MONASH University
Accident Research Centre

ANCIS

PROGRESS REPORT
JULY 2003 – DECEMBER 2005

THE AUSTRALIAN NATIONAL CRASH IN-DEPTH STUDY

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Abstract:

ANCIS (The Australian National Crash In-depth Study) is a collaborative research program involving the automotive manufacturing industry, State and Federal Government agencies, the insurance industry and Australian automobile associations. In-depth data on a representative sample of passenger vehicle crashes is collected currently in Victoria and New South Wales, along with a completed pilot study in Tasmania. The main entry criterion is severe crashes where at least one occupant has been hospitalised as a result of the crash. Information collected includes occupant injuries, vehicle damage and crash causation from a retrospective examination of the crash. This second report describes an analysis of 392 cases contained in the ANCIS database, examining the patterns of crashes and injuries sustained by the occupant(s), the source of their injuries, the extent and severity of damage to the vehicle and the characteristics of the crash. These data are rich in terms of the amount of detail contained in each case and are provided to throw new light on the crashworthiness of the vehicles and aspects of their crash involvement.

Key Words:	Disclaimer
In-depth, crash investigation, injury, injury severity, vehicle safety, airbag, seat belt use, road infrastructure, crash analysis, single vehicle crashes, multiple vehicle crashes, urban, rural	This report is disseminated in the interest of information exchange. The views expressed here are those of the authors, and not necessarily those of Monash University

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STUDY TEAM DETAILS

The ANCIS research program is managed and administered by the Monash University Accident Research Centre at the Monash University Clayton Campus, Victoria, Australia. Data collection is undertaken in each jurisdiction by local data collection teams. The study team as at the end of 2005 is outlined below.

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(April - December 2004)

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- Box Hill Hospital, Eastern Health, Inner and Eastern Health Care Network
- Frankston Hospital, Peninsula Health Care Network
- Dandenong Hospital, Southern Health Care Network
- Monash Medical Centre, Clayton Campus, Southern Health Care Network
- Geelong Hospital, Barwon Health
- The Royal Melbourne Hospital, Melbourne Health, Western Health Care Network
- The Royal Children's Hospital, Women's and Children's Health Care Network (WCH)

NSW:

- Westmead Hospital, Western Sydney Area Health Service
- Liverpool Hospital, Sydney South West Area Health Service
- St George Hospital, South Eastern Sydney Area Health Service
- Prince of Wales Hospital, South Eastern Sydney Area Health Service, Eastern Section

Tasmania:

- Royal Hobart Hospital

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- Dr Valerie Malka, Westmead Hospital
- Dr Alastair Meyer, Royal Hobart Hospital
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CONTENTS

GLOSSARY

ADR	Australian Design Rules: Set the standards that each vehicle model is required to meet, prior to their first supply to the market. In the environmental context, the ADRs set standards for emissions, noise and fuel consumption labelling[1].
ANCAP	Australian New Car Assessment Program: Gives consumers consistent information on the level of occupant protection provided by vehicles in serious front and side crashes[2].
AIS	Abbreviated Injury Scale: An internationally-recognised scale for coding traumatic injuries. AIS severities range from 1 (minor) to 6 (catastrophic), with the severity level indicating threat-to-life risk if the injury in question was the only one sustained.

AIS	Description	Example injury
1	minor	Cuts, abrasions
2	moderate	Fractured collar bone
3	serious	Fractured thigh bone
4	severe	Perforated bladder
5	critical	Serious head injury
6	maximum	Decapitation

CDC	Collision Deformation Code: A coding system for vehicle collision damage developed by the Society for Automotive Engineers. The first two digits represent impact direction (on a clock face) and the last digit the extent of damage (1 minor to 9 severe). The other digits indicate the location of damage on the vehicle[3].
Crash severity	Generic term for the measures expressed by Delta-v and EBS (see below)
Delta-v (or Δv)	Vector difference between impact velocity and separation velocity[4]. In lay terms, it represents the change in velocity of the vehicle during a crash event. Delta-v is usually calculated using damage reconstruction software and the mass and stiffness characteristics of both vehicle and collision partner must be known.

1 From http://www.dotars.gov.au/roads/environment/impact/index.aspx

2 From http://www.aaa.asn.au/ancap.htm

3 From SAE J224 (1980)

4 From ISO 12353-1 (2002)

EBS	Equivalent Barrier Speed: Also known as Barrier Equivalent Velocity (BEV). This is the approximate Energy Equivalent Speed (EES) of a vehicle with respect to a 90° fixed, rigid and flat barrier. EES is the speed at which a vehicle would need to contact any fixed object in order to yield the same observed residual crush[5].
ISS	Injury Severity Score: A measure of overall injury severity. Equal to the sum of the squares of the highest AIS in each of the three most severely injured ISS body regions (head, face, chest, abdomen, extremities and external). Ranges from 1-75, with any AIS6 injury resulting in a score of 75. Hospitals regard ISS scores of 15 and higher as 'major trauma'
MAIS	Maximum AIS: The highest AIS score in any body region. Sometimes used as an indication of overall injury severity.
MPV	Multi-Purpose Vehicle: A passenger-carrying van-like vehicle, usually with more than two rows of seats. Typical vehicles include the Honda Odyssey, Toyota Tarago and Kia Carnival.

[5] From ISO 12353-1 (2002)

EXECUTIVE SUMMARY

ANCIS (the Australian National Crash In-Depth Study) is a collaborative research project comprising Monash University, the Australian automobile manufacturers, Federal and State Government Transport and insurance agencies, a vehicle parts supplier and motoring clubs in Victoria and NSW. Its objective is to provide an in-depth analysis of a sample of vehicle crashes for use in improving vehicle crashworthiness and better understanding the contributing factors to crash involvement.

THE ANCIS PROCESS

Occupants are recruited into the study if they are hospitalised following a motor vehicle crash and voluntarily agree to participate. The vehicle in which they were travelling must be a passenger vehicle (car, MPV or 4WD) manufactured after 1989. MUARC research nurses conduct a semi-structured interview with the participant (where able) and examine their medical records to compile a detailed list of their injuries.

Vehicle engineers then locate and examine the vehicle involved using international procedures for determining level of deformation and intrusion, impact severity, cause of injury and compile a detailed photographic record. They also visit the crash site and determine the crash circumstances using all available evidence. The police report is also obtained for each crash to help clarify the crash event. Where possible, all other vehicles involved in the crash are also photographed and measured to facilitate a more accurate estimate of the crash severity.

At the conclusion of the data collection process, a multi-disciplinary group, using a best evidence synthesis approach, determine the crash circumstances, injury causation factors, crashworthiness of the vehicle and contributing factors. The case is then entered into a database without any personal identifying details. Up until the end of 2005, 392 cases were available for analysis.

2004 DATA COLLECTION SUMMARY

During 2004, the changes brought about by the Victorian Privacy Act 2003 began to be implemented, allowing data collection to once again proceed steadily, albeit with a variety of modifications to the patient screening process used to identify potential participants prior to recruitment. A total of 86 participants were recruited during the year.

Of the more than 1500 patients who were approached in the 3¼ years between March 2002 and June 2005, 1 in 7 were recruited to the study. Reasons for non-recruitment included ineligible vehicle, patient unfit to be approached, those with particular medical and psychological conditions, and those who were not interested.

Recruitment rates varied widely across the study hospitals, with Monash Medical Centre and The Alfred yielding the highest recruitment rates of 1 in 5 and 1 in 6.6 respectively. Of particular interest, more than 90 percent of those eligible patients who were approached agreed to participate in the ANCIS program.

ANCIS DATA FINDINGS

The following is a summary of the results presented in this report. Caution needs to be taken in the interpretation of these data, especially in assuming that they represent all serious casualty crashes that occur in Australia at this time. There were few fatalities among the crashes inspected as the sample was confined to serious injuries only. A weighting process is currently under development to ensure that the sample is representative of all Australian crashes and will be available for use in future reports.

Sample overview

Analyses were carried out on occupant distributions by seating position, reported belt use, various demographic factors, impact type, primary collision partner and airbag fitment and deployment. Multiple impact crashes comprised 20% of the cases and involved multiple impact partners in combination with rollovers. Other findings of interest are summarised below:

- 392 cases have been analysed to date.
- 93% of participants were seated in one of the two front seating positions.
- Seatbelts were worn or claimed to be worn in 97% of the cases inspected (and in 19 of the 26 rear seat cases [73%]). There was no evidence of belt use in 4% of cases and it was not possible to determine seatbelt use in just 1% of cases overall.
- 39% of participants suffered a head injury, of which almost half were AIS3 or greater.
- Two-thirds suffered a chest injury, with just under half (43%) of AIS3+ severity.

Frontal crashes

- The airbag was deployed in 94% of frontal impacts involving an airbag-equipped vehicle;
- Mean crash severity was around 50 km/h (the ADR 69 full frontal test speed is 48.3 km/h EBS), with 73% of all crashes occurring below the ADR 73 offset frontal test speed of 56 km/h EBS and 80% of all crashes occurring below the ANCAP test speed of 64 km/h EBS. Three-quarters of frontal crash victims had an Injury Severity Score (ISS) below 15;
- The body regions most often sustaining AIS3+ injuries were the chest (22%) and lower limbs (16%). The most common contact sources for frontal crash injuries were the seatbelt (15%), instrument panel (14%) and steering assembly (13%). Airbags contributed just 1% of AIS3+ injury contact sources in frontal crashes.

Side impact crashes

Side impact crashes were separated into *struck (or near) side*, where the collision partner was on the same side of the vehicle as the occupant, and *non-struck (far) side*, with the bullet vehicle or collision partner impacting the opposite side of the vehicle;

- Mean struck side crash severity was around 33 km/h, with 90% of all struck side impact crashes occurring below a crash severity of 45 km/h and 95% below the ADR 72 and ANCAP test speed of 50 km/h;
- Mean struck side ISS was 18 for males (compared with 13 in frontal impacts) and 16 for females (compared with 12 in frontal impacts);
- 40% of occupants involved in struck side impacts suffered AIS3+ injuries from contact with their own side door panel, compared with only 3% of non struck side occupants. The most common contact point resulting in AIS3+ injuries to far side impact occupants was the opposite B-pillar (16%)

- Mean non struck side crash severity was around 39 km/h with a mean ISS of approximately 17 for both males and females and;
- AIS3+ head injuries were recorded in 32% of non-struck side cases compared with 19% for struck side occupants.

Rear impact crashes

- There are currently only 14 rear impact cases in the database, constituting less than 4% of the sample. This confirms the relatively low frequency of this crash type compared with others. The following indicative points should be read with the caveat that they are based on only 14 cases.
- Mean crash severity was around 52 km/h, with a mean ISS of 11, indicating the benefits of a large crush space and softer vehicle structure when impacted from the rear, as well as the advantage of a superior force loading path to the occupant when entering a crash rearward.
- Just over one-third of rear impacted occupants sustained an AIS3+ injury to the chest, 14% each to the head and neck and only 7% suffered a severe spinal injury.
- The most common contact source for AIS3+ injuries was the seatbelt, most likely as a result of the occupant rebounding off the seat back into the belt immediately after the initial impact. Three of the 14 rear-impacted occupants sustained such seatbelt-related injuries, which are likely due in part to seat back stiffness.

Multiple impacts (including rollover)

A crash was coded as a multiple impact when two or more impacts occurred, each resulting in non-cosmetic damage to the vehicle. Rollovers were also grouped in this category, as they often occur in conjunction with one or more horizontal impacts.

- Multiple impacts with/without rollover made up 18% of the ANCIS sample;
- In multiple impact collisions with no associated rollover (61% of the multiple impact sample), 18 different collision sequences were observed, the most common being an impact with another car, followed by a collision with a pole or post;
- Of these eighteen different multiple impact scenarios (with rollover), the most common impact sequence was a rollover followed by a collision with a tree. However, there was a great deal of variety with rollovers generally occurring after a horizontal impact rather than before.
- There were few differences observed in injury severity by collision type, with mean ISS approximately 14 for single impact crashes, 16 for multiple impact crashes, 15 for crashes where rollover was the sole 'impact' and 18 for crashes where a rollover with one or more other impacts occurred.
- The body regions most commonly sustaining one or more AIS3+ injuries varied considerably between the impact types. In single impact crashes, 28% of occupants suffered a severe chest injury, with this figure rising to 33% in multiple impact crashes and 35% in multiple impacts with a rollover. Severe head injuries were sustained by 14% of occupants in single impact crashes, 21% in multiple impacts and 24% in multiple impacts with rollover. By comparison, when rollover was the sole impact, 38% of occupants sustained a serious head injury, with the seat belt used or believed used in 75% of cases compared with 95% and above for the other crash types. Table 1 below has more details.

Table 1. Distribution of occupants by AIS body region and crash.

AIS Body Region	Single impact	Multiple	Rollover with other impact	Rollover, no other impact
	Proportion of occupants sustaining one or more AIS3+ injuries (to nearest %)			
Head	14	21	24	**38**
Face	2	-	-	-
Neck	2	4	-	-
Chest	**28**	**33**	**35**	13
Abdomen/Pelvis	11	4	3	-
Spine	4	8	16	12
Upper Extremities	8	17	14	13
Lower Extremities	18	21	22	12
External	-	-	-	-

EARLY TRENDS

A number of targeted analyses were attempted during the year. No significant patterns were found for side airbag deployments, frontal airbag deployments to front-left passengers and front wheel drive versus rear wheel drive vehicles. Two areas that did show some interesting trends, however, were the effectiveness of frontal airbags and the outcomes of single versus multiple vehicle crashes.

Effectiveness of frontal airbags

The results of mean ISS by airbag activated and airbag not fitted or activated are shown in Figures 1 and 2 below.

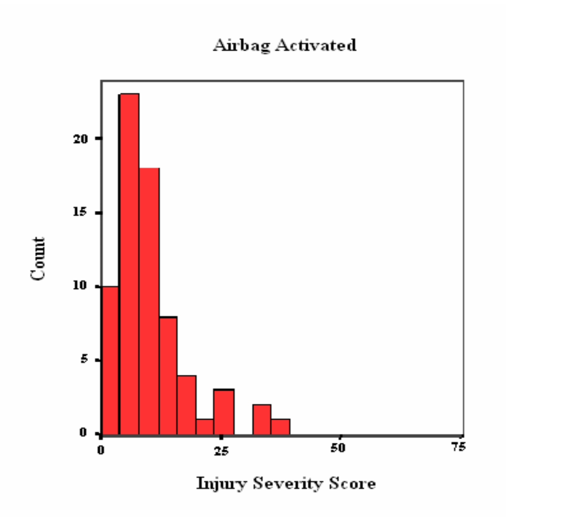

Figure 1. ISS for occupants of vehicles with airbags fitted and deployed.

