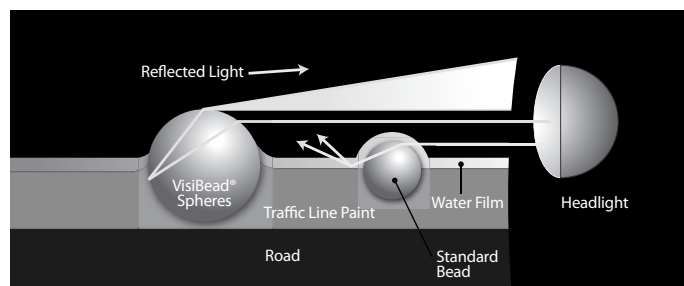
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Literature Review

Recent reports reviewed by Road Safety Literature Editor, Andrew Scarce

Greek study highlights the risks of in-vehicle distractions

A study by the National Technical University of Athens (NTUA) has found that in-vehicle devices seem to impair drivers more than external distractions. The study, *Distracted Driving*, was presented to a European Transport Safety Council lecture in Athens last November. The author, Associate Professor George Yannis, aimed to provide a comprehensive picture of the impact of driver distraction on road safety.

Research suggested that about 30% of drivers who were involved in a road accident reported having been distracted prior to the incident. Professor Yannis' research concluded that mobile phone use (hand-held or hands-free) and complex conversation (using a mobile phone or with passengers) were the most critical in-vehicle distractions. 'The penetration of various new technologies inside the vehicle and the expected increased use of such appliances in the next few years, makes further investigation of their influence on the attention of drivers, on traffic flow and on road safety very essential', Yannis said. His research particularly focused on the effects of mobile phone use (an internal distraction) and advertising signs (external distraction). Yannis reviewed more than 90 studies on driver distraction and listed the following in-vehicle factors on a graduating scale of influence to crashes.

- mobile phone use (Impairment increases in complex road environments. Older drivers find it hard to share attention. Younger drivers are more vulnerable.)
- complex conversations
- operating radio or entertainment systems
- entering destination into in-vehicle route guidance devices
- eating or drinking while driving
- smoking while driving.

Yannis found the external distraction of advertising signs did not attract the attention of the majority of drivers. However, studies had found that pedestrians distracted by phone conversation, eating or listening to music took greater risks when crossing roads. Yannis outlined results from three studies on the effect of mobile phone use on road safety which were conducted by the NTUA in recent years. He presented a detailed range of measures to counter the dangerous effects of in-vehicle driver distraction. These included a range of technological measures such as

- steering-mounted button systems to input information
- systems which rely on voice activation for input
- tactile marks on the phone keypad buttons to give each button a distinct feel, reducing the need for drivers to look away from the road
- more ergonomic design of the human-machine interface of in-car information systems to allow safer use.

National Technical University of Athens, European Transport Safety Lecture, *Distracted Driving*, by Associate Professor George Yannis, November 7, 2011 – available at <http://www.etsc.eu/documents/ETSL-Yannis17.pdf>

Contributed Articles

Project RAPTAR: Reduce Accidents, Prevent Tragedy, Activate Resources

by Sergeant Michael Musumeci, Ravenshoe Police, Queensland

Introduction

The Ravenshoe area in North Queensland had an unacceptably high rate of serious traffic accidents and ongoing traffic-related offences, with a high rate of injuries and fatalities. The Ravenshoe Police Division recognised that something had to be done urgently to address this ongoing carnage. After much research and community consultation, Project RAPTAR was formulated.

RAPTAR stands for Reduce Accidents, Prevent Tragedy, Activate Resources. Key representatives from the community, local businesses, government and others concerned about road safety were approached to form an action group. Interested participants formed a working group to discuss, develop and implement a range of initiatives to combat the high rate of road crashes and to bring about lasting change in road safety in the area.

The RAPTAR team consisted of:

Michael Musumeci	Sergeant of Police, Ravenshoe
Paul Casey	Constable, Ravenshoe Police
Ben Herbert	Constable, Ravenshoe Police
William Shaw	Constable, Ravenshoe Police
Robert Doyle	Captain, Ravenshoe Fire Service and Community
Henry Condon	Principal, Ravenshoe State High School
Mary Waltz	Principal, St Theresa's Catholic School
Tom Penna	Works Supervisor, Tablelands Regional Council
Arthur Scarborough	Roads Inspector, Tablelands Regional Council
Michael Ringer	Engineer, Department of Main Roads and Transport
Phil Rae	Roads Inspector, Department of Main Roads and Transport
Geoffrey Solly	RSL, RAISE Corporation and Community Representative

Aims of Project RAPTAR

Project RAPTAR was designed to actively engage and involve the community in finding solutions to local road safety

concerns. The RAPTAR team identified and worked with numerous stakeholders including owners of licensed premises, regional council representatives, government departments such as Department of Main Roads and Transport, various businesses and community organisations. The RAPTAR team also referred to, and were guided by, the *Queensland Police Service Strategic Plan 2011-2015*, the *National Road Safety Action Plan 2009-2010* and the *Queensland Government's Toward Q2: Tomorrow's Queensland ambitions*.

Specifically, the objectives of RAPTAR were to

- bring members of the community together to work towards a common goal to improve road safety in the Ravenshoe region
- reduce road trauma, deaths and injuries
- educate the community about road safety issues and the tragic consequences and costs of road trauma.

Methodology and activities of RAPTAR

From the outset, consultation and collaboration were key to the success of the RAPTAR team. RAPTAR held regular monthly meetings. If serious issues needed more attention, further meetings were held. These meetings instigated a coordinated and collaborative approach to what to do, how to do it and when to do it. The meetings focused on identifying the issues, considering solutions, and implementing effective actions to address the issues within certain timeframes. The RAPTAR team developed the **3E Formula** to combat the identified issues in three ways: Engineering, Enforcement and Education.

Through the localised team approach, all members shared responsibility for the majority of tasks, liaising with external agencies and carrying out prevention, education and enforcement phases of the project. Throughout Project RAPTAR, consultation was the ongoing positive attribute. Members claimed ownership and could see positive change. This was one of the core successes of RAPTAR.

Engineering phase and solutions

RAPTAR identified the dangers in a number of well known crash locations in the district and sought engineering solutions. For instance, Ravenshoe was well known for numerous fog-related crashes occurring within the area. The RAPTAR team

decided a specific FOG warning sign was needed to alert motorists to the danger (Figure 1). Signs were strategically placed in areas throughout the district where heavy fog was known to be a contributing factor in vehicle accidents. Fog-related crashes diminished after the implementation of such signage.



