In-depth crash investigation in South Australia and its use in roadside safety research

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Abstract - This paper gives an overview of the in-depth crash investigation activity conducted by the Centre for Automotive Safety Research (CASR) at the University of Adelaide, in South Australia. Recent changes in method include: an expansion in on-call hours for the crash investigation team, providing the option of a phone interview for crash participants to discuss the crash, and downloading objective crash data from vehicle airbag control modules. These changes have resulted in: increased representativeness of crashes by hour of day; a decrease in the over-representation of fatal crashes in our sample; an increase in the proportion of crashes that involved a pedestrian, bicycle or scooter (moped); an increase in the proportion of crash participants consenting to an interview; and an increase in the objective data available, through airbag control module downloads. Our in-depth crash investigations enabled research into road departures that found barriers were a more feasible solution than clear zones for eliminating serious and fatal injury resulting from run off road crashes.

INTRODUCTION

The University of Adelaide has been conducting in-depth crash investigation research in various forms since 1963, first through the Department of Pathology, then through the Road Accident Research Unit, which became the Centre for Automotive Safety Research (CASR) in 2002. CASR is part of the Faculty of Engineering, Computer and Mathematical Sciences. More detailed discussion on the history of in-depth crash investigation in South Australia can be found in Baldock *et al.* [1]. At times these investigations have been focussed on a particular road safety issue, such as speed or pedestrian crashes, but generally have been aimed at collecting a large quantity of high quality data on a sample of crashes, in order to understand the factors that contribute to crashes occurring. Currently the investigations aim to collect representative samples of metropolitan and rural crashes within 100 km of Adelaide. This paper will give a brief description of the method, discuss adjustments to the method in 2014, and describe how the data are used in roadside safety research.

METHOD

CASR's in-depth crash investigation team is composed of a mixture of academic and research support staff from engineering, psychology and health backgrounds. Participation in in-depth crash investigation is viewed within CASR as a key part of the development of new academic staff in the field of road safety research. The current team is comprised of an automotive engineer, two mechanical engineers, a mechatronic engineer, a civil engineer, two behavioural scientists, and a health professional.

CASR's crash investigations begin with notification by pager from the local ambulance service. This notification occurs a matter of seconds after an ambulance is dispatched. Two members of the team will then immediately drive to the scene of the crash, provided it has occurred within 100 km of Adelaide, and not within a rural township. These limitations are designed to limit travel time so that the scene evidence is sufficiently preserved upon a team's arrival. Other criteria for case selection are: at least one participant must be transported by ambulance, the crash occurred on a public road, and it involved at least one motor vehicle (including motorcycles).

On arrival at a the scene of a crash, CASR staff talk to emergency services' personnel, participants and witnesses; mark the scene evidence; photograph the scene, vehicles, and road infrastructure; collect data on the vehicles, road and crash circumstances; digitally map the road environment and crash evidence; and record videos from each crash participant's point of view.

After the crash, further sources of information are obtained, including: the police report, hospital and ambulance notes, driver and witnesses interviews, Coroner's report (if fatal), forensics report (alcohol and drugs test results), and the crash history of the location and drivers. The speeds of the vehicles are also determined, if possible, by a crash reconstruction that utilises the scene evidence.

Finally the crash is reviewed, an agreed version of events is decided upon, and the factors that contributed to the crash occurring are identified. A more detailed description of the data collected can be found in Baldock *et al.* [1].

RECENT CHANGES TO METHOD

Prior to 2009, crash investigations at CASR had focussed on either metropolitan or rural crashes exclusively for a period of time. In 2009 CASR began sampling from both areas within the same period. This was aimed at building a sample from both areas simultaneously. To this end, weeks where only rural crashes were investigated were included to produce similar sample sizes between the two regions. It was found that, to achieve a similar sample size to metropolitan crashes, investigators needed to be on call to exclusively investigate rural crashes at a ratio of 2:1.

At the end of 2014 a new series of crash investigations was commenced following a two-and-a-half year hiatus. A number of important changes to CASR's method of crash investigation were made at this time.

On-call times

The most significant of these changes is the expansion of on-call hours. The on-call hours have varied considerably over the 53 years that crash investigations have been conducted at the University of Adelaide. From 1996 the on-call hours were limited to regular business hours, with selected evening shifts on Thursday and Friday. These evening shifts, however, had been phased out completely by 2006. Crashes outside these hours were only investigated if the South Australian Police Force's Major Crash Investigation Unit had attended and preserved the evidence. Major Crash attends all crashes in which a fatality has occurred, or it is believed could result in a fatality. In 2014 the on call hours were expanded to 9am to 9pm, broken up into two shifts, 9am to 2pm and 2pm to 9pm. A rotating roster was developed to manage the logistics: a week of being on-call from 9am to 2pm was followed by two weeks of alternating between a day of being on-call from 2pm to 9pm, and a day dedicated to following up crashes attended by Major Crash that occurred between 9pm and 9am. When a follow up day falls on a Monday, crashes attended by Major Crash between 9pm Friday and 9am Monday are investigated. This ensures all of the week is sampled equally, in terms of time: although crashes occurring between 9pm and 9am weekdays, and on weekends, that are investigated have a bias to high severity crashes.