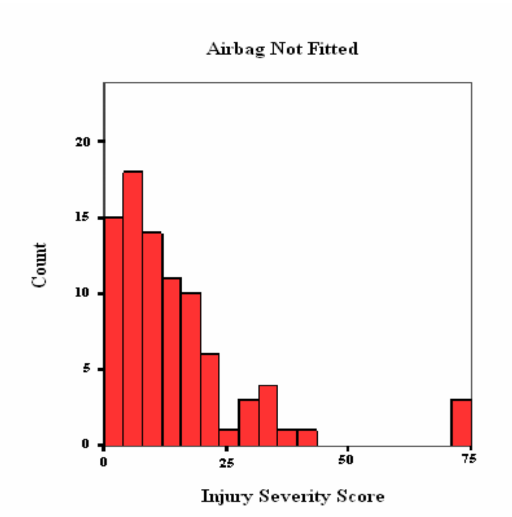

Figure 2. ISS for occupants of vehicles with airbags not fitted.

While a trend was observed for cases without frontal airbags fitted to have higher Injury Severity Scores in frontal impacts than cases in which frontal airbags were deployed (14.4 compared with 9.9), the trend was not significant ($p = 0.138$), probably due to the low number of cases analysed ($n = 0.157$ in total).

Single vs. multiple vehicle crashes

An analysis was conducted of outcome for both single- and multi-vehicle crashes, as shown in Table 2 below.

Table 2. Comparison of mean Injury Severity Score for occupants involved multiple vehicle crashes and occupants involved in single vehicle crashes.

Crash Type	N	Mean	Std. Deviation	Minimum	Maximum
Single Vehicle	173	17.07	14.98	0	75
Multiple Vehicle	217	12.63	13.14	0	75

It can be seen that occupants in single vehicle crashes had higher mean Injury Severity Scores on average than those involved in multiple vehicle crashes (ISS = 17.1 c.f. 12.6) which was statistically robust ($U = 14902, p < 0.001$). This demonstrates the higher impact forces applied to occupants involved in single vehicle crashes (predominantly with poles and trees) compared to those involving another vehicle.

Other findings

In addition to those results presented here, a number of papers at national and international conferences have demonstrated the power of ANCIS data. For example, a paper for the Road Safety Research, Policing and Education Conference in 2004, addressing the problem of multiple impact crashes, found that they tended towards having higher injury severity levels, with this trend being more pronounced when the most severe impact occurred later in the crash sequence. They also showed a significantly greater incidence of severe head and spinal injuries. In 2005 a paper was presented to the Canadian Multidisciplinary Road Safety Conference in Fredericton, New Brunswick relating to the differences between real-world crash outcomes in ANCIS compared with one of its predecessors, the Crashed Vehicle File. It demonstrated that a greater proportion of serious injury crashes in newer vehicles were occurring in higher speed zones than older vehicles and that newer vehicles were being more severely damaged but with a lower incidence of the most severe injury levels. This study also found a greater than expected incidence of rollover in the newer vehicles, but a lower incidence of serious head and abdominal injury. Finally, a paper for the 2005 Road Safety Conference in Wellington, New Zealand, showed a number of interesting characteristics relating to the important area of AIS3+ brain injury sustained by the occupants of vehicles in ANCIS. Brain injury was more likely to occur in rollover, as well as three times more likely when the collision partner was a narrow, rigid object such as a tree, pole or post. A higher than expected incidence of brain injury occurred in mid-block crashes compared with intersections. Logistic regression analysis found AIS3+ brain injury was three times more likely in 70-90 km/h zones compared with 40-60 km/h speed zones and nearly twice as likely again in 90-110 km/h zones.

CONCLUSION

The ANCIS study is a valuable adjunct to mass databases in that it provides much more detail on the cause and severity of individual crashes, as well as the injuries sustained by the vehicle occupants.

These data are rich in terms of the amount of detail contained in each case and throw new light on the crashworthiness of the vehicles and aspects of crash involvement. Preliminary analyses have revealed interesting trends that will be able to be strengthened as the database continues to grow.

A number of papers presented at national and international conferences have also demonstrated the value of ANCIS data. Research has been conducted by MUARC into issues relating to injury severity in multiple impact crashes, the performance of newer compared with older vehicles and an important paper addressing a number of detailed characteristics relating to more severe brain injuries in the vehicle occupants recruited into ANCIS.

Many analyses using these data, particularly those examining specific subsets, will demonstrate trends rather than statistically significant findings; nevertheless they are extremely important if we are to gain a greater understanding of the causal factors behind crashes in this country and new and innovative solutions to address the burdening road toll problem. More important then is an ongoing commitment to continue to collect these data to highlight emerging crash trends and new ways to address injury prevention on the road.

1 INTRODUCTION

1.1 Background

The National Road Safety Strategy for 2001-2010 and the associated biennial Action Plans aim to enable the co-ordination of federal, state, territory and local government road safety strategies, as well as initiatives from other associated influential organisations.

Mass databases are traditionally used to establish road safety initiatives and priorities. Although such databases are useful in determining the extent of crashes and resulting injuries across states and territories, they are limited in their ability to provide in-depth data in order to establish the causation of crashes. In order to establish the causal factors related to serious crashes and fatalities, it is necessary to conduct in-depth crash investigations, which involve a multi-disciplinary approach. Only when such data are available can a fuller understanding of crashes be achieved and new countermeasures be devised and implemented.

In recognition of the need for in-depth real-world data relating specifically to Australia, MUARC commenced the Australian National Crash In-depth Study (ANCIS) in 2000 with support from the ANCIS consortium partners. ANCIS is retrospective crash investigation research conducted in Victoria, NSW and more recently Tasmania, with a focus on both serious injuries and fatalities. The ANCIS data supplement mass databases and provide high quality, reliable information with which a better understanding of the causation of crashes can be achieved. Such knowledge will enable the design and implementation of novel interventions which are hoped to contribute to the reduction of the road toll in Australia.

1.2 The ANCIS Partnership

The collaboration between MUARC and key road safety stakeholders marks a new era in road safety research in Australia and paves the way for similar collaborations between stakeholder groups. It is evidence of the recognition of a need to work together to further understand the causal factors leading to crashes and to identify solutions to long-standing road safety problems.

The consortium comprises members of the automotive and parts manufacturing industries, the Federal Department of Transport and Regional Services, State transport authorities from Victoria, NSW and Tasmania, the Transport Accident Commission of Victoria and the Motor Accident Authority of NSW, and the motoring authorities RACV, NRMA and the AAA. Partners in the ANCIS program are shown in Table 3.

Table 3. Partners in the ANCIS project.

Partner	Status	Partner	Status
Australian Transport Safety Bureau, Dept of Transport and Regional Services	Member	Royal Automobile Club of Victoria Ltd	Member
Autoliv Australia	Member	Roads & Traffic Authority (NSW)	Member
Ford Motor Company Australia Ltd	Member	Transport Accident Commission (TAC) (Vic)	Member
Holden Ltd	Member	Toyota Motor Corporation	Member
Insurance Australia Group Ltd	Member	VicRoads	Member
Department of Infrastructure, Energy & Resources (Tasmania)	Member	Mitsubishi Motors Australia Ltd	Observer
Motor Accidents Authority of NSW	Member	Australian Automobile Association (AAA)	Observer
National Roads and Motorists' Association Ltd (trading as NRMA Motoring & Services)	Member	Federal Chamber of Automotive Industries	Observer

ANCIS partners sponsor the in-depth crash investigations conducted by MUARC and advise on the direction of the program at Sponsors' Meetings held at least three times a year, at which MUARC investigators report in detail on the progress of the program. MUARC undertakes all in-depth investigations in Victoria (and Tasmania as required) and subcontracts data collection in NSW and Tasmania. Data collected in all three jurisdictions are held at MUARC where they are input into the comprehensive database and analysed. Further to the cases collected in 2004, the inclusion of 92 cases contributed by Holden Ltd (for the entire ANCIS triennium) also commenced in 2004.

ANCIS is currently in its second triennium, covering the period July 2003 to June 2006 and it is hoped that the study can continue beyond this period. With the collection of in-depth crash data over a number of years, ANCIS is able to provide updated information on issues such as crashworthiness and crash involvement. Access to such data enables the early detection of emerging problems, which can be addressed with safety improvements implemented quickly and effectively.

1.3 ANCIS Entry Criteria

The recruitment of participants for ANCIS is conducted at major hospitals in each of the three jurisdictions, to which participants have been admitted as a result of injuries sustained in a motor vehicle crash. Fatalities are also included in the study in Victoria and in 2004 a Confidentiality Agreement between VicRoads and MUARC enabled the collection of data to further supplement this sample. Although no age limits apply, there are a number of exclusion criteria. Occupants of stolen vehicles or those in vehicles destroyed by fire are not included in the study. In addition, also excluded are patients with a psychiatric illness and wards of the State. Vehicle-related inclusion criteria also apply. Participants must have been travelling in passenger vehicles manufactured from 1989 onwards, which fall into one of the following categories: MA (sedan) or MA-derived NA (utility), MB (passenger van/MPV) or MC (off-road passenger-carrying) vehicles (Australian Design Rules, Part B, Subpart 2, 2001).

1.4 The ANCIS Process

ANCIS employs in-depth, retrospective crash investigation procedures, which entail the collection of human, vehicle and crash site data. Secondary sources of data are also available from Police Reports, ambulance notes, individuals who were present at the crash scene, where possible, and the National Coroners' Information System for fatalities in Victoria. The collection of data from a variety of sources, both primary and secondary, enables the determination of the sequence of events prior to, during, and following the crash with a considerable level of accuracy in the majority of cases.

The data collection process commences with the recruitment of the patient, an interview and the recording of injuries. With the information collected from this source, the vehicle is located and inspected in detail, both externally and internally, to record the data specific to the performance of the vehicle during the crash event and its interaction with the occupant(s). The crash site is also inspected in detail to examine the vehicle's interaction with the environment. At present, it is not possible to inspect the scene at the time of the crash due to both monetary constraints and the absence of collaborative structures with the Police and rescue services. Despite this, retrospective crash site inspections usually yield a considerable amount of evidence of the crash and significantly contribute to a better understanding of the crash event.

Once all the data are collected, further analyses and coding are conducted and in-depth discussions of conflicting issues assist in their resolution and the finalisation of each case.

1.5 Comprehensive investigation

Compared to Police crash investigations, which primarily focus on culpability, ANCIS displays a broader field of foci, adopting a holistic approach to crashes. This approach enables consideration of items such as crash and injury factors concerned with vehicle design, human factors, road and traffic engineering, emergency services, trauma management etc., applicable to both metropolitan and regional areas.

By adopting a systematic in-depth approach to crash investigations, it is possible to gain a better understanding of areas relating to the wider crash context, including:

- Vehicle crashworthiness
- Crash causation
- Highway design influences
- Human factors including road user behaviour
- Injury biomechanics
- Effectiveness of countermeasures (current and proposed) and
- Interaction between the above factors.

1.6 Expected Benefits from ANCIS

ANCIS is unique in that it has achieved two crucially important changes in the manner with which road safety is dealt with in Australia. It has brought together leading Australian road safety researchers and road safety related Government and industry bodies. Further to this, the in-depth data collected, based on a multi-causal approach to crashes, has broadened the scope and understanding of crash-related areas, enabling ANCIS partners to work together to achieve the goals set out in the National Road Safety Strategy. This research and the collaboration between partners is evidence of the leading role that Australia plays internationally in innovative approaches and solutions to road safety issues. Also of great importance, and only now emerging, is the role that ANCIS is playing in paving the way for new collaborative research, a change which is instrumental in the adoption of novel and effective road safety initiatives.

The principle benefits from a comprehensive program of in-depth crash investigations, spanning the full range of Australian fatal and serious injury road crashes, include:

1. The level of protection offered by today's vehicles and any emerging problems;

2. New countermeasure programs and initiatives, covering road infrastructure development, education and behaviour change, vehicle design, trauma management, enforcement and various combinations of these disciplines;

3. More sharply focussed road safety strategies for future investment in road trauma reduction, in line with current state and national targets;

4. "Time-stamping" Australia's fatal and serious injury crash problem and its characteristics, early in the new decade, thereby enabling comparisons and evaluations to be made at critical times in the future, as well as providing an objective basis for adjusting and strengthening the State's strategic effort over the period 2001 to 2005;

5. Enhancing the effectiveness of crash investigation and countermeasure development methods by drawing on innovative models.

1.7 Analysing ANCIS cases

The collection of detailed crash-related data over a period of years has enabled the development of a unique database. Such in-depth data make possible a wide variety of analyses to addresses specific road safety related issues, which cannot be conducted using mass databases such as those held by the police.

Due to the anonymous nature of the data input into the database, analyses are generally limited to identifying overall trends. The rich nature of data, however, enables analyses focusing on emerging problems related to crash and vehicle characteristics, injury causation and outcomes as well as human, temporal and road environment factors contributing to both urban and regional crashes. Other specialised analyses conducted with the approval of the ANCIS partners in 2004 include the examination of issues such as side airbag deployments, front left passenger fascia airbag deployments, vehicle compatibility, occupant age factors, struck side impact crash injury factors, and front-wheel-drive vs. rear-wheel-drive vehicle injury factors, all of which are elaborated on in Section 3.3. Furthermore, analyses relating to harm injury costing, crash and injury modelling and comparisons of ANCIS data with those of other Australian and US databases were also conducted in 2004 and are available from MUARC.

2 SUMMARY – 2004/2005

2.1 Data Collection Summary

Data were collected in Victoria, NSW and Tasmania. The primary data collection procedures involve the collection of data from three sources: the patient (with whom an interview is conducted where possible), the vehicle and the crash site.

Human data are collected by Research Nurses at participating hospitals, where patients have been hospitalised as a result of their involvement and injury in a motor vehicle crash. The data collected during this phase is vital to the completion of each case, as preliminary data relating to all other aspects of the crash are also collected. Such data include information about the vehicle and its current location as well as details of the crash site. Based on this information and that from supplementary sources, the crashed vehicle is located and the Vehicle Inspector carries out a detailed examination. Following this, or in parallel with this phase, the crash site is located and data relating to the road and roadside setting are collected. The site of the crash is only inspected when it is within a two hour drive of the corresponding data collection team headquarters in Melbourne or Sydney, while all crash locations are examined in Tasmania. For both the vehicle and crash site inspections, extensive photography is also conducted to assist with further determination of the crash circumstances and the occupant contact points with the vehicle or the external environment.