Figure 1. New fog warning signage along a rural highway

Extensive road upgrades, hazard reduction and roadside clearing were carried out throughout the Ravenshoe district. Crashes occurred on this particular stretch of road (shown in Figure 2) on a monthly basis. RAPSTAR instigated a complete roadway reseal with appropriate signage and delineators. Since the new reseal, no crashes have been reported.



Figure 2. A well known crash location before RAPSTAR

In other dangerous areas where fatalities had occurred, HIGH CRASH warning signs were installed. No fatal crashes have been reported in these danger zones since the installation of these signs. A notorious intersection where many serious crashes involving heavy vehicles had occurred, and which had claimed the lives of three people, was upgraded. In other areas where crashes regularly occurred, other measures were taken such as

- installation of glass stud delineators (Figure 3)
- installation of double white lines in curved and troublesome sections of road
- implementation of POLICE ENFORCEMENT ZONE signage in high speed areas throughout the highway network
- installation of audible lines to counteract fatigue
- installation of STOP signs

- reduction of speed limits where appropriate
- installation of LED warning systems.

For example, some urban zones were reduced from 60 km/h to 50 km/h (Figure 4) and a dangerous stretch of the Kennedy Highway at Ravenshoe was reduced from 100 km/h to 80 km/h. Again, these 'blackspot' areas have seen a dramatic decrease in crashes since the implementation of the new speed limits.



Figure 3. Glass stud delineators installed on a notorious stretch of Kennedy Highway



Figure 4. Speed limits were decreased and speed zones extended in some areas

Enforcement phase and solutions

Traffic-related enforcement was a vital and strategic part of Project RAPSTAR. Intelligence-based locations, high-risk crash zones, and high speed locations were nominated for specific divisional operations to be performed.

Team members monitored these locations by conducting static and mobile traffic enforcement within these areas. Targeting these specific locations successfully modified road user behaviours and provided effective deterrence. A comparison of Traffic Infringement notices issued showed a dramatic increase in notices being issued in 2008, followed by a significant reduction in traffic offences and infringements issued in subsequent years, as can be seen at Figure 5.

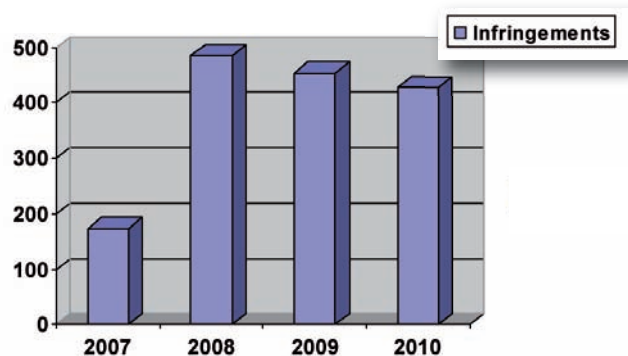


Figure 5. Traffic infringements issued 2007 - 2010

It was very clear that further police resources were needed on an ongoing basis to achieve RAPTAR goals. The following resources are now attached to Ravenshoe Station

- Vehicle Mobile Radar
- LIDAR
- Intoxiliser
- LED Safety interception warning lights
- additional RBT device on permanent loan from Mareeba Station.

In addition, Project RAPTAR has been extremely successfully in reducing the problem of drink driving within the Ravenshoe rural division. In response to intelligence, police carried out Random Breath Testing at specific targeted locations. RAPTAR members also worked closely with members of the Southern Tablelands Liquor Accord to consider various options to address drink driving. As a result, a specific condition was introduced to licensed premises in the area, restricting the sale of alcohol after 10.00 pm. This measure brought about a reduction in the number of drink drivers being intercepted by police, and also a reduction in alcohol-related violence.

Ravenshoe Police Division actively carried out 6764 random breath tests throughout 2010 and found that drink driving offences were decreasing since the introduction of targeted measures. The incidence of drink driving in 2010 was considerably less than in previous years – see Figure 6 – and the community response was very positive.

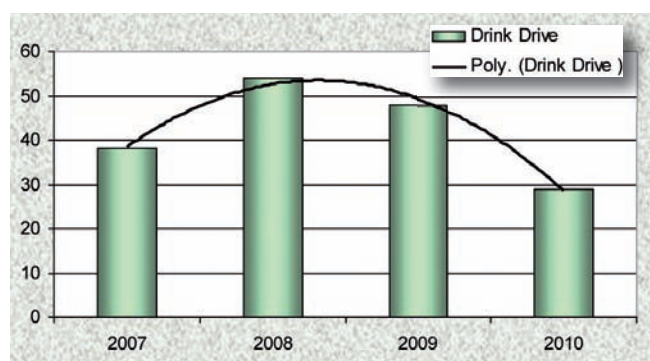


Figure 6. The dramatic drop in drink driving offences in 2010 for the Ravenshoe Police division

Education phase and solutions

Ravenshoe Police and Emergency Services attended the Ravenshoe High School with targeted audiences to discuss drink driving, road carnage, accident prevention, driver's licences and youth in cars. Students in Years 9, 10, 11 and 12 were targeted with a total of over 80 students attending these seminars. At these seminars, all students were confronted with the Jacqueline Saburido story – a 20 year old female who suffered burns to 90% of her body and the constant struggle to stay alive after she had been involved in a collision with a drink driver in the United States. The powerpoint presentation proved compelling, with students commenting on the horrific tragedy drink drivers can cause. This presentation was very effective in bringing the message home to the students of Ravenshoe High School.

Further to this, RAPTAR team members conducted numerous school visits implementing further road safety initiatives. These initiatives included Drivers Licences legislation, Queensland Transport information booklets, Party Safe initiatives including external agencies, as well as Traffic Infringement Notice information. RAPTAR also researched P-Plate traffic accidents throughout the division, as a large number of P-Platers had been involved in drink driving offences and traffic accidents. This research prompted education programs aimed at P-Platers and focused on traffic-related offences including Drink Driving, and the causes of traffic accidents.

Another important community education measure was the installation of a community display at a highway rest stop (Figure 7). The display, funded by community donations, features a wrecked car after a single vehicle crash, with confronting signage. The installation is covered with reflective tape to make it stand out at night-time.



Figure 7. An emotive display designed by RAPTAR and installed at a highway rest stop

Outcomes of RAPTAR

Project RAPTAR fulfilled its main aim of reducing the incidence of traffic offences, injuries and fatalities in the Ravenshoe area. The success of RAPTAR has had a significant impact on Ravenshoe and surrounding police divisions. It should also be noted that in 2010 the Ravenshoe police division did not itself suffer any fatalities.