Interviews of crash participants

Interviews with crash participants provide valuable information on the human factors involved in the crash. These interviews are conducted on a purely voluntary basis. Importantly, CASR has protection from subpoena, which allows interviewers to assure participants that consenting to an interview and divulging incriminating information will not affect any legal proceedings. Usually, only drivers, riders or struck pedestrians are formally interviewed. Participants in fatal crashes are often not approached for an interview by CASR as an interview can be accessed in the Coroners Report. Prior to 2014, interviews were almost always conducted in person. Between 2002 and 2008, 70% of rural participants and 50% of metropolitan participants consented to an interview. By 2011 this had declined to 15% overall. Part of the reason for the decline may have been staffing changes, but it was also believed that people were becoming increasingly unwilling to take the time to meet with researchers in person. In 2014 the option of a phone interview was added and the participants were encouraged to select the option they preferred, a telephone interview, an interview at their home, an interview at CASR, or an interview at a neutral location of their choosing.

Airbag control module downloads

A recent technological innovation in crash investigation is the downloading of information from a vehicle's airbag control module. The information stored in the module after a crash varies between manufacturers and model years, but will usually include at least: vehicle speed, brake use, accelerator pedal use, delta-v, safety systems deployed and seatbelt use. Prior to the resumption of crash investigation in 2014, CASR purchased a tool to perform these downloads. The range of vehicles that the tool can download from is limited in Australia, though some top selling brands, such as Holden and Toyota, have good coverage dating back to the 2007 model year.

RESULTS OF RECENT CHANGES TO METHOD

On-call times

Figure 1 shows the crashes investigated, by hour of day, before the extended investigation hours (2009 to 2011) and after the extended investigation hours (post 2014), compared to police reported injury crashes over similar time periods. The extended hours have reduced the extent of over-representation of business hours in the sample. The morning peak period, late night, and early morning crashes remain under-represented.

The move to a more systematic method for following up crashes outside the on-call hours, limited to fatal or near-fatal crashes, reduced the over-representation of fatal crashes. Between 2009 and 2011, 18% of crashes investigated were fatal. Post 2014, this has reduced to 12.8%, though it remains well above the 2.4% of police reported injury crashes that are fatal.