The data collection procedure can often be hindered by external factors beyond the control of the researchers, such as medical procedures the patient is undergoing, difficulties in tracing the vehicle when little information is available, and difficulties in determining the exact crash location, especially in more remote areas, due to conflicting accounts of where the crash occurred. Despite such issues generally being resolved with the extensive expertise available to the team, some cases have missing information.

2.1.1 Ethics

As a result of changes to privacy legislation in Victoria in 2002, which greatly impacted on the research team's ability to recruit the projected number of participants, significant changes were introduced to the study. In recognition of the importance of addressing ethical issues and the need to design and implement study procedures which complied with health and privacy legislation as well as the National Statement on Ethical Conduct in Research Involving Humans (1999), a new position within the team was created in 2004. Ethics-related and study design issues are now handled by a single researcher with expertise and training in ethics, in conjunction with the Chief Investigator and Co-Investigator.

Apart from the practical difficulties implicit in multi-centre research, ANCIS presents unique ethical and privacy issues due to the sensitive nature of the research. Participants are vulnerable both due to the traumatic event they have experienced and their dependence on medical care. Furthermore, despite the great efforts made to protect participants' privacy, the research team is subject to involvement in legal action related to crashes investigated. In order to comply with legislation, extreme care is taken in permanently de-identifying all hard-copy data and including only anonymous electronic data in the database.

All amendments proposed for ANCIS in 2004 in Victoria were successfully approved and have assisted in maximising the number of participants recruited into the study.

NSW ANCIS procedures also underwent great amendments in 2004 due to changes in NSW health and privacy legislation (paralleling those in Victoria) effective from July 2004. The great obstacles faced in Victoria, however, were not experienced in the NSW transition despite some delays with approvals. The ethics expertise now available to MUARC as a result of the Victorian experience has and will continue to greatly assist in identifying and implementing successful study procedures and solutions and has provided guidance to NSW hospital staff and Ethics Officials who were still adjusting to the implementation of the Health Records and Information Privacy Act 2002 (NSW) in 2004.

2.1.2 Recruitment

The identification of potential inpatient participants is conducted in accordance with the relevant current privacy and health legislation. Hence, one of two methods is used to recruit participants. In Victoria, hospital staff members form the link between patients and MUARC recruiting staff in hospitals where honorary status has not been granted to MUARC staff. Where MUARC nurses have been appointed honorary hospital staff, participants are identified directly. The method utilised is based on the preferences of each participating hospital and their ethics committee.

In response to the negative impact changes to Victorian privacy legislation had on the study, alternative recruitment methods were devised to increase the pool of participants. The approval and implementation of these procedures was completed in 2004. One of the alternative recruitment methods employed to supplement the hospital-based procedure, involves the recruitment of discharged patients, identified via hospital records. An alternative procedure, devised and approved but not implemented to date, involves identifying potential participants via the location of their vehicle in salvage yards, where vehicles damaged beyond repair are auctioned.

Privacy legislation has also been revised in NSW and changes resemble those implemented in Victoria. With the experience gained from the intricate problems arising from changes to Victorian legislation, amendments to the NSW arm of the study have been implemented smoothly but are not fully complete at present. It is expected that data collection will resume in July 2005.

In addition to amendments to the study protocol in Victoria and NSW, an additional recruitment procedure was also proposed and implemented in Tasmania. This involved the inclusion of patients who had already been discharged and was employed to boost participation rates.

2.1.3 Data Collection Forms

A number of data collection forms is used in ANCIS, with each set corresponding to each primary data collection phase. The data collection forms have been substantially improved since the commencement of the study in 2000, and now assist in the collection of more in-depth human, vehicle and crash site data. Following are summaries of the many variables collected for each phase of data collection.

PARTICIPANT INFORMATION

Crash Events

- Driver's description of crash
- Manoeuvre being attempted
- No. of collisions/vehicles, collision partner(s)

About the vehicle

- Make, model
- Ownership, familiarity

- No. of occupants
- Adaptations for special needs

Pre-Crash Events

- Purpose of journey, familiarity with road
- Speed limit, travel speed
- Journey time (total/completed)
- Weather/lighting (+contribution), headlight usage
- Road surface/condition (+contribution)
- Vision obstructions
- Avoidance actions

Contribution to crash occurrence from own vehicle or other road user

- Any other contributing factors (mobile, CD, etc.)

Vehicle restraint systems/safety features

- Airbags (fitment/deployment)
- Seatbelt (wearing/removal post-crash)
- Child restraint -type, position, orientation

Post-crash events

- Extrication, entrapment, ejection
- Transportation to hospital

Personal information

- Gender, age, height, weight, nationality
- Length of time in Australia
- Years of driving experience (Aus + O/S)
- Licence type, place of issue
- Average annual distance driven
- Prior crash involvement

Medical Data

- Description of injuries from participant
- Detailed description of injuries from medical record

- Length of stay in hospital
- Injury severity measures
- Visual, hearing, physical impairments
- Medical conditions, medications taken

VEHICLE INSPECTION

Basic vehicle data

- Make, model, colour, year, odometer, body style
- Engine, transmission, braking details
- Other features
- Towing (towbar, towing at time of crash, overloaded)
- Presence of load
- Load barrier
- Cruise control, electronic stability control
- Satellite navigation, in-car entertainment

Impact details, damage measurements

- For crash severity computation, both vehicles involved in the crash where possible

Structural performance

- Bonnet
- Pillars
- Front structures
- Windscreen
- Doors/door glazing
- Side structures
- Steering wheel, column

Fuel system

- Fuel, storage, leakage, etc.

Wheels and tyres

- Damage, tyre tread condition, mismatches

Intrusions

- Frontal (including pedal movement)
- Side
- Rear
- Roof

Seats

- Type, performance, damage
- Head restraints

Restraint systems, airbags

- Usage (evidence)
- Type, system deployment

Probable occupant – vehicle contact points

Photography (exterior and interior)

CRASH SITE INSPECTION

Basic crash, environmental data

- Date, time, place (GPS co-ords)
- Speed limit (in force <500m)
- Adjacent land use
- Road slope, alignment, camber, crossfall
- Lighting

Road description

- Class/type (freeway, arterial, etc.)
- Intersection type ('T', 'Y', roundabout, etc.)
- Traffic signals

Road surface, material, condition

Carriageway separators, lane details

Traffic control, management devices

- Traffic lights, signs, pedestrian crossing, speed humps etc.

- Features to left of road (case vehicle direction)
- Shoulder, barrier, kerb, drain, etc.
- Features in median (where present)
- Shoulder, barrier, kerb, drain, etc.
- Features to right of road case vehicle direction.)
- Shoulder, barrier, kerb, drain, etc.
- Crash scene damage
- Skids/tyre marks

Crash site sketch

Photography

2.2 Recruitment Report

Since early 2002 MUARC's Victorian research nurses have been collecting data on hospital patients who have been approached but were not able to be recruited. This section presents some statistics on these people.

Between 18/3/02 and 8/06/05, a total of 1539 patients were approached, of whom 219 (14%, or 1 in 7) were recruited to the study. The tables in this section generally detail only those excluded. Table 4 shows the distribution among study hospitals of those patients who did not participate, compared with those recruited.

Table 4. Distribution of patients who did not participate, compared with those recruited.

Hospital	Number of patients excluded		Number of patients recruited		
	Freq.	%	Freq.	%	Hit rate*
The Alfred	587	44.5	105	15.2	1 in 6.6
Royal Melbourne	219	16.6	30	12.0	1 in 8.3
Geelong	112	8.5	13	10.4	1 in 9.6
Dandenong	101	7.7	13	11.4	1 in 8.8
Monash Medical Centre	87	6.6	22	20.2	1 in 5
Western (Sunshine)	67	5.1	Nil	Nil	N/A
Royal Children's	54	4.1	7	11.5	1 in 8.7
Box Hill	51	3.9	8	13.6	1 in 7.4
Frankston	42	3.2	2	4.5	1 in 22
Total	1320	100	200	100	1 in 7.6

* Hit rate represents the ratio of total patients approached (excluded + recruited) to those recruited. This table covers the period March 2002 to May 2005 and does not include Holden case contributions or fatalities.

The best recruitment rate is from Monash Medical Centre, with 1 in 5 approached patients eventually recruited. The Alfred is second, with 105 patients recruited from 692 approaches. Recruitment rates are lower than average at the Royal Children's, pointing to difficulties in gaining consent from minors, while a similar trend at Geelong is probably indicative both of short stays and the 1½ hour travelling time from MUARC. Due to complications arising from the new Victorian Privacy Act, recruitment ceased at Frankston and Western Hospitals in mid-2003.

Table 5. Distribution of exclusion reasons.

Exclusion Reason	Number of patients	
	Freq.	%
Car too old	321	21.1
Discharged before consent able to be obtained	292	19.2
Recruited	200	13.2
Inappropriate to be approached	130	8.6
Unable to give own consent/no next-of-kin available	123	8.1
Not an occupant of a passenger car	110	7.2
Not interested/refused	84	5.5
Instructed not to approach by hospital staff	47	3.1
Unable to gain consent from car owner to inspect car	46	3.0
Patient did not speak English/interpreter unavailable	33	2.2
Patient undergoing medical procedure	23	1.5
Readmission	22	1.4
Admission not due to injuries sustained in crash	14	0.9
Age of car not able to be determined	11	0.7
Transferred to another hospital	8	0.5
Fatality	6	0.4
Car unavailable (repaired/sold/scrapped)	2	0.1
Car not damaged	1	0.1
Crash occurred overseas	1	0.1
Other	24	1.6
Unknown	22	1.4
Total	1520	100

This table covers does not include Holden case contributions or fatalities.

Although the most common exclusion reason is vehicle age, it should be noted that for some of the survey period the vehicle age entry criterion was 10 years or younger. This has since been changed to a fixed build year of 1989, which means that vehicles located during 2004 could be up to 15 years old. Only 5.5%, or 1 in 18 of total approached patients, were not interested or refused to participate. Where the gender of the not interested/refused subset of patients was known, 59% were male. Where occupant driver/passenger status was known, 74% of refusal/not interested responses were from drivers.

Of those patients whose gender was known, 60% were male compared with 53% of participants. Patients who were passengers appeared to be more likely to be excluded, comprising 32% of excluded patients (where position in the vehicle was known) compared with 27% of participants.

2.3 Web-Based Data Access

During 2004, a prototype system was developed in conjunction with the Victorian Partnership for Advanced Computing (VPAC) to allow ANCIS sponsors access to key case data via a web interface. Authorised users access a search page by entering a unique username and password. A variety of search terms may be entered, relating to vehicle size and engine category, crash type/damage and occupant demographics and injuries.

A list of matching cases is returned and by clicking on the case of interest, further details relating to the vehicle and person may be examined. At the time of writing, the trial system was nearing the end of its evaluation period, with a plan being prepared for a suite of improvements to be incorporated, including an enhanced interface, an expanded number of input variables and access to crash site variables.

3 SPECIAL ANALYSES

During the past year, the ANCIS database has been used to complete several special analyses. This section presents of three of these analyses completed by MUARC using the ANCIS data.

Note that in this section, 'nearside' refers to the left-hand side of the vehicle and 'offside' the right-hand side of the vehicle.

3.1 Side Airbag Deployments

An analysis of side airbag deployments in the ANCIS database was completed in September of 2004. There are presently 11 cases in the ANCIS database in which a side airbag was fitted for the seat in which the case occupant was seated. However in September of 2004, there were only ten such cases (in eight different case vehicles). Below is a brief description of each case, as provided to ANCIS Sponsors in September 2004. In the original analysis, for cases in which a side airbag did deploy, the injuries suffered were compared with injuries suffered in similar cases in which a side airbag did not deploy or was not fitted. However, for reasons of brevity, these comparisons are omitted in the present report.

3.1.1 Case Vehicle #1: 0001-1AVD – Side Airbag Deployed

The case vehicle was a 1999-build small hatchback that was involved in a crash with another passenger car. The bullet vehicle struck the offside of the case vehicle. The EBS of the crash was calculated to be 10 km/h and the maximum intrusion of 80 mm occurred at the base of the rear door. The maximum crush of 150 mm occurred at the offside front door. The 84-year-old male driver of the case vehicle was using a seat belt and the car was fitted with a steering wheel airbag but, being a side impact, it did not deploy. The car was also fitted with door mounted side airbags, with the driver's side airbag deploying. Case notes indicate that there is a strong possibility that the driver's side airbag deployed incorrectly. At inspection, only part of the side airbag was protruding from a seam in the offside door's interior. It is not clear whether this is a result of an erroneous deployment or the airbag being partially pushed back into the door after deployment. The side airbag was proposed as the injury causation mechanism for a haematoma to the liver, multiple fractured ribs and haemothorax suffered by the driver. All these injuries seem quite severe for a minor impact (EBS=9.9 km/h). The driver had an MAIS of three with an ISS score of 19.

There was also a front left passenger in the case vehicle (case 0001-2AVD). For the front seat passenger, neither the fascia airbag nor the door mounted side airbag opened. This is not unusual as the impact was a non-struck side impact from the perspective of the front passenger. The occupant was belted at the time of the collision and only received minor injuries.

3.1.2 Case Vehicle #2: 0006-1AVD – Side Airbag Deployed

The case vehicle was a 2000-build large sedan. The vehicle was struck on the offside by another vehicle and then continued to travel forward before striking a pole in a narrow offset frontal collision. The EBS of the first impact was calculated to be 32 km/h and the Delta-V was 39 km/h. The non-case vehicle directly engaged the offside passenger cabin from the glass level to the base of the offside doors. The maximum intrusion into the passenger cabin of 230 mm occurred at the offside front door. The 56-year-old male driver was belted at the time of the impact. The driver's frontal airbag deployed, as did the driver's seat mounted side airbag. The side airbag was listed as the cause of several rib fractures (with associated haemo-pneumothorax) to the male driver. The driver also received minor abrasions and bruises to the upper extremities and right hip, suffering an MAIS of four and an ISS of 17.

The side impact protection provided by the side airbag may have prevented more severe injuries. In particular, it is worth noting that the driver from case 0006-1AVD suffered no head injuries. However, the risk of head injury was probably reduced partly because the non-case vehicle engaged only the side of the case vehicle below the level of the driver's window sill.