The project has created a focused emphasis on the community's needs and supports the *Queensland Police Service Strategic Plan 2011-2015*, the *National Road Safety Action Plan 2009 – 2010* and the *Queensland Government's Toward Q2: Tomorrow's Queensland ambitions*, particularly *Supporting safe and caring communities*. The project also generated an effective operational interlinking relationship between the Queensland Police Service, agencies and the community in working together to address road safety. Project RAPTAR has been able to effectively utilise the Scan, Analysis, Response and Assessment Model with many divisional issues being addressed.

RAPTAR has been instrumental in forming workable relationships between various agencies and members of the community and has shown how effective these relationships can be. The multi-agency approach and team effort achieved positive results. The method used by RAPTAR could be easily

utilised by other concerned communities to address similar issues and achieve similar results. In particular, the RAPTAR experience could assist other communities to find solutions to the ongoing tragedy of the road toll in other states.

Conclusion

Project RAPTAR has proved that it is possible to engage the local community to work collaboratively in order to promote road safety, to reduce road crashes and traffic-related offences, and above all to reduce injuries and fatalities on the roads.

Sergeant Michael Musumeci and the RAPTAR team won the inaugural 3M-ACRS Diamond Road Safety Award in 2011. As part of the prize, Michael travelled to Florida in mid-February to attend the American Traffic Safety Services Association Annual Convention and Traffic Expo.

Hoon club culture: A South Australian policing response

by Detective Inspector Philip Newitt, Operations Inspector - Organised Crime Investigation Branch

Introduction

The rise in popularity of 'hoon' driving clubs in South Australia in recent years saw three clubs build large, active memberships. The focus of these clubs was to actively promote and organise car cruises and hoon driving events on public roads. The activities of these clubs led to the formation of a policing task force called 'Task Force Diagonal' whose mandate was to move beyond the general enforcement of organised car cruises, to a targeted criminal approach designed to disrupt and dismantle an established hoon culture.

In July 2009, a South Australian newspaper featured an article with the headline *Mob Rule – Nightmare on Main Street*. It described the activities of the 'All Car Club', a group of car 'enthusiasts' captured the previous weekend by a reporter and photographer during a monthly cruise.



Figure 1. Lower Light on 5 July 2009 (reproduced with permission of The Sunday Mail)

The article outlined a night of continual hooning and what can only be described as patently stupid behaviour which posed a danger to participants, spectators and others. Groups of people were photographed standing on Highway 1, Lower Light (approximately one hour north of Adelaide's CBD), during the early hours of a Sunday morning while cars took turns to perform burnouts and 'circle work' in and around spectators. Their actions generated so much smoke and dust that the vision of oncoming traffic was obscured (Figure 1).

In a subsequent police interview, the newspaper reporter described B-double trucks travelling at 100 km/h passing through thick plumes of smoke from burning rubber as group members leapt off the carriageway. Other road users were forced to stop and wait for the burnouts to stop before proceeding. Young men and women were seen standing either side of stationary vehicles as rear wheels were spinning, participants seemingly oblivious to the danger of their actions. The hoon driving session was the culmination of a long night of 'cruising' throughout metropolitan Adelaide where on more than one occasion dangerous driving was photographed and described in detail within the article.

The actions of the group, the level of organisation, the sheer number of participants and unlawful activity clearly raised a significant public safety issue. Understandably the public reaction was intense and many looked towards South Australia Police (SAPOL) seeking a response. Prior to the publication of this story, police were aware of a number of hoon car clubs operating out of Adelaide's northern suburbs. However, the escalation of their activities created a major road safety issue which required an immediate policing response. Task Force Diagonal was created.

Hoon car club culture in South Australia

South Australia enjoys a strong car club culture with allegiances determined along the lines of manufacturers, models, vehicle configuration (V8, turbo, 4WD), country of manufacture and age or vintage of vehicles. Clubs vary markedly in their level of organisation and prestige.

It is important to note that the majority of car club members do not create risks to other road users and Task Force Diagonal only targeted groups whose members consistently engaged in dangerous driving - commonly referred to as 'hoon' driving (hence the term 'hoon car clubs'). Hooning activities generally involve 'misuse of a motor vehicle' as defined by the *Road Traffic Act (SA)* and include behaviours such as driving at excessive speed, 'street racing', wheel spinning, burnouts, noise generation and disturbance, and causing damage to road surfaces.

In July 2009, three main hoon driving clubs operated within metropolitan Adelaide. Widespread media coverage of the formation of Task Force Diagonal saw one group, the Modified Car Klub, immediately cease its organised events. However, the two remaining clubs, Ragerz Commodore Klub (RCK) and its spin-off, the All Car Club (ACC), proved highly resilient and willing to flout the law despite the new enforcement activity.

In 2009, 'Ragerz' or RCK was the most established hoon club operating within South Australia, with the club holding their 10th anniversary run during the height of police investigations. RCK maintained a strong membership base with approximately 800 Facebook members directed and encouraged by two principal organisers. Meeting on the first Saturday night of each month, cruises began at nightfall and set off from the same suburban shopping centre car park that had been used for the previous ten years. Flyers with a predetermined route were distributed as participants rallied around the organisers for a 'briefing'. Upwards of 130 vehicles and occupants would attend and participate. The tradition of the monthly cruise was well established as were the culture of irresponsible and dangerous driving during the cruise and the post-cruise burnout spectacle.

ACC were the group depicted in the newspaper article. With a Facebook following of 1200, a sizeable network of participants and associates existed. Formed in about 2007 and holding cruises on the last Saturday of each month, ACC used social networking to organise and promote events which attracted more than 150 vehicles and at times in excess of 300 participants. The club was popular, well patronised and, in the view of many members, a legitimate social outing. A cruise or 'run' would venture throughout metropolitan Adelaide and nearby country locations, across local policing boundaries and covering perhaps 150 to 200 kilometres.

Anecdotally, the demographics of both groups were very similar. Drivers were almost exclusively Caucasian males aged in their late teens to early 30's, employed in a blue collar or semi-skilled occupation. Employment enabled group members to purchase, register, modify and fuel their vehicles. Driving behaviour commonly described as 'hooning' was not viewed by group members as dangerous or serious, and was undertaken as a social activity or for showing off in front of a crowd.

Whenever possible, police would address participants at the commencement of a cruise to ensure the police presence was noted. The standard address would outline the consequences of risky driving behaviour as well as reiterating police support of their lawful right to participate in a cruise provided members complied with the road rules. Police appeals were frequently met with disdain and at times defiance.