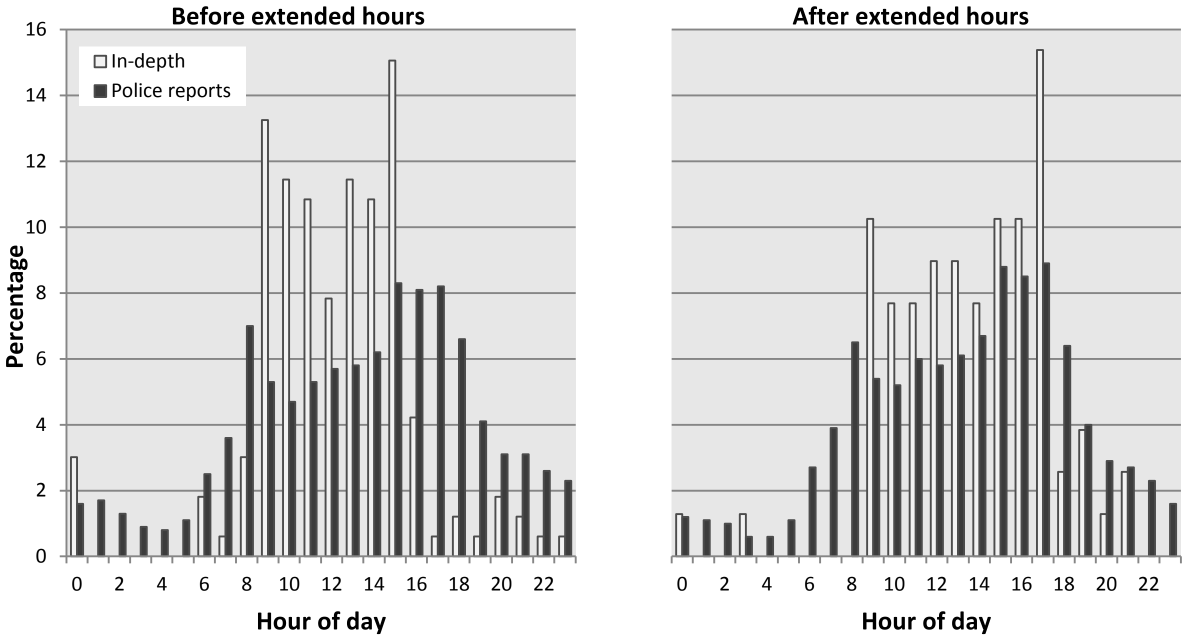

Figure 1. Comparison of distribution of crashes by hour of day
before (2009 to 2011) and after (post 2014) on-call hours were extended

An increase in the number of pedestrians, bicycles and scooters (mopeds) post 2014 may also be, at least in part, a result of extending the on-call hours into the evening commuting time. In the 2009 to 2011 period these vulnerable road users made up 3% of all crashes investigated by CASR. Post 2014, they currently represent 22% of the sample.

Interviews of crash participants

The interview acceptance rate has risen to 47% since the option of a telephone interview was added in 2014. Some of this increase may be attributable to additional staffing changes within CASR. The skill and dedication of staff plays a role in the interview acceptance rate: staff may need to make more than ten telephone calls to organise an interview, and must be willing to do so in the evenings as well as during business hours. However, anecdotal evidence from the staff involved in interviews suggests that a number of interviewees would not have consented to an interview without the option of a telephone interview. To date, a telephone interview has been chosen by a quarter of the interviewees.

Airbag control module downloads

A download from the airbag control module was obtained in 8% of all vehicles involved in a crash investigated by CASR. This percentage would be higher if CASR staff had been able to download from all vehicles that are accessible with its tool; in a few cases the owner did not give consent. This percentage would be expected to increase over time, as accessible vehicles represent an increasing percentage of vehicles involved in crashes. The information that has been gained from these downloads has provided highly valuable objective information as to what occurred in the crash. This has reduced the time taken to reconstruct the crash, or in one case where all involved vehicles were downloaded from, eliminated the need for a reconstruction altogether. It has also provided valuable information on the timing of pre-impact braking, helped determine if a vehicle came to a complete stop at a junction, and shown that a driver was not wearing his seatbelt.

USE IN ROADSIDE SAFETY RESEARCH

The value of conducting in-depth crash investigation research is not just in the data it provides; it is also valuable for the generation of research hypotheses based on field observations. One example of this pertains to a study CASR did on roadside safety.

Roadside safety in many regions, including South Australia, has traditionally been based on the principle of clear zones: providing an area by the side of the road free of obstruction to allow an errant vehicle to recover [2]. CASR’s crash investigators observed that many errant vehicles travelled beyond the recommended clear zone and struck a fixed object. This was the catalyst for research into road departures using CASR’s in-depth crash investigation data.

The following describes some of the central CASR research in this area. Further information on this research can be found in other publications [3-5]. Research has also been conducted on the related topics of median widths and barriers [6] and post impact trajectory of vehicles following intersection collisions [7,8].

Method

This study included data from 132 rural crash investigations conducted from 1998 to 2010 in which a single vehicle had left the road. The site diagrams produced for each investigated crash were used to determine the departure angle and lateral distance travelled after leaving the roadway. It was also noted if the vehicle had struck a hazard, reducing the magnitude of the departure.

These run off road crashes were categorised into types by the number of changes of direction the vehicle undertook before leaving the road. These different types were:

- drift off type run off road crashes in which the vehicle simply drove off the road without losing control,
- single yaw type run off road crashes in which the vehicle was experiencing a yaw (or sideslip) angle before leaving the road, and
- double yaw crashes in which an initial yaw is followed by an overcorrection, resulting in a yaw in the opposite direction.

Computer simulations were performed based on 15 of the crashes to gain a more detailed understanding of the dynamics of the vehicle throughout the departure. This included five of each of the three run off road crash types. Each case was simulated using two different driver scenarios. The first driver scenario simulated the driver attempting to recover to the roadway with steering input only. The second driver scenario simulated the driver beginning emergency braking half a second after running off the road. The computer simulations were also used to examine the appropriateness of barrier protection offsets.

Results

There were only 18 of the 132 crashes in which a vehicle did not strike a hazard. For cases in which a hazard was not struck, more than 80% of vehicles had a lateral displacement that exceeded 10 metres. It was also common for the vehicles to rollover at some point during their road departure (42%). The run off road crash type had a large effect on the departure angle. Vehicles that drifted off the road had much shallower median departure angles (6°) than single and double yaw type run off road crashes (17°). This resulted in loss of control type crashes (single and double yaw) having greater median lateral displacements from the roadway (8.1 metres) than drift off type run off road crashes (4.4 metres).