Case 0006-2AVD was a front left passenger travelling in the same vehicle as case 0006-1AVD. The passenger's fascia airbag deployed but the passenger's side airbag did not deploy. Both these airbag deployment outcomes were as expected considering the two types of impacts in which the vehicle was involved. The passenger suffered minor injuries to multiple body regions (scoring an ISS of three).

3.1.3 Case Vehicle #3: 0011-2ANL – Side Airbag Deployed

The case vehicle was a 2001 large passenger sedan. The vehicle struck a concrete bollard and then a pole. Both impacts were to the nearside of the vehicle. The case vehicle rolled after the series of impacts. Both the Delta-V and EBS of the crash were estimated to be 43 km/h. The occupant was belted at the time of the impact and the passenger's fascia airbag did not deploy. The seat mounted side airbag seems to have only partially deployed (see Figure 3). The apparent failure of the side airbag to fully deploy could have been due to the significant intrusion at the nearside front door. The intrusion at the cant rail level and window level was 460 mm, while at the mid-door level the intrusion was 360 mm. The front seat passenger suffered fractured ribs due to contact with the car's door and one of the collision partners (the tree) and received an ISS of 24.

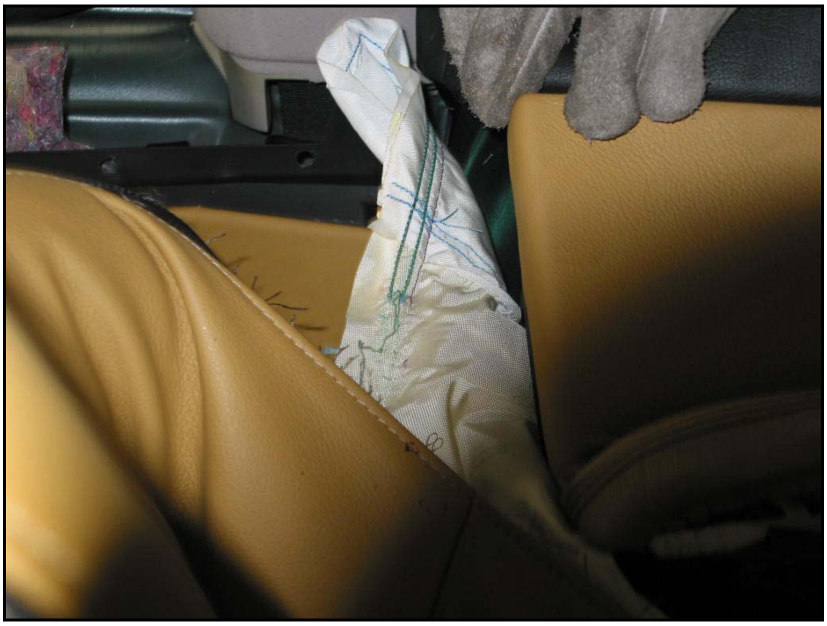

Figure 3. Partial deployment of the front left passenger's seat-mounted side airbag in case 0011-2ANL.

3.1.4 Case Vehicle #4: 0016-1AVA – Side Airbag Deployed

The case vehicle was a 1997 model large passenger sedan. The non-case vehicle struck the offside of the case vehicle, with the EBS of the crash 28 km/h. The maximum crush of 290 mm occurred at the B-Pillar on the case vehicle's offside. While the maximum intrusion of 230 mm occurred at the mid-door level of the offside front door. The driver was belted at the time of the crash. The driver's frontal airbag did not deploy, but the driver's door-mounted side airbag did deploy. The driver received bruising to the side of the chest due to contact with the side airbag but the driver claims the side airbag protected the driver's head. The driver also suffered a fractured pelvis due to contact with the B-pillar and as a result suffered an MAIS of two and an ISS of five.

3.1.5 Case Vehicle #5: 0058-1AVA – Side Airbag Fitted, Not Deployed

The case vehicle was a 1999 large passenger sedan. The vehicle suffered extensive damage after it left the roadway and hit several trees and bushes on the median strip of a divided rural highway. Figure 4 shows a sketch of the damage to the vehicle caused by impacts with the various collision partners. The primary impact was to the front of the vehicle and the Delta-V and EBS of the crash were both estimated to be 53 km/h. The driver was belted at the time of the crash. The driver's frontal airbag did deploy, but the driver's seat-mounted side airbag did not activate. The driver received a fracture to the T12 vertebrae due to the inertial forces during the collision as well as minor abrasions and bruises to the face, hands, chest and lower extremities. Some of these minor injuries were due to contact with broken glass. The driver suffered an MAIS of two and an ISS of five.

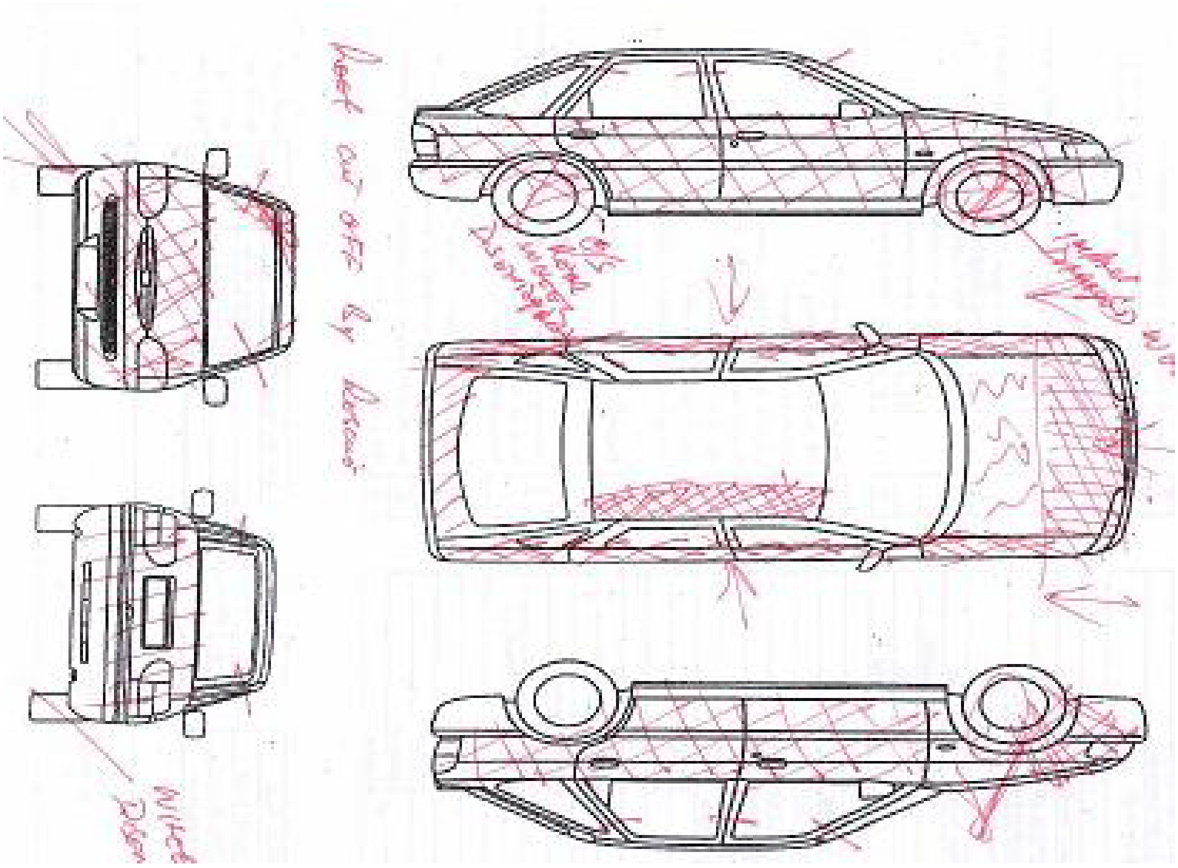

Figure 4. Sketch of the damage to the case vehicle of 0058-1AVA

3.1.6 Case Vehicle #6: 0090-1AVR – Side Airbag Deployed

The case vehicle was a 2000 model large passenger sedan that was struck by another car. The EBS of the collision was 31.7 km/h. The impact involved the passenger region and front third of the offside of the case vehicle. The b-vehicle only engaged the region below the glass level of the side doors (however the region above the glass level was deformed by the impact). The maximum crush for the case vehicle was 510 mm at the offside front door. The maximum intrusion was 380 mm at the base of the offside front door (340 mm at the mid-door level). The 43 year-old male driver was belted at the time of the crash and the driver's front airbag did not deploy. However, the driver's door mounted side airbag did activate, as did the driver's tubular cant-rail airbag. The driver suffered multiple rib fractures due to intrusion of the front offside door. The driver received an ISS of 27 due to AIS3 head, chest and abdomen injuries. These injuries included multiple rib fractures with haemothorax, a pulmonary contusion, multiple fractures to the pelvic region and a ruptured urethra (all caused directly or indirectly by intrusion of the B-Pillar and/or door). The driver also received a fractured tibia due to the left leg being trapped between the door and the footwell, a fractured skull due to contact with the door as well as other less severe shoulder, leg and spinal injuries.

3.1.7 Case Vehicle #7: 0150-2AVA – Side Airbag Deployed

The case vehicle was a 1999 model large passenger sedan that was struck on the nearside by a passenger vehicle. The EBS of the crash was calculated as 50 km/h. However, this is probably a significant over-estimation of the crash's severity because the lock of the rear nearside door failed during impact. This reduced the stiffness of the side of the vehicle at the point of impact and caused greater than expected intrusion, preventing the EBS from being calculated accurately.

The front left passenger was belted at the time of impact and their seat mounted side airbag deployed. However, the front left passenger's fascia airbag did not deploy. The front left passenger suffered multiple rib fractures due to intrusion of nearside door. The front left passenger also suffered an AIS4 chest injury due to probable contact with the seatbelt and an AIS4 head injury due to contact with the B-Pillar. Several AIS3 spinal injuries were also suffered due to probable contact with the B-Pillar. The front left passenger suffered an ISS of 41. The injury outcome for this case was more severe than one would usually expect. This is due to failure of the rear nearside door lock which resulted in increased intrusion on the nearside of the vehicle.

3.1.8 Case Vehicle #8: 0197-2AVA – Side Airbag Deployed

The case vehicle was a 2001 hatchback that was struck on the nearside by a passenger vehicle. The EBS of the crash was 18 km/h and the Delta-V was 39 km/h. The intrusion from the top of the front nearside door to the mid-door region was 100 mm. The maximum crush of 200 mm occurred at the nearside B-Pillar. The front left passenger was wearing a seat belt at the time of the collision and their seat mounted side airbag deployed. However, the 84 year-old female passenger's fascia airbag did not deploy. The front left passenger died in hospital six days after receiving AIS4 chest injuries (multiple rib fractures and haemothorax) in the crash. These injuries were probably caused by contact with the side airbag. The passenger also received a fracture to the left superior pubic ramus and thus received an ISS of 21.

3.1.9 Comparison of Injury Outcomes for Side Airbag Deployments with all Nearside Cases

Occupants involved in nearside impacts typically receive more severe injury outcomes than other occupants because they are closer to the point of impact. In the analysis of side airbag deployments completed in September of 2004, the injury outcomes for nearside cases identified as having a side airbag deploy were compared with all nearside cases.

Figure 5 shows a scatter plot of ISS for occupants involved in a nearside impact versus the EBS of the impact for the 59 nearside cases in which the EBS could be determined. Cases in which the occupant's side airbag deployed are indicated using arrows. It can be seen that for nearside crashes with low EBS, the two cases where a side airbag deployed resulted in higher ISS values than all other cases with similar or lower EBS values. While for cases with an EBS between 25 km/h and 45 km/h, the ISS values for cases in which a side airbag deployed appear to be in the range of ISS values for non-deployed side airbag cases with comparable EBS values.

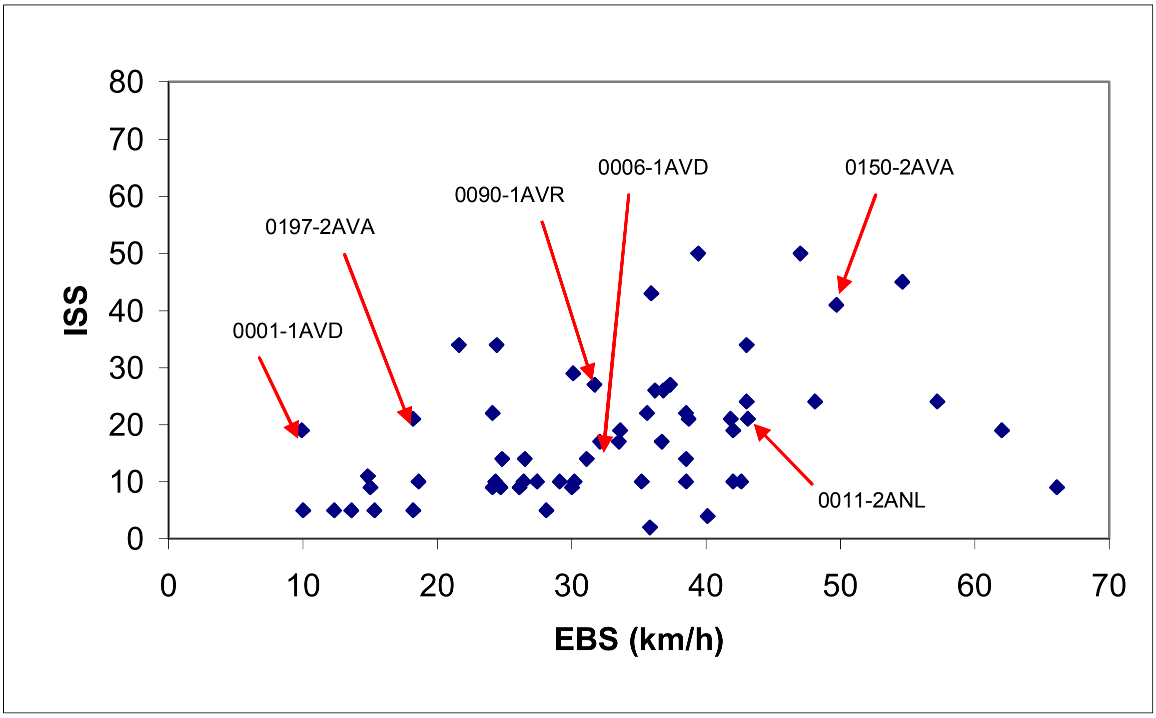

Figure 5. ISS versus EBS for occupants involved in nearside impacts (N=59).