Sometimes cruise participants were alone in their vehicles but in the main at least one other occupant was present. Additional occupants were both men and women of a similar demographic profile. Examples of older participants and family groups were observed, and it was not uncommon to see baby capsules in cars during a Saturday night cruise, or toddlers wandering around car parks in pyjamas into the early hours of the morning. Unfortunately, the presence of children in a vehicle did not preclude the driver's involvement in instances of excessive speed, drink driving or hoon driving behaviour.

Vehicles of choice were almost exclusively older than 10 years of age with the majority either a Holden Commodore or Ford Falcon. Cars were relatively cheap, in an average to poor state of repair, sometimes modified, or not maintained in a roadworthy condition. 'Patching' of vehicles (wearing a 'patch' or sticker to signify members' association or belonging to a particular group or 'clan') and other club identifiers were evident amongst both groups. Unlike a traditional criminal gang, dual membership was common and even encouraged. ACC and RCK vehicle stickers were commonplace and, as with other gangs, were symbolic as a point of membership or allegiance to a club and sub-culture (Figure 2).



Figure 2. Rear window 'patch' and defiant behaviour of some club members (reproduced with permission of The Sunday Mail)

Police Response

The initial response of South Australia Police to the events reported by the Sunday Mail was to locate the witnesses, secure the evidence, identify those involved and take positive action. The initial response resulted in the arrest of three suspects, permitting police an initial insight into hoon car club culture. Given the semi-formal structure and hierarchy of each group, their extensive use of social networking sites to organise virtual and physical meetings, and their entrenched sub-culture, it was clear that a once-off police operation was not going to create the lasting change in attitude needed to reduce the serious risks associated with the hooning activity.

A review of previous enforcement initiatives with respect to both clubs demonstrated the difficulty in policing large numbers of cruise participants who were able to disperse and re-form at will. The geographical area covered and the time period over which a cruise would occur (12 hours plus) further complicated police efforts. To monitor activity and enforce compliance with legislation, a degree of police coordination which was higher than any previously undertaken was required.

Until the formation of Task Force Diagonal, local traffic enforcement officers and intelligence sections had sole responsibility for targeting hoon clubs. However, they largely operated in isolation and without broad and consistent coordination or centralised support. The introduction of Task Force Diagonal on 9 July 2009 brought about a more sustained and coordinated policing response. The approach brought together a mix of experienced detectives, field intelligence officers, a criminal analyst, traffic enforcement specialists and general duties members under the management of the Officer in Charge of the Major Crash Investigation Unit, Traffic Support Branch. Eleven full-time staff were supplemented by the combined resources of local services areas and traffic enforcement specialists during club cruises and runs.

Diagonal's mandate was to take action against those organising and taking part in aggravated recidivist hoon driving activities. The central policing concept was that professional but consistent pressure, education and enforcement would change attitudes and behaviour. Persistence and consistency of effort proved crucial in achieving these goals.

The attitude of group organisers is typified in comments quoted in the Sunday Mail article, where the President of the All Car Club describes himself as 'a bit of a hoon', justifying group actions as 'It's fun, it's just showing what your car is made of. We're just letting off steam'. Similar comments and attitudes were repeated by participants many times during Task Force Diagonal operations. It became apparent that for some participants, group culture had normalised and legitimised activity to a point where policing actions were seen as curtailing legitimate and acceptable behaviour.

Although initially considered to be a 'traffic policing' initiative, the strategy of using criminal investigators, intelligence officers

and an analyst meant a more rigorous investigation and greater focus on the criminality of driver actions to achieve real change in the activity of recidivist, persistent offenders. The targeting of key identities to break down the culture became a priority. Traditional traffic policing tools such as defecting and seizing vehicles under hoon legislation, issuing expiation or instant loss of licence notices and sending offenders to Court for traffic (summary) offences were important components of the response; however, entrenched attitudes and the ability of the groups to persist despite policing actions required police to adopt a more innovative approach. The real potential for serious injury or death reinforced this approach.

Group memberships were traced and plotted to inform targeting and guide the deployment of resources. It became apparent that members and affiliates of RCK and ACC, and more widely those who enjoyed participating in burnout activities, shared information concerning a network of hooning 'hot spots'. Local residents and businesses helped to build a picture of activity upon which police tactics were based. This proved highly beneficial as participants would visit hot spots repeatedly, and it was possible to collect good quality evidence which led to prosecutions (Figure 3).



Figure 3. A targeted hoon hot spot reviewed by police

Policing RCK and ACC cruises and burnout congregations proved a labour-intensive task over an extended period. Where possible, immediate enforcement action was instigated both to mitigate the risk of offending and send a clear message to other participants. However, police continued to carry out arrests and seizure of vehicles that could not be conducted on cruise nights due to the sheer number of participants involved.

Intelligence indicated that the timing of cruises, and the separation and re-formation during the early hours of the morning, were a deliberate tactic to disrupt police attention. This tactic was used in the knowledge that the majority of late night traffic police completed their weekend shift at 2.00 a.m. Needless to say, surprised faces met police as they regularly arrived at burnout locations at 4.30 a.m. Additional hoon car club tactics included the use of hire cars by central figures of the groups and continually varying routes and meeting points. Such was their determination to continue their activities.

Despite a high degree of police attention during a ‘cruise’, police still apprehended drivers travelling at very high speeds in suburban locations, drink and drug drivers, and those who could not resist spinning their vehicle wheels in front of a crowd. Nights of intense police presence did not dissuade splinter groups from forming for sustained wheel spin and burnout activities.

Good quality low light video was regularly obtained from group burnout sessions, highlighting the obvious danger posed to drivers and spectators alike. This footage was highly persuasive and greatly assisted prosecution and the laying of more serious charges including ‘Acts to Cause Harm’ under the *Criminal Law Consolidation Act 1935*. Provisions under this offence permitted a higher range of penalties including imprisonment and the instigation of longer licence disqualification periods. Briefs of evidence against RCK and ACC organisers were established over time. Because cruise organisers might not actually drive a vehicle, police collected evidence to demonstrate the offence of ‘Promote or organise an event involving misuse of a motor vehicle’; this charge had not previously been laid in South Australia. Two prosecutions were launched against RCK and ACC organisers; however, due to a number of factors the benchmark of ‘beyond reasonable doubt’ could not be reached and, disappointingly, convictions were not obtained. Where possible the most serious available criminal offence was laid and pursued through to prosecution.