Figure 2 compares the results of all the simulations to the in-depth crash investigation data using a cumulative distribution of maximum lateral displacement. It can be seen that the vehicles in the simulations travel at lot further than in the investigated crashes. This is not surprising considering that many vehicles in the investigated crashes struck a roadside hazard, and hence were impeded from having a greater lateral displacement. If only investigated crashes in which no hazard was struck are considered, the distribution of lateral displacements in these crashes is similar to the distribution of all the simulation results. Figure 1 also displays the large difference in the lateral displacement of vehicles that simply drift off the road rather than lose control and yaw.

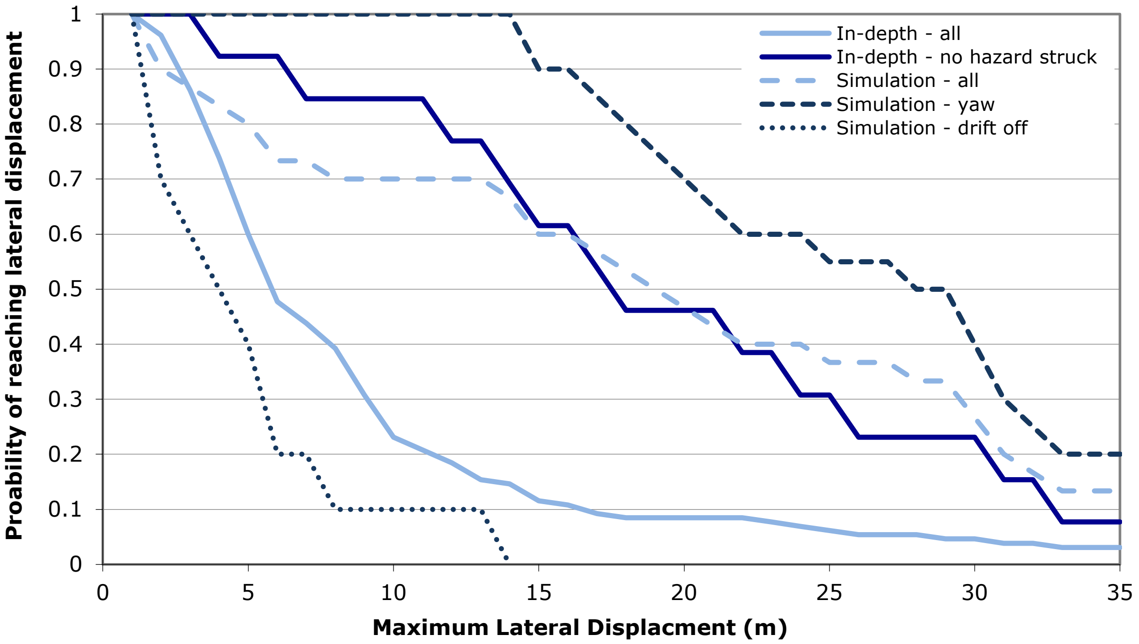

Figure 2. Cumulative distribution of lateral displacement for in-depth and simulation data

In all the simulations for loss of control departures (single and double yaw) the impact speed of a vehicle with an object just beyond a nine metre clear zone would be above the 'safe speed' of 30 km/h [9], and in many cases greater than 70 km/h.

The simulations also found that a barrier placed four metres from the edge of the road would be impacted at a barrier normal velocity of less than 40 km/h, a speed that is unlikely to produce serious injuries [10,11].

Further work

Research at CASR into roadside safety, using in-depth crash investigation data, is ongoing. The potential for vehicles to roll over in clear zones is currently being examined. The merits of clear zones and barriers in the metropolitan context is also being examined using a similar method to that described above.

CONCLUSIONS

Recent changes to in-depth crash investigations in South Australia, conducted by CASR at the University of Adelaide, have resulted in: increased representativeness by hour of day; a decrease in the over-representation of fatal crashes in the sample; an increase in the proportion of crashes that involved a pedestrian, bicycle or scooter (moped); an increase in the proportion of participants consenting to an interview; and an increase in the objective data available, through airbag control module downloads.

The data produced by in-depth crash investigations has enabled research into roadside safety that has demonstrated clear zones would need to be impractically large to eliminate serious and fatal injury arising from road departures. Barriers placed close to edge of the road were found through simulations to have the potential to achieve this aim. This demonstrates how in-depth crash investigation at CASR enables research questions to be answered that cannot be answered with police report data alone.

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