Figure 6 shows the data points for cases in Figure 5 in which the occupant was travelling in a hatchback. It can be seen that the ISS scores for side airbag deployed cases travelling in a hatchback were greater than one might expect given the ISS scores for comparable (in terms of EBS) non-deployed cases.

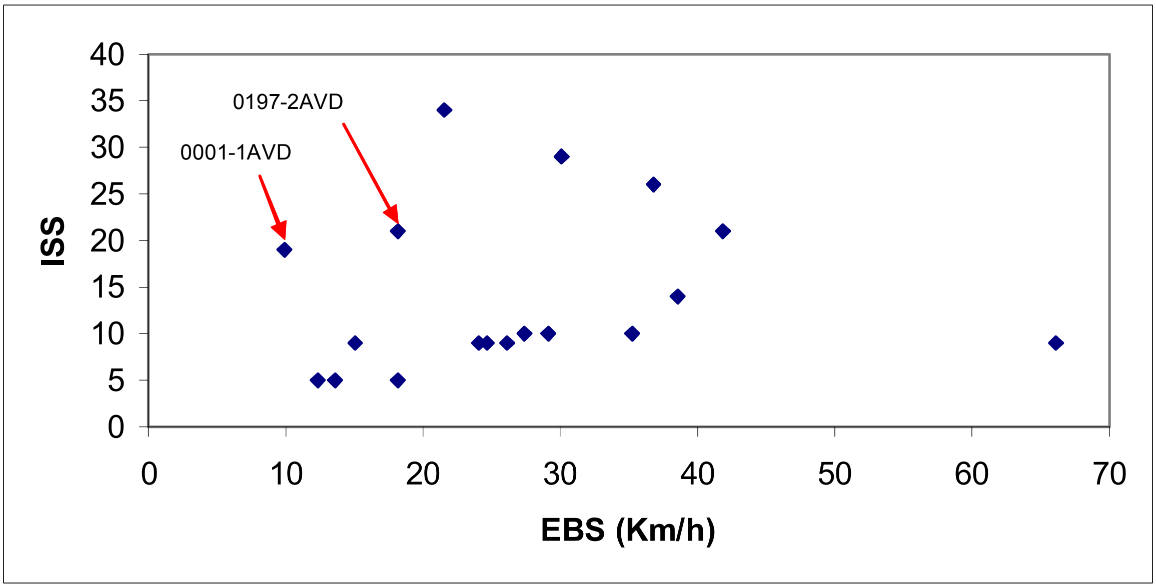

Figure 6. ISS versus EBS for occupants of small cars involved in nearside impacts (N=18).

Finally, Figure 7 shows the ISS values plotted against the age of the occupant involved in a nearside impact. It is worth noting that all the side airbag deployed nearside cases are aged 45 or older. The absence of younger people in the side-airbag-deployed sample could suggest that side airbags are effective in preventing younger people from presenting at hospitals with serious injuries. Yet the airbag deployments, while still preventing some types of serious injuries in older people (such as the prevention of head injuries), may be causing injuries for older people that require hospital admission. From the case studies presented in the earlier part of this report, such injuries would typically involve fractured ribs. It could be that young people are more resistant to rib fractures caused by side airbag deployments and so receive all the benefits of airbag deployments (such as preventing head injuries) without the potential disadvantages (i.e. rib fractures and other types of chest injuries). It is interesting to note that at the time of analysis, the mean maximum AIS score for injuries to the chest region for the 73 near side occupants was equal to 2.19. However three of the six occupants that were involved in a nearside impact in which the side airbag deployed received an AIS chest injury equal to four, while the other three received chest injuries of AIS severity three. The average maximum AIS for head injuries for all 73 nearside impacts was 1.38. Three of the six cases in which an occupant's side airbag deployed did not receive a head injury, while in one case an occupant received an AIS1 head injury and in the other two cases the respective occupants received an AIS3 and an AIS4 head injury.

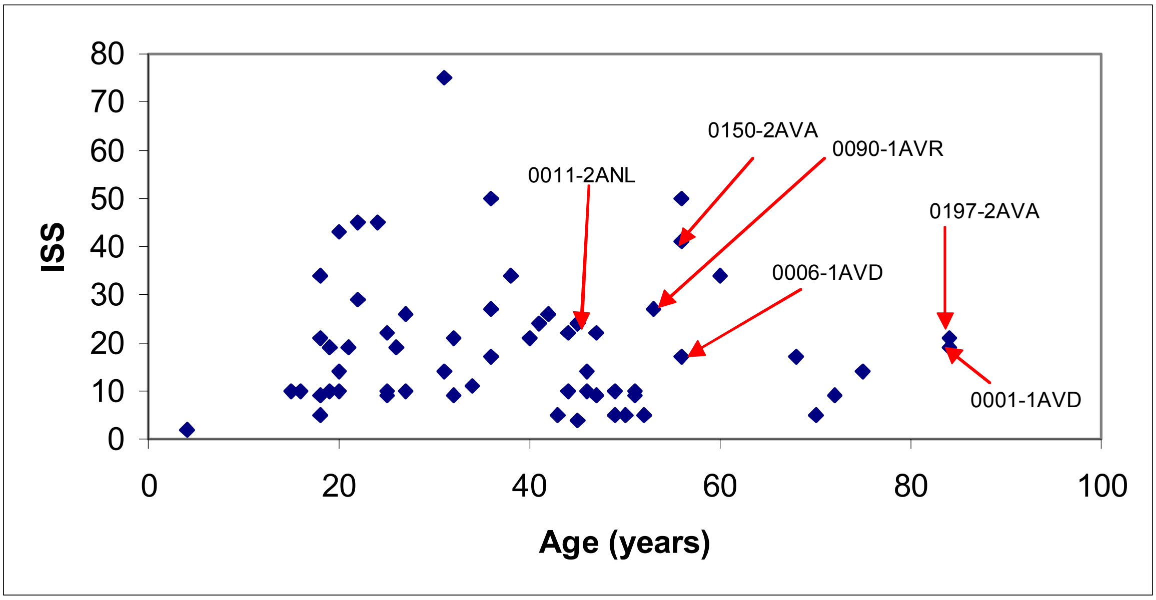

Figure 7. ISS versus age of occupant for occupants involved in nearside impacts (N=61).

3.2 Front Left Passenger Fascia Airbag Deployments

In September 2004, an analysis of front left fascia airbag deployments was completed using ANCIS cases. At the time of this analysis there were 254 cases in the ANCIS database involving 235 case vehicles. Of these case vehicles, 51 were fitted with front left fascia airbags, of which 24 activated in the crash. Of these 24 activated cases, 19 were involved in impacts in which the primary region of damage to the case vehicle was the front. For one vehicle (Case 0161-1AVA), the front left fascia airbag deployed during a rollover in which the top of the case vehicle and its nearside were damaged. Case notes suggest that while the vehicle was rotating during the rollover, its bonnet struck a small tree, possibly triggering both the driver and passenger front airbags. The driver of the vehicle was the only occupant in the vehicle at the time of the crash. There were also four cases (0020-1AVD, 0026-1AVA, 0071-1AVA and 0127-1AVA) in which the front left fascia airbag deployed when the primary region of damage to the case vehicle was the nearside. In each of the cases, the case vehicle struck a tree in which there was a frontal component to the primary direction of the impact force (PDOF). That is, the PDOF value of the Collision Deformation Classification (CDC) was either '01' or '02'. As discussed below, the front left passengers of five of the 24 vehicles in which the front left fascia airbag deployed were recruited as cases in the ANCIS project.

For eight of the 17 vehicles in which a front left airbag was fitted but did not deploy, the most severely damaged region of the case vehicle was the offside. While for two vehicles the most severely damaged region was the nearside. In five of the 17 cases, the vehicle was involved in a roll-over, while for one case the impact was to the rear of the case vehicle. In the remaining case the impact was a low speed (EBS=12 km/h) frontal impact.

At the time of analysis, there were 50 cases of front left passengers in the ANCIS database. Table 6 shows that of these 50 cases, 33 were passengers in vehicles in which no front left fascia airbag was fitted, while nine were travelling in vehicles in which a front left fascia airbag was fitted but did not deploy. There were five cases of front left passengers whose front left fascia airbag did deploy. The analysis completed in September 2004 examined each of these five cases and compared the injury outcomes of the five cases against all other cases in the database.

Table 6: Distribution front left fascia airbag status for cases in which the occupant was a front left passenger.

	Frequency	Percent
Not fitted	33	66
Fitted and activated	5	10
Fitted and not activated	9	18
Unknown	3	6
Total	50	100

3.2.1 Case 0006-2AVD

The case vehicle was a 2000 model large sedan. The vehicle was struck on the offside by another vehicle and then struck a pole. The second impact was a narrow offset frontal collision. The CDC of the first impact was 02RPEW3 while the CDC of the second impact was 12FLEN6. The front left passenger's fascia airbag deployed but the passenger's seat-mounted side airbag did not deploy. The passenger was a 51-year-old female. She was wearing a seat belt at the time of the collision and suffered minor injuries to multiple body regions, scoring an ISS of three. These injuries included bruising to the chest, shoulder, both hips, pelvis, the left elbow, the left shin and the right thigh. Contact with the centre console was suggested as a possible source of the pelvic, hip and thigh injuries, while contact with the lower fascia/glovebox possibly caused the minor shin injury. The chest and shoulder injuries were probably caused by contact with the seat belt. The driver of the case vehicle was a 56 year-old male. He received six rib fractures (AIS4) due to contact with the side airbag as well as other minor injuries, resulting in an ISS of 17.

3.2.2 Case 0020-2AVD

The case vehicle was a 2000 model medium sized 4-door sedan. The crash occurred at night while it was raining. It is believed that the case vehicle was travelling on a bend in the road when it moved onto a gravel lane adjacent to the nearside of the road. After a short distance the driver lost control and the case vehicle crossed the opposing lane of traffic, left the road and hit a tree. The CDC of the impact with the tree was 01RFEW2. The EBS and Delta-V of the impact was 30 km/h, although these estimates may not be wholly accurate because the case vehicle's right front wheel assembly probably absorbed some of the impact energy. The front left occupant was a 19-year-old male. The only injuries the front left passenger received were three contusions to the scalp, which were probably caused by contact with the front left fascia airbag. The ISS for the front left occupant was one, as was the MAIS. The driver of the vehicle was a 44-year-old male. He received an ISS of 19 and an MAIS score of three. The driver's front airbag also deployed during the impact.

3.2.3 Case 0074-2AVA

The case vehicle was a 1996 model large passenger sedan. The case vehicle was travelling along a rural highway with a lane in each direction when a utility travelling in the opposite direction crossed into the case vehicle's lane, resulting in a head-on collision. The collision occurred on the grassed area to the nearside of the lane in which the case vehicle was travelling. The crash happened in full daylight in fine and dry weather conditions. The EBS of the impact was 58 km/h and the Delta-V was 54 km/h. The CDC of the impact for the case vehicle was 12FZEW4. The maximum crush was 950 mm and the location of the maximum crush was the offside third of the vehicle's bonnet. Both the driver and the passenger's front airbags deployed. The frontal intrusion to the nearside of the passenger compartment was 40 mm at knee level and 80 mm at the level of the base of the A-pillar. The frontal intrusion at the driver's side (offside) was 240 mm at the footwell, 200 mm at the fascia level and 270 mm at the level of the base of the A-pillar. The front left passenger was a 54-year-old female and the driver a 66-year-old male. Both front occupants were wearing seatbelts at the time of the impact. The front left passenger sustained a wedge fracture to the L2 vertebrae of the spine which was attributed to the seat bottoming out (airbag involvement not known), as well as contusions to the chest and abdomen caused by contact with the seatbelt. She also received abrasions to the arm. The contact source for these abrasions was unknown. The MAIS score for the front left passenger was two and the ISS was five. The driver also received an MAIS score of two and an ISS of five. His injuries included various internal injuries to the abdomen region (all AIS2) caused by contact with the seatbelt. He also received lacerations to the face and lower extremities probably caused by flying glass and contact with the right instrument panel respectively.

3.2.4 Case 0170-2AVG

The case vehicle was a 1997 model 4-door passenger sedan. The crash occurred at night in clear weather conditions. The case vehicle was travelling on a rural road with one lane in each direction when the driver of a vehicle travelling in the opposite direction lost control while negotiating a bend in the road. The non-case vehicle slid across the path of the case vehicle and the front of the case vehicle struck the nearside of the non-case vehicle. The speed limit of the segment of the road where the crash occurred was 100 km/h, the Delta-V of the collision was 57 km/h and the EBS was 60 km/h. The CDC for the case vehicle was 12FDEW3, and as well as damaging the entire width of the front of the case vehicle, the impact resulted in the deformation of the front offside A-pillar. The maximum crush for the case vehicle was 860 mm, occurring at the offside corner of the front of the vehicle. There was a 50 mm intrusion to the toepan on the nearside of the passenger compartment, 100 mm intrusion to the offside toepan and 50 mm intrusions to the offside fascia and windscreen. Both front airbags in the case vehicle deployed as a result of the collision. The 62-year-old female who occupied the front left passenger seat was wearing a seat belt at the time of the collision. She sustained a perforation/rupture of her duodenum (AIS3) probably caused by contact with the seatbelt, under which she may have submarined. She also received a bruised left shoulder attributed to the seat belt as well as bruised knees, probably caused by contact with the glovebox or lower nearside fascia. The front left passenger received an ISS of ten and a MAIS score of three. The front passenger had a pre-existing condition (diverticulitis), which may have contributed to the severity of her AIS3 abdominal injury.

3.2.5 Case 0186-2AVA

The case vehicle was a 2001 model 4-door hatchback. The crash occurred at night in clear weather conditions. The case vehicle was travelling along an unlit two lane rural road when the driver swerved to avoid a small animal on the road, causing the vehicle to veer off the nearside of the road, striking an embankment with the underside of the vehicle and then a tree head-on. The speed limit for the segment of road on which the crash occurred was 100 km/h. The CDC for the impact with the tree was 12FCEN2. The EBS and Delta-V for the impact with the tree were both 39 km/h. The frontal impact with the tree caused direct damage to the front centre of the vehicle as well as some creasing of the roof near the offside B-pillar. Both front airbags deployed during the impact. The front left passenger was a 52-year-old female. She sustained injuries that resulted in an MAIS score of three and an ISS of 14. Her most severe injury was a fractured right tibia (AIS3), accompanied by a fractured right fibula and a fractured left medial malleolus, all three of which were attributed to contact with the toepan of the vehicle. She also received transverse process fractures to the L2, L3 and L4 vertebrae (all AIS2) as well as a fracture of the L2 anterosuperior cortical end plate. All these spinal injuries were attributed indirectly to the seatbelt, but may have involved the seat base as well. She also received a laceration to the eyebrow, probably caused by contact with the airbag.