Considerable effort was made to engage with responsible clubs to explain police activities and demonstrate support for legitimate activities. Media reporting caused much trepidation concerning the police and government response. As a part of the overall engagement and media strategy, members of the investigation team provided presentations and attended legitimate club meetings, cruises, runs, and ‘show and shine’ days to allay fears and discuss policing priorities. Importantly, police media messages focused on reinforcing responsible use of vehicles and legitimate vehicle clubs.

If the success of Task Force Diagonal is to be judged by enforcement outcomes alone, it can be described as highly successful. Between July 2009 and November 2010:

- 206 drivers were either arrested or reported for driving matters.
- 883 infringement notices were issued.
- 614 vehicles were ‘defected’.
- 102 vehicles were impounded and two forfeiture applications processed.
- 26 drivers had their driving licence instantly disqualified as a result of driving behaviour.

Conclusion

To combat the culture of hoon car clubs in South Australia, police made every effort to work with the organisers of the hoon runs, asking them to modify their behaviour and comply with road traffic rules. However, their disregard for the laws and safety of themselves and others, coupled with their persistence, left SAPOL with little option other than to create a dedicated task force to address the problem.

The work of Task Force Diagonal was a resounding success. By April 2010, the All Car Club had ceased operations and by July 2010, Ragerz Commodore Klub had given up organised cruises.

Following the success of Task Force Diagonal and as part of a SAPOL traffic policing restructure, the State Traffic Enforcement Section was created in December 2010. This section undertakes traffic enforcement across South Australia, collecting intelligence and adopting a proactive tactical approach to significant road safety issues, including the policing of car clubs and targeting organised dangerous driving activities. The *SAPOL Road Safety Strategy 2011 – 2014* was developed with the goal of reducing serious road trauma in South Australia by at least 12%. The strategy is underpinned by the philosophy that as a society we must agree that death and serious injuries on our roads are not inevitable or simply a by-product of community road use. The strategy sets seven priorities including specific reference to drivers who misuse motor vehicles and create danger for other road users.

Specific outcomes for State Traffic Enforcement Section include:

- a reduction in road trauma
- a reduction in organised dangerous driving events
- targeting of recidivist dangerous drivers
- the efficient and safe regulation of major event traffic.

Task Force Diagonal successfully halted organised dangerous driving events associated with car clubs. Since then State Traffic Enforcement Section has monitored the conduct of various car clubs to distinguish between legitimate cruising activity and organised dangerous driving. Adopting fundamentally the same tactics as Task Force Diagonal, State Traffic Enforcement Section attends cruises to maintain an overt police presence to deter offending and to take enforcement action where appropriate with the aim to bring about a long-term change in car club culture and behaviour.

DI Phil Newitt was formerly the Officer-in-Charge of the Major Crash Investigation Unit, South Australia Police.

Vulnerable road users: Characteristics of pedestrians

by Zoran Bakovic, Principal Traffic Engineer, Parsons Brinckerhoff, Sydney

Introduction

Pedestrians are vulnerable road users and comprise the largest single road user group. Walking is a major form of transport in urban areas and crossing a road is a key element in a journey on foot. A pedestrian network is part of the transport system and cannot be separated from it. Road crossing points are the critical links in a connected pedestrian network. Crossing the road is one of the most hazardous activities that a pedestrian can undertake as there is greater potential for conflict with the other road users.

This paper presents some of the findings from a literature review as part of the author's Masters degree research report [1], the goal of which was to discover how pedestrians negotiate the urban walking environment and describe some of the most important characteristics of pedestrian crossing behaviour in urban areas - information that traffic engineering practitioners can use for selecting the correct pedestrian facilities at appropriate locations.

The research project investigated pedestrian movement characteristics and crossing behaviour and compared results with the findings sourced from a literature review. The research involved reviewing the existing literature and conducting empirical research to study microscopic pedestrian flow characteristics.

Keywords

Pedestrian, Pedestrian behaviour, Pedestrian characteristics, Pedestrian crossing point

Characteristics of pedestrians

The qualitative and quantitative design of a pedestrian environment requires a basic understanding of related human characteristics and capabilities. The pedestrian population is not homogeneous. It means there is no such thing as an 'average' pedestrian; size, speed, strength and judgement can vary significantly between individuals depending on age, gender, mobility, level of awareness or aggression [2]. Pedestrians require the following skills in order to interact safely with traffic [3]:

- *Detecting the presence of traffic*: the detection of traffic involves a range of basic processes, including selective attention, visual search, resistance to distraction, co-ordination of visual and auditory information, and the perception of crossings (in terms of the opportunity they afford for detecting approaching traffic).
- *Visual timing judgements*: this requires the pedestrians to determine a vehicle's direction and rate of movement so that accurate time-to-contact judgement can be made. Such judgement provides information about the time available for crossing.
- *Co-ordination of information from different directions*: the pedestrians rarely have to deal with traffic approaching from a single direction, thus timing and other judgement must be made in relation to vehicles approaching from two or more directions. This requires the ability to divide attention, to hold information in memory and to co-ordinate and integrate this information.
- *Co-ordination perception and action*: this involves the ability to relate the time available for crossing to the time required to cross. The latter will vary according to characteristics of the individual's own movement, as well as to other factors such as the width of the road. Such knowledge about movement capability must then be calibrated to visual information about the time available to cross, so that realistic safety margins can be set and other decisions made.

Pedestrian characteristics by age groups

In general, common pedestrian characteristics by age groups are [4]:

Age 0 to 4 years

- learning to walk
- requiring constant parental supervision
- developing peripheral vision, depth perception

Age 5 to 12

- increasing independence, but still requiring supervision
- poor depth perception
- susceptible to darting out or 'intersection dash'

Age 13 to 18

- sense of invulnerability
- susceptible to intersection dash

Age 19 to 40

- active, fully aware of traffic environment

Age 41 to 65

- slowing of reflexes

Age 65+

- street crossing difficulty
- poor vision
- difficulty hearing vehicles approaching from behind
- high fatality rate.

Land Transport New Zealand (LTNZ)¹ [5] noted that pedestrian physical ability is affected by a great range of factors. Table 1 shows the ways in which pedestrians differ and how those differences affect the road/street crossing function.