3.2.6 Comparison of injury outcomes in cases where a Front Left Passenger's Fascia Airbag deployed with all cases

The mean ISS of the 254 cases in the ANCIS database at the time of the analysis was 14.72 while the mean MAIS score was 2.77. Thus, for the five cases in which a front left passenger's fascia airbag deployed, the injury outcome for that occupant, in terms of ISS, was less severe than the mean injury outcome (only slightly less than average in the case of 0186-2AVA for which the ISS was14). Figure 8 shows the ISS score for all the cases (in which EBS and ISS values could be calculated) plotted against the EBS of the case vehicle. It can be seen from this figure that for each case in which a front left passenger's fascia airbag deployed, the occupant fared well with respect to the resulting ISS when compared with all other occupants. Figure 9 shows ISS plotted against EBS for all front left passengers. Low numbers of cases of front left passenger fascia airbag deployments prevents further analysis of the effect of confounding factors other than EBS from being carried.

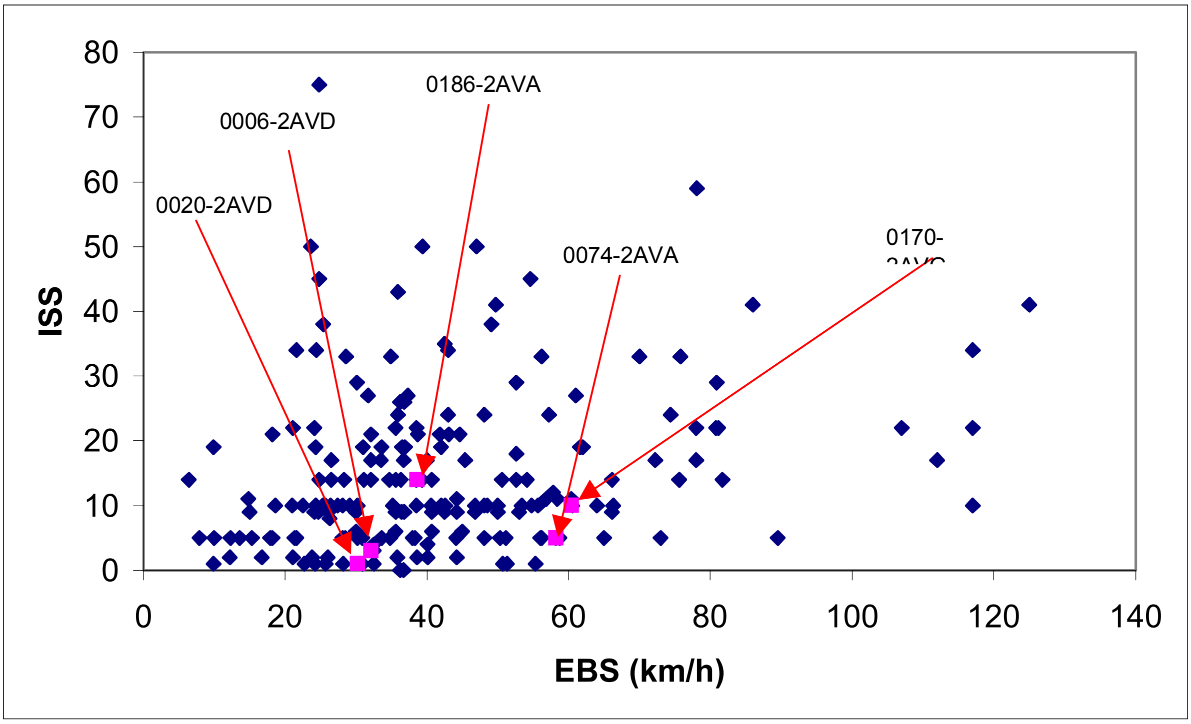

Figure 8. ISS plotted against EBS (km/h) for all cases in which EBS and ISS was known (N=202).

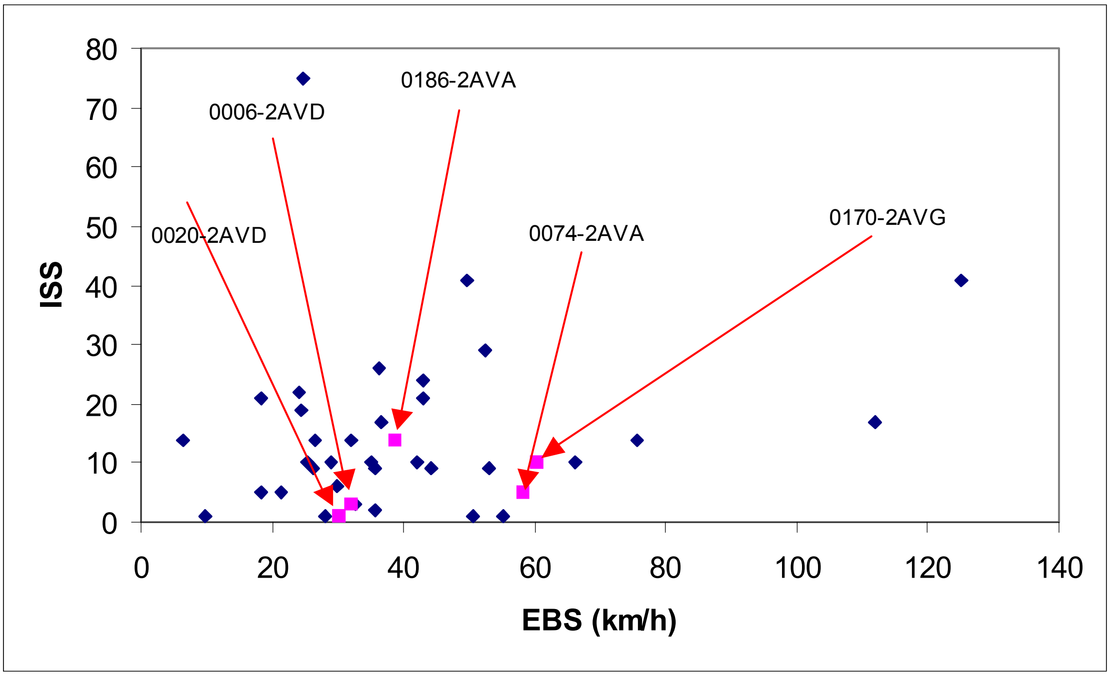

Figure 9. ISS plotted against EBS (km/h) for cases of front left passengers in which EBS and ISS was known (N=39).

3.3 Front Wheel Drive versus Rear Wheel Drive

In March 2004, an analysis of front wheel drive versus rear wheel drive vehicles in the ANCIS database was carried out. The aim of this analysis was to determine whether there were any differences in the types of crashes rear wheel drive cars are involved in when compared to front wheel drive cars. As shown in Table 7, at the time of analysis there were 215 vehicles in the ANCIS database for which the driving wheel location was known. Of these, 111 (51.6%) were front wheel drive cars and 85 (38.5%) were rear wheel drive. Only 19 (8.8%) were 4WDs.

Table 7. Distribution of the driving wheel location of vehicles in the ANCIS database (N=215)

Drive	N	%
Front Wheel Drive	111	51.6
Rear Wheel Drive	85	39.5
4WD	19	8.8
Total	215	100

Table 8 shows the distribution of the driving wheel location of vehicles in the ANCIS database by the market group of each vehicle (note that there were 11 cases in which the market group was not assigned). It can be seen that 72.5% of front wheel drive vehicles in the sample were small cars and 87% of rear wheel drive vehicles were large cars. Care needs to be taken when analysing crash involvement characteristics with respect to driving wheel location. This is because perceived effects of driving wheel location may actually be effects of vehicle size.

Table 8. Distribution of the driving wheel location by vehicle market group.

Market Group	Driven wheels						Total	
	Front wheel drive		Rear wheel drive		4wd			
	Count	%	Count	%	Count	%	Count	%
Small car	79	72.5	1	1.3	2	11.1	82	40.2
Medium car	15	13.8	0	0.0	3	16.7	18	8.8
Large car	11	10.1	67	87.0	1	5.6	79	38.7
4WD	0	0.0	1	1.3	11	61.1	12	5.9
Luxury car	1	0.9	4	5.2	0	0.0	5	2.5
Sports car	3	2.8	4	5.2	1	5.6	8	3.9
Total	109	100.0	77	100.0	18	100.0	204	100.0

Clearly, market group or vehicle size are not the sole potential confounding variables that should be considered when trying to distinguish between FWD and RWD vehicle crashes. Consequently, the relationship between vehicle driving wheel location and a number of crash site and crash configuration-related variables was examined to determine whether, rear wheel driven vehicles were crashing in different locations or experiencing different types of crashes to each other. Fisher's Exact Test was used to compare the distributions for each of the following variables:

- Location of the crash (rural versus urban);
- Road curvature;
- Evidence of braking before impact;
- Side of the vehicle most damaged in the collision;
- Collision partner for the case vehicle;
- Estimated Barrier Speed (EBS) of the primary impact;
- Injury outcome of the crash.

With this in mind, logistic regression was used to examine differences in crash circumstances while controlling for each of the above confounding factors. The above list is not necessarily exhaustive, but controlling for this subset is likely to increase the reliability of results.

The distribution of crashes among rural, urban or mixed use areas was not significantly related to drive wheel location, nor was the finding with regard to straight versus curved roads.

There was no significant relationship between drive wheel location and crash type, except that 4WD vehicles were more likely to be involved in a rollover crash.

The relationship between drive wheel location and primary collision partner was almost significant (p = 0.06). As above, a higher than expected number of 4WD vehicles were involved in rollover collisions and a higher than expected number of rear wheel drive cars were involved in impacts with narrow objects such as trees, poles and posts. However, after adjusting for confounding factors, the odds ratio for a RWD vehicle involvement in a narrow object impact compared with a FWD or 4WD vehicle was found to be 1.75, but was non-significant (p = 0.132). Conversely, a greater than expected number of front wheel drive vehicles collided with trucks/buses/semitrailers and campervans as well as cars/utes/4WDs, but again these relationships were not found to be significant.

Table 9. Distribution of the primary collision partner by the driving wheel location of the case vehicle.

Collision Partner		Driven wheels			Total
		Front wheel drive	Rear wheel drive	4wd	
Car / ute / 4WD	Count	49	31	4	84
	Expected Count	43.5	33.2	7.3	84
Truck / bus / semitrailer / Campervan	Count	15	7	1	23
	Expected Count	11.9	9.1	2.0	23
Tree / pole / post / lamppost	Count	27	30	6	63
	Expected Count	32.6	24.9	5.5	63
Rollover	Count	10	9	6	25
	Expected Count	13.0	9.9	2.2	25
Total	Count	101	77	17	195

FET (2-sided) p=.057

No significant relationship was found between crash severity (EBS) and drive wheel location, nor was there an association with maximum AIS sustained.

In conclusion, two statistical methods were used to study any relationships between case vehicle drive wheel location and the types, locations and outcomes of crashes in which they were involved. There were no significant relationships found. The major problem with this analysis is that drive wheel location is strongly related to vehicle market category, with a larger sample being required to remove corresponding vehicle size effects.

4 CUMULATIVE ANALYSIS, JULY 2000- DECEMBER 2005

4.1 All Cases

As at 9 February 2006 there were a total of 392 cases available for analysis.

4.1.1 Basic Crash and Case Information

Table 10. Occupant position distribution.

Position	Freq.	%
Driver	290	74.0
Front left	73	18.6
Front centre	2	0.5
Rear left	13	3.3
Rear centre	5	1.3
Rear right	6	1.5
Back left	2	0.5
Back Centre	Nil	Nil
Back Right	Nil	Nil
Other	1	0.3
Total	392	100

Since the last report, the proportion of front left passengers has increased slightly (from 17.2% to 18.6%) and that of rear or back seat passengers has decreased (from 8.9% to 6.9%).

Table 11. Occupant position by belt use.

Position	No Evidence of Belt Use		Belted - Used or Claimed		Unknown		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Driver	7	2.4	282	97.2	1	0.3	290	100.0
Front Left	2	2.7	70	95.9	1	1.4	73	100.0
Front Centre	2	100.0	Nil	Nil	Nil	Nil	2	100.0
Rear Left	3	23.1	8	61.5	2	15.4	13	100.0
Rear Centre	Nil	Nil	5	100.0	Nil	Nil	5	100.0
Rear Right	1	16.7	5	83.3	Nil	Nil	6	100.0
Back Left	Nil	Nil	1	50.0	1	50.0	2	100.0
Back Centre	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Back Right	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
Other	1	100.0	Nil	Nil	Nil	Nil	1	100.0
Total	16	4.1	371	94.9	5	1.3	392	100.0

Compared with the previous analysis, the proportion of front seat occupants using or claiming to have used their seatbelt has increased to 97% from 87% in the last analysis. Note that this includes those occupants who claimed to have worn their seatbelt, but there was insufficient evidence to refute this claim during the vehicle inspection.

4.1.2 Case Demographic Characteristics

Table 12. Occupant age by gender.

Age (years)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1-5	1	0.3	2	0.5	3	0.8
6-9	2	0.5	1	0.3	3	0.8
10-14	2	0.5	3	0.8	5	1.3
15-24	52	13.3	29	7.4	81	20.7
25-34	45	11.5	29	7.4	74	18.9
35-44	29	7.4	19	4.9	48	12.3
45-54	46	11.8	40	10.2	86	22.0
55-64	12	3.1	25	6.4	37	9.5
65-74	15	3.8	19	4.9	34	8.7
75+	9	2.3	11	2.8	20	5.1
Total	213	54.5	178	45.5	391	100

The age and sex of one occupant (case 0104-1AVC) was unknown. This occupant died and thus could not be interviewed. Coronial information was not available at the time of writing.

The following tables provide height and weight information for the ANCIS sample. Also computed was Body Mass Index (BMI), an obesity index computed by dividing the square of the person's mass (kg) into their height in centimetres. The normal range for this parameter is generally given as 15-25, with those with a BMI less than 15 classed as 'underweight' and over 25 as 'overweight'.

Table 13. Occupant height, summary statistics.

Height (cm)	Male	Female
Mean	177.2	163.2
Median	178	164
Minimum	120	120
Maximum	201	189
Number of cases	194	159
Missing / Unknown	19	19

Table 14. Occupant height distribution by gender.

Height (cm)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<150	2	1.0	5	3.1	7	2.0
150-154	Nil	Nil	16	10.1	16	4.5
155-159	3	1.5	26	16.4	29	8.2
160-164	6	3.1	34	21.4	40	11.3
165-169	21	10.8	44	27.7	65	18.4
170-174	28	14.4	19	11.9	47	13.3
175-179	44	22.7	11	6.9	55	15.6
180-184	52	26.8	3	1.9	55	15.6
185+	38	19.6	1	0.6	39	11.0
Total	194	100	159	100	353	100

Table 15. Occupant mass, summary statistics.

Mass (kg)	Male	Female
Mean	82.1	65.7
Median	80.5	63
Minimum	24	12
Maximum	140	150
Number of Cases	194	159
Missing / Unknown	19	19

Table 16. Occupant mass distribution by gender.

Mass (kg)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
1-15	Nil	Nil	1	0.6	1	0.3
16-30	1	0.5	4	2.5	5	1.4
31-45	3	1.5	6	3.8	9	2.5
46-60	9	4.6	62	39.0	71	20.1
61-75	55	28.4	47	29.6	102	28.9
76-85	49	25.3	18	11.3	67	19.0
86-100	57	29.4	17	10.7	74	21.0
101-115	16	8.2	2	1.3	18	5.1
116+	4	2.1	2	1.3	6	1.7
Total	194	100	159	100	353	100

Table 17. Body Mass Index (BMI) distribution by gender.

BMI (kg/cm^2)	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
<20	10	5.2	27	17.3	37	10.6
20-24	75	39.1	66	42.3	141	40.5
25-29	76	39.6	31	19.9	107	30.7
30+	31	16.1	32	20.5	63	18.1
Total	192	100	156	100	348	100

4.1.3 Crash Characteristics and Vehicle Types

In this section, a 'multiple impact' is defined as any crash with two or more CDC codes in which more than one has a damage extent value (7th digit) greater than one. For cases with two or more CDC codes all with extent equal to one, the CDC of the first impact is used to classify the type of impact for the case. As can be seen from Table 18, both rollovers and impact combinations involving a rollover were categorised separately.

Table 18. Occupant distribution by impact type.

Impact Type	Freq.	%
Front	183	46.7
Struck side (near side)	93	23.7
Non struck side (far Side)	31	7.9
Multiple Impact	24	6.1
Rollover with single Impact	24	6.1
Rear	14	3.6
Rollover with multiple Impacts	13	3.3
Rollover with no other Impacts	8	2.0
Top	1	0.3
Unclassifiable	1	0.3
Total	392	100

When coding collision partners, for the purposes of this report, cases listed as multiple impacts in Table 18 are grouped as such in Table 19. Furthermore, cases listed as rollovers in the previous table are also grouped as "rollover" for collision partner in Table 19, even though the rollover may have occurred in conjunction with an impact. For a more in-depth analysis of these impact types, refer to Section 4.6.

Table 19. Occupant distribution by the primary collision partner of the vehicle in which they were travelling.

Collision Partner	Freq.	%
Car or ute	81	20.7
Tree	67	17.1
Other / Unknown Vehicle	47	12.0
Pole or Post	40	10.2
Van / Truck / Bus	38	9.7
Multiple Impact	35	8.9
Rollover	34	8.7
4WD / MPV	21	5.4
Embankment / Ditch / Culvert	7	1.8
Concrete Barrier / Wall	6	1.5
Other Vehicle	5	1.3
Roadside Furniture	3	0.8
Animal	1	0.3
Other or Unknown Object	7	1.8
Total	392	100

Vehicle to vehicle impacts constituted just under half (49%) of collisions, while narrow object impacts comprised the next most common collision partner, with 27% of the sample.

Table 20. Airbag fitment and deployment by occupant position.

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	141	48.6	219	75.5
	Fitted and deployed	103	35.5	4	1.4
	Fitted and not deployed	45	15.5	6	2.1
	Unknown*	1	0.3	61	21.0
	Total	290	100	290	100.0
FLP	Not fitted	53	53.4	51	69.9
	Fitted and deployed	9	30.9	2	2.7
	Fitted and not deployed	10	15.2	3	4.1
	Unknown*	1	0.6	17	23.3
	Total	73	100	73	100.0

* 'Unknown' cases are those included from the Holden study and were collected under a different study protocol that did not include the side airbag variable. These cases are likely to be primarily 'Not fitted'. For one driver and one front left passenger, it was unknown if the forward airbag deployed because of extensive damage.

The rate of airbag fitment in the vehicles of this sample is quite low, with 51% of drivers having an airbag available and 46% of passengers. This is likely due to both the age of the vehicles in this sample (see Table 24) and the fact that this is a seriously injured sample, which presumes that occupants are less likely to be injured than in non airbag-equipped vehicles.

There were 362 separate vehicles and 392 cases in the ANCIS database. Delta-V was able to be calculated for 171 (43%) of the cases, while EBS was calculated for 289 (74%) cases.

Table 21. Crash severity, summary statistics.

Severity measure	Delta-V (km/h)	EBS (km/h)
Mean	43.9	42.5
Median	40.7	39.3
Minimum	6.4	6.4
Maximum	124.7	127
Number of cases	171	289
Missing / Unknown	191	73

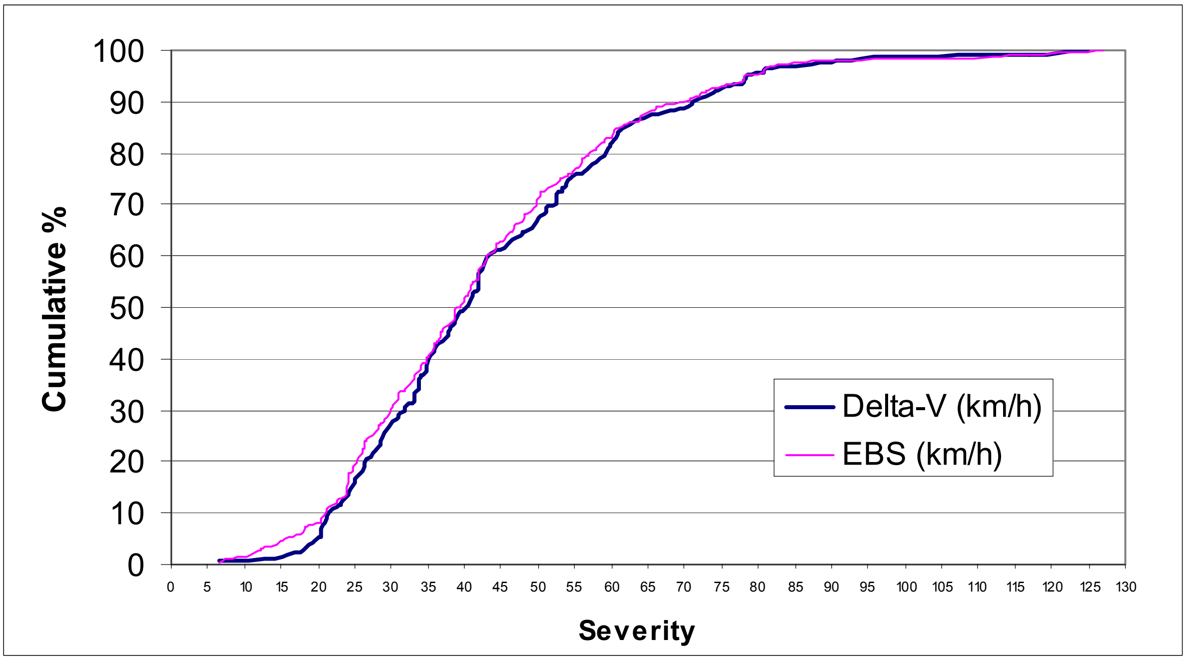

Figure 10. Delta-V and EBS Cumulative distribution for all impact types (N=171 and N=289 respectively)

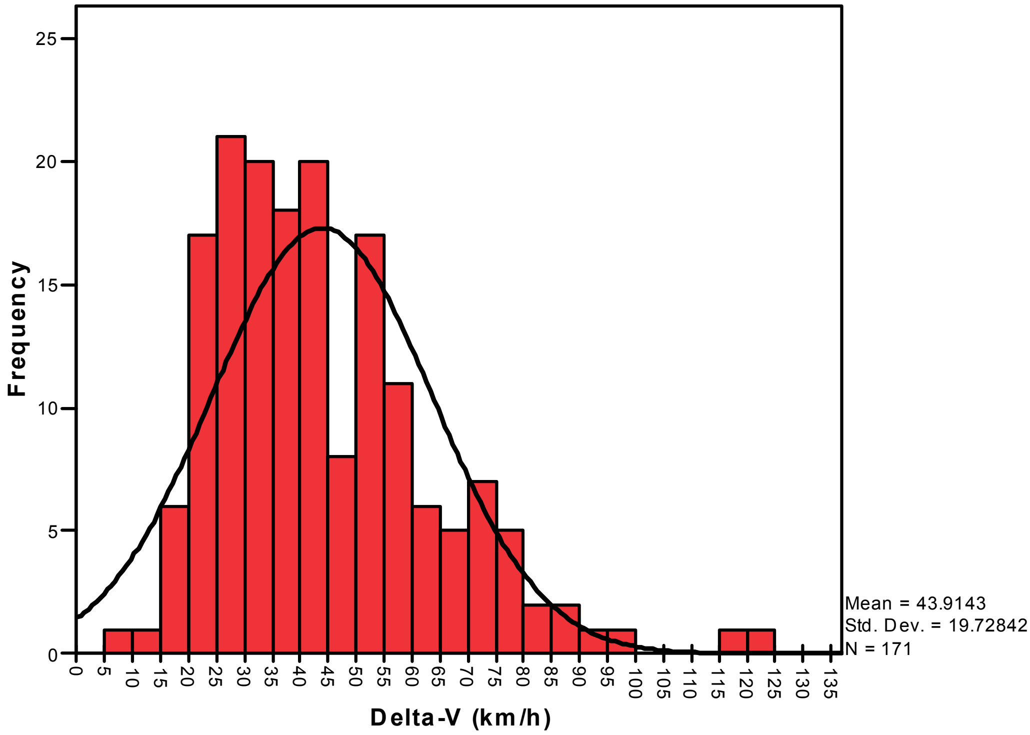

Figure 11. Histogram and Normal Curve of Delta-V distribution for all vehicles (N=171)

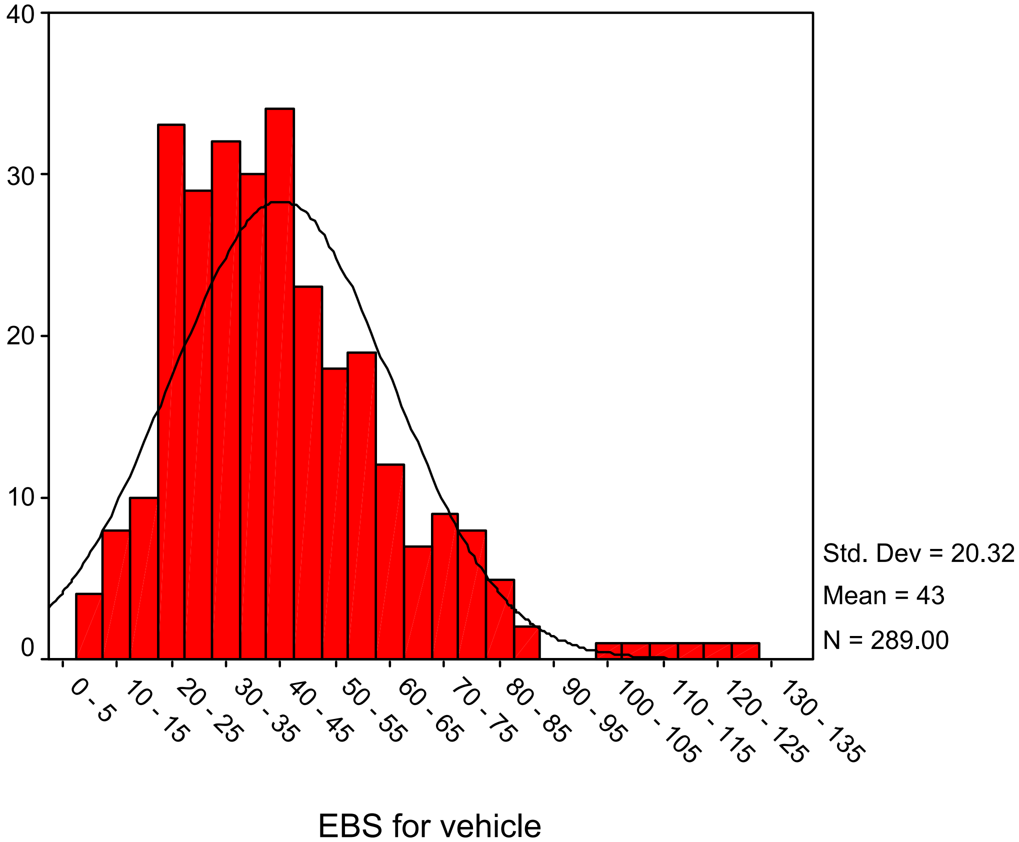

Figure 12. Histogram and Normal Curve of EBS distribution for all vehicles (N=289)

Table 22. Distribution of occupants (cases) and vehicles by vehicle type.

Vehicle Type	Number of Vehicles		Number of Cases	
	Freq.	%	Freq.	%
Sedan	219	60.5	238	60.7
Hatchback	64	17.7	65	16.6
Station Wagon	45	12.4	52	13.3
Utility	15	4.1	15	3.8
4WD/SUV	9	2.5	12	3.1
Sports / Convertible	8	2.2	8	2.0
MPV	2	0.6	2	0.5
Total	362	100	392	100

Table 23. Distribution of vehicles in ANCIS sample and Australian fleet by manufacturer.