Table 1. Pedestrian physical abilities [5]

Ways in which pedestrians differ	Affecting	Impacting upon
Height	Ability to see over objects; ability to be seen by others	<ul style="list-style-type: none"> • Sight distance
Speed of reflexes	Inability to quickly avoid dangerous situations	<ul style="list-style-type: none"> • Crossing opportunities
Visual perception	Ability to scan the environment and tolerate glare	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerbs and crossing locations • Crossing hazards • Tactile paving • Judging traffic
Attention span and cognitive abilities	Time required to make decisions; difficulties in unfamiliar environments; inability to read or comprehend warning signs	<ul style="list-style-type: none"> • Positive detections • ‘Legibility’ of streetscape • Consistency of provision • Use of symbols
Balance and stability	Potential for overbalancing	<ul style="list-style-type: none"> • Provision of steps and ramps • Kerb height • Gradients • Crossfall
Manual dexterity and coordination	Ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian activated traffic signals
Accuracy in judging speed and distance	Audible clues to traffic being missed	<ul style="list-style-type: none"> • Need to reinforce with visual information
Energy expended in movement	Walking speed	<ul style="list-style-type: none"> • Crossing time

Characteristics of children as pedestrians

Child pedestrians (pedestrians aged less than 15 years [6]) display significantly different characteristics to adults, not only in physical build but also in developmental maturity [5]. Quite often adults consider that children are more capable than they actually are [7] but children are still developing their cognitive and social skills and abilities. The ability to cross a street safely develops with age. Children do not reach an adult level of performance in traffic (i.e. do not have the perceptual and cognitive capacity to make sound judgements about traffic safety) until about 12 years of age [8, 3, 9].

A child's capacities to perform the task of crossing the street, particularly in scanning the environment as a whole, are poorer than an adult's. The more complex the traffic environment, the more difficult the crossing task will be for children to perform. Young children have limited ability to process information in their peripheral vision, so they need more time to react once an object in the periphery is seen [7]. Children also tend to believe that others will protect them, and can be overconfident in many circumstances [5].

A brief examination of the limitations and characteristics of children as road users helps to illuminate the problems which may occur during their street crossing activities [10]:

- *Up to age 2* children are not fit to cope with traffic in any way.

- *Between 2 and 7 years*, children are thinking but of the immediate task in hand (one matter at a time). Vision is not fully developed.
- *Between 7 and 11 years* children are capable of abstract thought. They reason about events not actually present but need experience to relate to the task in hand.
- *Children 12 years and over* have reached the stage of formal operations and have an adult grasp of the particulars of logical thought. They are ready to participate at adult level. Vision is not fully developed until around age 16.

The major characteristics which could affect a child's crossing behaviour are presented in Table 2.

Characteristics of older pedestrians

Older pedestrians (aged over 65 years [6]) face reducing capabilities with increasing age [11]. The ageing process generally causes deterioration in physical, cognitive and sensory abilities. More than 50% of the over-65s in New Zealand, for instance, consider themselves to have some form of impairment [5, 6].

Some characteristics of older pedestrians that can affect their walking and crossing ability are [11, 12]:

- impaired vision
 - difficulty seeing pedestrian signals on opposite side of the street

- often find it necessary to look at the ground while walking
- difficulty seeing curbs, cars, other pedestrians and other obstacles
- impaired hearing
- decreased agility, balance and stability
- slow gait, shorter stride
- lack of confidence

- inability to determine boundary between curb and street
- slower reflexes
- exaggerated start-up time.

Table 3 lists the characteristics of older pedestrians which affect their road crossing activities.

Table 2. Characteristics of child pedestrians which affect their crossing activities [5]

Characteristic	Resulting in	Impacting upon
Shorter height	Reduced ability to see over the top of object	<ul style="list-style-type: none"> • Sight lines and visibility
Reduced peripheral vision	Reduced ability to scan the environment	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerb • Crossing locations • Crossing hazards
Limited attention span and cognitive abilities	Inability to read or comprehend warning signs and traffic signals	<ul style="list-style-type: none"> • Positive directions • 'Legibility' of streetscape • Use of symbols
Difficulty localizing the direction of sounds	Audible clues to traffic being missed	<ul style="list-style-type: none"> • Need to reinforce visual information
Unpredictable or impulsive actions	Poor selection of routes and crossings	<ul style="list-style-type: none"> • Lateral separation from cars • Traffic speed and density • Barriers
Lack of familiarity with traffic patterns and expectations	Lack of understanding of what is expected of them	<ul style="list-style-type: none"> • Complexity of possible schemes

Table 3. Characteristics of older pedestrians which affect their crossing activities [5]

Characteristic	Resulting in	Impacting upon
Reduced range of joint motion	Slower walking speed	<ul style="list-style-type: none"> • Crossing time
Vision problems such as degraded acuity and poor central vision	Reduced ability to scan the environment	<ul style="list-style-type: none"> • Legibility of signs • Detection of kerbs • Crossing locations
Limited attention span, memory and cognitive abilities	Require more time to make decision, difficulties in unfamiliar environments, lack of understanding of traffic signals	<ul style="list-style-type: none"> • Positive directions • 'Legibility' of streetscape • Consistency of provision
Decreasing agility, balance and stability	Difficulties in changing level	<ul style="list-style-type: none"> • Provision of steps / ramps • Kerb height
Slower reflexes	Inability to quickly avoid dangerous situations	<ul style="list-style-type: none"> • Crossing opportunities
Reduced manual dexterity and coordination	Reduced ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian activated traffic signals

Table 4. Characteristics of mobility impaired pedestrians and their effect on crossing [5]

Characteristic	Resulting in	Impacting upon
Extra energy expended in movement	Slower walking speed	<ul style="list-style-type: none"> • Crossing time
Use of mobility aids	Increased physical space needed and good surface quality	<ul style="list-style-type: none"> • Footpath width • Obstruction
Decreasing agility, balance and stability	Difficulty in changing level	<ul style="list-style-type: none"> • Provision of steps/ramps • Kerb height
Reduced manual dexterity and coordination	Reduced ability to operate complex mechanisms	<ul style="list-style-type: none"> • Pedestrian- activated traffic signals

Pedestrians with disabilities

Assuming that the typical pedestrian is fit and healthy, has satisfactory eyesight and hearing, is paying attention and is not physically hindered, will misrepresent a significant proportion of the population [13]. Table 4 shows some characteristics of mobility impaired pedestrians and their effect on street crossing.

Conclusions

The main findings of the literature review were that:

- The pedestrian population is not homogenous. There is no such thing as an ‘average’ pedestrian because size, speed, strength and judgement can vary significantly between individuals depending on age, gender, mobility, level of awareness and aggression.
- Children and older pedestrians face particular challenges when crossing the street. Children do not reach an adult level of performance in traffic until about 12 years of age, and older pedestrians are affected by age-related decline in the function of their visual, perceptual, cognitive and motor systems. However, in contrast to younger pedestrians, elderly people are aware of their limitations.
- Many people have some kind of disability affecting their crossing action and behaviour. Assuming that the typical pedestrian is a person who is fit and healthy with satisfactory eyesight and hearing, who pays attention and is not physically hindered, will misrepresent a significant proportion of the population.

Notes

¹ The organisation formerly known as Land Transport New Zealand (LTNZ) has been amalgamated into the New Zealand Transport Agency (NZTA) since this research was conducted.

References

1. Bakovic Z. Pedestrian Behaviour at Road Crossings. Masters Degree Thesis. Christchurch, NZ: University of Canterbury, 2006.
2. Willis A, Kukla R, Hine J, Kerridge J. Developing the Behavioural Rules for an agent-based model of pedestrian movement. In 25th European Transport Congress, Cambridge, UK, 2000
3. Thomsom J, Tolmie A, Fot H, McLaren B. Child Development and the Aims of Road safety Education: A Review and Analysis. Road Safety Research Report No 1. London, UK : Department of Transport, 1996.
4. Litman et al. Pedestrian facilities Guidebook – Chapter: About Pedestrians. Atlanta, US: Georgia Institute of Technology, 2000.
5. Land Transport New Zealand. Pedestrian network planning and facilities design guide -The principles of pedestrian network planning, New Zealand, 2005.
6. Statistics New Zealand. Wellington: STN 2006. Viewed 5 September 2006. <http://www.stats.govt.nz>
7. Tuter E.A Safe Road Environment for Children. IPENZ Traffic Management Workshop and Technical Conference 2004. Wellington, NZ, 2004.
8. Malek M, Guyer B, Lescohier I. The Epidemiology and Prevention of Child Pedestrian Injury. Accident Analysis and Prevention 1990; Vol 22, No 4, pp 301-313.
9. Vinje P. Children as pedestrians: Ability and Limitations. Accident Analysis and Prevention 1981; Vol 13, , pp 225-240.
10. Federal Highway Administration. Mid-Block Crossing – Lesson 16. Course on Bicycle and Pedestrian Transportation. Washington DC: United States Department of Transportation, 1998.
11. Oxley J. Safety for Senior Working Group. Research Report. Melbourne: Monash University, 1989.
12. Oxley J, Corben B, Fildes B, O'Hare M, Rothengatter T. Older Vulnerable Road Users-Measurement to Reduce Crash and Injury Risk. Report No.218. Melbourne: Monash University, 2004.
13. Gadd M. Guide to Pedestrian Crossing Facilities. Christchurch: TRAFINZ, NZ, 2005.

Road lighting: A review of available technologies and appropriate systems for different situations

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Abstract

This review focuses on the criteria a lighting system should satisfy with regard to road safety issues and then lists the light source technologies that meet the needs of different situations.

Important factors to consider when choosing technologies are the visual needs (whether peripheral vision is important), colour rendering, light efficacy and lifetime of the system.

Introduction

Traditionally, for outdoor spaces a wide range of light source technologies have been used, with sodium discharges (high and low pressure) being the most frequent for efficacy reasons (highest efficacies in the market reaching 200 lm/watt for the low pressure version) followed by mercury lamps (high pressure mercury and low pressure mercury fluorescent lamps). However, as the issue of outdoor lighting in the road environment is closely connected to the safety of people (pedestrians and drivers), more specific proposals are made based on special visual requirements.

Before considering the actual light sources, there are certain criteria that the whole *luminaire* (device or system which creates artificial light via electric lamp) must satisfy for road and general outdoor lighting:

- The luminaire or lighting system must be designed in such a way that it has protection from weather and vandalism (considering such factors as height of pole, materials used and protection masks). Generally speaking, the higher up a lamp is fixed, the bigger the area of illumination, but the greater the requirement for lamps with greater lumen (measure of visible light emitted from a source) outputs.
- The illumination must be uniform, avoiding shadows and dark spots. This generally means that the distance between poles and the number of lamps (it is better to have many lamps than a few brighter ones) must be carefully considered. The advantage of using more lamps is that failure of some will still provide some illumination until replacement takes place.
- The luminaire chosen must also reduce glare and light pollution. Various groups of people (such as astronomers) already push the demand for light pollution reduction so cut-off luminaires such as the one shown in Figure 1 (see images at the end of the article) must be preferred.
- The issue of adaptation (and glare) is of particular importance when it comes to tunnels where drivers move from very bright environments to low light levels and vice versa in a very short time (Figures 2 and 3). This contrast causes adaptation difficulties for the drivers so specially built entrances and exits must be designed in order to prevent such abrupt changes.

Recommended light source technologies

With the above in mind, a number of proposals can be put forward for the type of lamps or light source technologies to be used in different situations in the road environment. It is important to match the features of each technology to the appropriate conditions.

- Off-axis visual detection is quite important as obstacles and pedestrians would be off the central vision axis. Research shows that illumination of the roads and streets with light sources that aid peripheral vision would prove beneficial [1-2]. The fact that the eye functions in mesopic conditions further enhances this reasoning. Therefore, light sources that stimulate the peripheral vision (rod stimulation) are important. This means that lamps with emissions **rich in blue light (cool white light sources)** should be preferred [3-4]. Mesopic vision describes the transition region from rod vision (scotopic) to cone vision (photopic), where signals from both rods and cones contribute to the visual response. This intermediate situation corresponding to dusk conditions is especially important for street lighting systems. Under photopic conditions, the sensitivity of the human eye peaks at 555 nm. As the luminance decreases, the peak of the sensitivity shifts towards lower wavelengths. The peak sensitivity under scotopic conditions is at 507 nm. These data are known as the spectral luminous efficiency functions or the $V(\lambda)$ curves. There is not an equivalent standard for the mesopic region yet and there will be developments in this area soon. The fact that rods are more sensitive to low light environments, that the scotopic vision shifts to shorter wavelengths and that rod concentration increases in the periphery of the retina, mean that rods and peripheral vision are more sensitive to blue light.
- A **high colour rendering index** is desirable as this would enhance colour contrast. This enhances perception of brightness and gives road users accurate information on events.
- As road lighting systems operate throughout the night, they must be cost-effective. This means that **high efficacies** and **long lifetimes** are required.

Table 1 shows the available technologies and some of their key characteristics, such as colour temperature ranges and colour rendering indexes. Some technologies have been excluded due to the fact they are either obsolete (simple incandescent, high pressure mercury, neon) or still in the developmental stages (organic LEDs).

Table 1. Characteristics of various light source technologies [3–4]

	HA	FL	LPS	HPS	MH	CMH	LED
Efficacy lm/W	30	<120	200	50-150	100	<95	<80
Power/W	<2000	5-165	<180	35-1000	<2000	20-250	0.1-7
Colour Temperature /K	<3500	wide	1700	<3500	wide	3000-4200	wide
Colour Rendering Index (CRI)	100	>90	0	20-85	>90	>90	>90
Lifetime/k hours	2-5	10-30*	20	10-30	10-20	10-20	>50

HA = halogen incandescent FL = all types of mercury fluorescent LPS = low pressure sodium HPS = high pressure sodium MH = metal halide lamps CMH = ceramic metal halides LED = light emitting diodes

Based on the above points of colour rendering, lifetime, more emissions in the blue region and high fluxes, the lighting technologies suggested are

- **Cool white metal halide lamps**
- **Cool white fluorescent lamps** (inductive lamps would offer longer lifetimes)
- **Cool white LED systems** could also be a good solution as they have long lifetimes and the appropriate colour temperature can be selected. However, there are still some issues to consider such as their cost, light fluxes and efficacies. It is a matter of time though before they can fulfil all the criteria and find a place in outdoor/road lighting. An important advantage of LEDs is that, due to thermal management issues, they perform better in cold environments, which is usually the case with outdoor spaces during the night.

Figure 4 shows photographs of these cool white technologies.

Solar LED lamp systems for road lighting can also be found in the market but such systems so far have found widespread use only in applications where not much light is required (such as in gardens or lighting of footpaths) as they are easily installed and maintained; they also provide a cheaper alternative to wired lamps. High pressure xenon lamps could offer the high light fluxes, the good colour rendering properties and the colour temperatures required for a range of outdoor spaces; however, this technology is not recommended because the efficacy and lifetime is lower than the above technologies.

Situations where sodium lamps should be retained

Although new light technologies which facilitate peripheral vision have made sodium lamps replaceable, there are a few cases where they should be retained.

- Sodium lamps should be used in open roads or tunnels where there are no pedestrians or significant traffic or known obstacles causing safety concerns (Figures 2 and 3).
- They should be used in places where fog and dust are frequent. This is due to the higher penetration of longer wavelengths (yellow compared to blue). Scattering increases with shorter wavelengths so in such environments the longer wavelength yellow light is desired.

Closing statement

It is clear that different situations have different requirements. For each case there will be different technologies that offer particular advantages. Lighting systems should be chosen to satisfy the relevant criteria regarding reliable performance, uniformity and appropriate visual stimulation to enhance road safety.

Terms and definitions

(sources: the websites of GE Lighting and Philips Lighting; an extended index can be found in [4])

Average rated lifetime As average rated lifetime we define the time duration beyond which, from an initially large number of lamps under the same construction and under controlled conditions, only 50% still function.

Colour Rendering Index (CRI) An international system used to rate a lamp's ability to render object colours. The higher the CRI (based upon a 0-100 scale) the richer colours generally appear. CRI ratings of various lamps may be compared, but a numerical comparison is only valid if the lamps are close in colour temperature.

Colour Temperature Measured in Kelvin, CCT represents the temperature an incandescent object (like a filament) must reach to mimic the colour of the lamp. Yellowish-white ('warm') sources, like incandescent lamps, have lower colour temperatures in the 2700K-3000K range; white and bluish-white ('cool') sources have higher colour temperatures.

Correlated Colour Temperature (CCT) A term used for discharge lamps, where no hot filament is involved, to indicate that the light appears 'as if' the discharge lamp is operating at a given colour temperature. CCT generally measures the 'warmth' or 'coolness' of light source appearance using Kelvin(K) temperature scale.

Cool White A lamp with a colour temperature of 5000 K to 6500K.

Efficacy A measurement of how effective the light source is in converting electrical energy to lumens of visible light. Expressed in lumens-per-watt this measure gives more weight to the green region of the spectrum and less weight to the blue and red region where the eye is not as sensitive.

Efficiency The efficiency of a light source is simply the fraction of electrical energy converted to light, i.e. watts of visible light produced for each watt of electrical power with no concern about the wavelength where the energy is being radiated. For example, a 100 watt incandescent lamp converts less than 10% of the electrical energy into light; discharge lamps convert more than 25% into light. The efficiency of a luminaire or fixture is the percentage of the lamp lumens that actually comes out of the fixture.

Eye Sensitivity The curve depicting the sensitivity of the human eye as a function of wavelength (or colour). The peak of human eye sensitivity is in the yellow-green region of the spectrum. The normal curve refers to photopic vision or the response of the cones.

Fovea, Foveal Vision A small region of the retina corresponding to what an observer is looking straight at. This region is populated almost entirely with cones, while the peripheral region has increasing numbers of rods. Cones have a sensitivity peaking in the green and corresponding to the eye response curve.

Kelvin A unit of temperature starting from absolute zero. Zero Celsius (or Centigrade) is 273K.

Photopic The vision for which the cones in the eye are responsible; typically at high brightness and in the foveal or central region.

Rods Retinal receptors that respond to low levels of luminance but cannot distinguish hues. Not present in the centre of the fovea region.



Figure 1. Cut-off luminaire

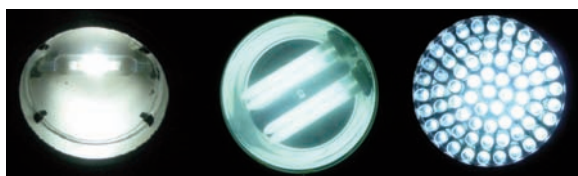


Figure 4. Cool white light emitting technologies – metal halide (left), fluorescent lamp (middle) and LED (right)

Scotopic The vision where the rods of the retina are exclusively responsible for seeing (very low luminance conditions and more sensitive to blue emissions).

Warm White This refers to a colour temperature of < 3500K, providing a yellowish-white light.

References

1. He Y, Rea MS, Bierman A and Bullough J, Evaluating light source efficacy under mesopic conditions using reaction times, J. Illumin. Eng. Soc., 1997; 26, 125–38
2. Lewis AL, Visual performance as a function of spectral power distribution of light sources at luminances used for general outdoor lighting, J. Illumin. Eng. Soc., 1999; 28, 37–42
3. Kitsinelis S, Light Sources: Technologies and Applications, Taylor and Francis, 2010 ISBN 978-1439820797
4. Kitsinelis S, The Right Light: Matching Technologies to Needs and Applications, Taylor and Francis, 2012, ISBN 978-1439899311

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Figures 2 and 3. The luminance contrast can lead to glare (top) or areas to appear darker (bottom) than they really are. The photos illustrate this in a tunnel.



Sergeant Michael Musumeci
(second from left) and
members of the Project
RAPTAR team

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