Manufacturer	Number of vehicles (ANCIS)		Australian Fleet (2004)	
	Freq.	%	Freq.	%
Holden	145	40.1	2,033,568	19.1
Ford	48	13.3	1,933,822	18.2
Toyota	44	12.2	1,930,065	18.2
Mitsubishi	26	7.2	1,001,575	9.4
Nissan	21	5.8	729,429	6.9
Hyundai	17	4.7	464,165	4.4
Subaru	14	3.9	272,985	2.6
Mazda	13	3.6	465,229	4.4
Honda	5	1.4	343,874	3.2
Daihatsu	5	1.4	137,833	1.3
Daewoo	4	1.1	131,998	1.2
BMW	3	0.8	150,605	1.4
Land Rover	3	0.8	51,432	0.5
Ferrari	3	0.8	1,548	0.01
Volkswagen	2	0.6	88,399	0.8
Peugeot	2	0.6	49,846	0.5
Mercedes	1	0.3	154,090	1.4
Kia	1	0.3	66,425	0.6
Jeep	1	0.3	44,515	0.4
Saab	1	0.3	42,115	0.4
Audi	1	0.3	32,957	0.3
Renault	1	0.3	15,994	0.2
HSV	1	0.3		
Total	362	100	10,629,401	100

NOTE: HSV wasn't in the last table so the Australian fleet data is missing. Australian Passenger Vehicle Fleet data taken from the ABS Motor Vehicle Census for 3rd March, 2004, Catalogue 9309.0.

It is to be expected that Holden vehicles will be over-represented in the ANCIS sample, as they have been contributing deidentified cases from their own study since the beginning of the study. Note also that the number of vehicles is lower than the number of cases due to multiple participants in some vehicles. It should also be noted that ANCIS vehicles are a specific subset of the fleet, in terms of age, vehicle type and model mix and therefore Tables 23 to 25 should not be considered indicative of the level of crash involvement of a particular manufacturer's vehicles.

Table 24. Distribution of vehicles in ANCIS sample and Australian fleet by year of manufacture.

Year of Manufacture	Number of Vehicles (ANCIS)		Australian Fleet (at 2004)	
	Freq.	%	Freq.	%
1989	2	0.6	***	***
1990	5	1.4	***	***
1991	5	1.4	386,157	3.6
1992	21	5.8	412,584	3.9
1993	28	7.7	438,175	4.1
1994	38	10.5	491,189	4.6
1995	50	13.8	520,247	4.9
1996	24	6.6	512,329	4.8
1997	41	11.3	597,370	5.6
1998	38	10.5	673,330	6.3
1999	32	8.8	633,234	6.0
2000	37	10.2	662,405	6.2
2001	27	7.5	652,038	6.1
2002	11	3.0	665,160	6.3
Unknown	3	0.8	Nil	Nil
Total	362	100	10,629,401	100

*** Data not available for individual years prior to 1991.

Table 25. Distribution of vehicles in ANCIS sample and Australian fleet by age at the time of the crash of the vehicle.

Case vehicle age (years)	**Number of Vehicles (ANCIS)**		**Australian Fleet (2004)**	
	Freq.	**%**	**Freq.**	**%**
Less than 1 year	11	3.0	106,771	1.0
1	43	11.9	722,630	6.8
2	22	6.1	665,160	6.3
3	30	8.3	652,038	6.1
4	28	7.7	662,405	6.2
5	26	7.2	633,234	6.0
6	28	7.7	673,330	6.3
7	28	7.7	597,370	5.6
8	16	4.4	512,329	4.8
9	30	8.3	520,247	4.9
10	11	3.0	491,189	4.6
11	1	0.3	4392698	41.3
Total Known	274	75.7	10,629,401	100
Unknown	88	24.3	Nil	Nil
Total	362	100	10,629,401	100

4.1.4 Injury Outcomes

Table 26. Occupant distribution by hospital of admission.

Hospital of Admission	**Freq.**	**%**
Alfred	136	34.7
Melbourne	32	8.2
Dandenong	28	7.1
Monash	18	4.6
Frankston	10	2.6
Box Hill	8	2.0
St Vincent's	7	1.8
Prince of Wales	7	1.8
Royal Children's	6	1.5
Geelong	6	1.5
Western	2	0.5
Fatal	15	3.8
Unknown	117	29.8
Total	392	100.0

Table 27. Occupant Injury Severity Score, summary statistics.

ISS	Male	Female	Total
Mean	15.4	13.7	14.6
Median	10	10	10
Minimum	0	0	0
Maximum	75	75	75
Number of cases	213	178	392
Missing / Unknown	Nil	Nil	0

Case 104-1AVC (sex unknown) died of multiple uncodeable injuries

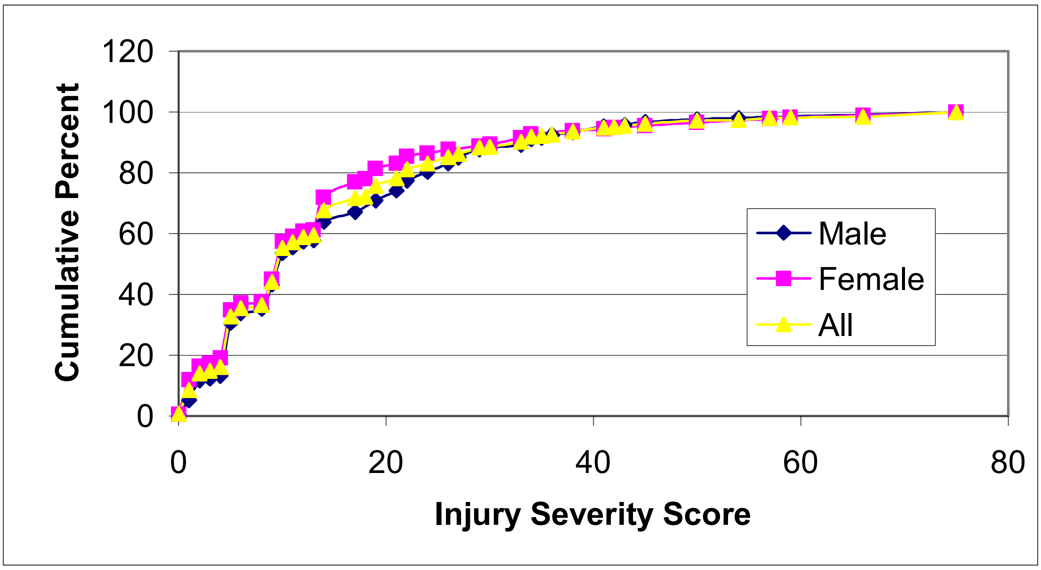

Figure 13. Cumulative ISS distribution for males and females in the ANCIS study.

Table 28. Occupant ISS range distribution by gender.

ISS Range	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
0-4	28	13.1	34	19.1	63	16.1
5-9	64	30.0	46	25.8	110	28.1
10-14	44	20.7	48	27.0	92	23.5
15-24	35	16.4	26	14.6	61	15.6
25-34	23	10.8	11	6.2	34	8.7
35-44	10	4.7	4	2.2	14	3.6
45-54	5	2.3	3	1.7	8	2.0
55-64	Nil	Nil	3	1.7	3	0.8
65-74	Nil	Nil	1	0.6	1	0.3
75	4	1.9	2	1.1	6	1.5
Total	213	100	178	100	392	100

The distribution of ISS ranges indicates that there is a trend toward female participants experiencing lower ISS scores (<15) and males higher injury severities (>15).

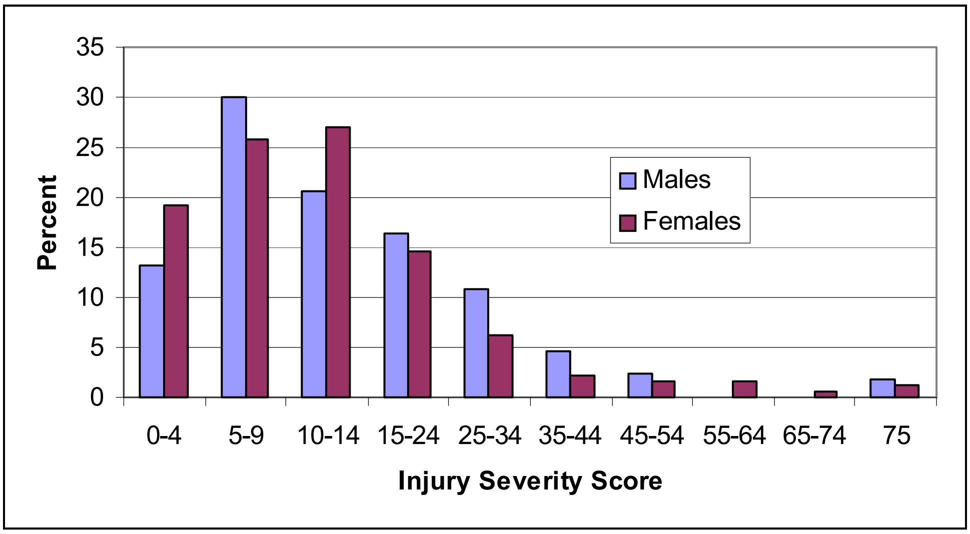

Figure 14. ISS distribution by gender.

Table 29. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and gender.

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
No codeable injury (0)	1	0.5	1	0.6	2	0.5
Minor (1)	24	11.3	29	16.3	53	13.6
Moderate (2)	64	30.0	52	29.2	116	29.7
Serious (3)	69	32.4	63	35.4	132	33.8
Severe (4)	38	17.8	17	9.6	55	14.1
Critical (5)	12	5.6	14	7.9	26	6.6
Maximum (6)	4	1.9	2	1.1	6	1.5
Uncodeable (9)	1	0.5	Nil	Nil	1	0.3
Total	213	100	178	100	391	100

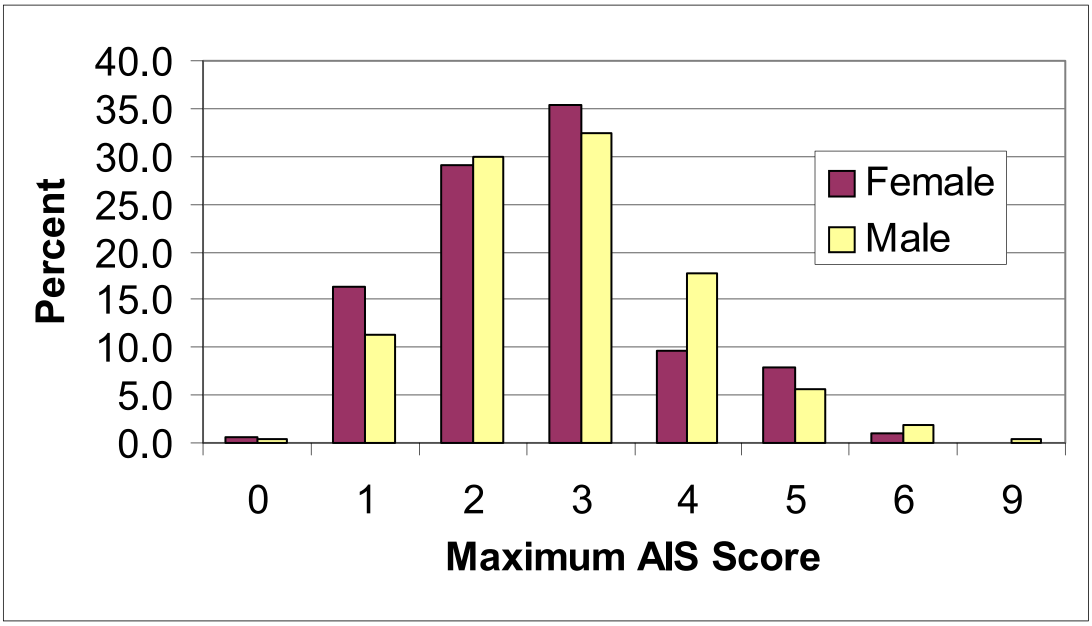

Figure 15. MAIS distribution by gender.

In the following table, and the remainder of this document, injury severities are frequently grouped into 'All AIS' and 'AIS3+', the latter being used to represent the more severe injuries.

Table 30. Distribution of occupants by AIS body region and injury severity.

AIS Body Region	All AIS		AIS3+	
	Number of cases	% of all cases	Number of cases	% of all cases
Head	153	39.0	63	16.1
Face	197	50.3	7	1.8
Neck	53	13.5	7	1.8
Chest	260	66.3	112	28.6
Abdomen / Pelvis	158	40.3	37	9.4
Spine	85	21.7	23	5.9
Upper Extremity	265	67.6	35	8.9
Lower Extremity	274	69.9	72	18.4
External	7	1.8	Nil	Nil

4.2 Frontal Impacts

Frontal crash victims comprised just under half the ANCIS sample (47%), with typical frontal crash injuries to belted occupants being to the chest and lower limbs. Unbelted occupants often receive head and facial injuries, as well as more severe injures to the chest and lower extremities.

4.2.1 Basic Crash and Case Information

Table 31. Occupant distribution by seating position, frontal impacts.

Position	Freq.	%
Driver	135	73.8
Front Left Passenger	31	16.9
Front Centre	2	1.1
Rear Left	6	3.3
Rear Centre	2	1.1
Rear Right	6	3.3
Other	1	0.5
Total	183	100

4.2.2 Crash Characteristics and Vehicle Information

Table 32. Occupant distribution by the primary collision partner of the vehicle in which they were travelling, frontal impacts

Collision Partner	Freq.	%
Car or ute	38	20.8
Tree	35	19.1
Other / Unknown Vehicle	32	17.5
Van / Truck / Bus	25	13.7
Pole or Post	16	8.7
4WD / MPV	15	8.2
Embankment / Ditch / Culvert	6	3.3
Concrete Barrier / Wall	5	2.7
Other or Unknown Object	4	2.2
Roadside Furniture	3	1.6
Other Vehicle	2	1.1
Rollover	1	0.5
Animal	1	0.5
Total	183	100

Table 33. Airbag fitment and deployment by occupant position, frontal impacts.

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	67	49.6	102	75.6
	Fitted and deployed	64	47.4	Nil	Nil
	Fitted and not deployed	4	3.0	4	3.0
	Unknown	Nil	Nil	29	21.5
	Total	135	100	135	100
FLP	Not fitted	24	77.4	19	61.3
	Fitted and deployed	6	19.4	Nil	Nil
	Fitted and not deployed	1	3.2	Nil	Nil
	Unknown	Nil	Nil	12	38.7
	Total	31	100	31	100

Table 34. Crash severity, summary statistics, frontal impacts.

Severity statistic	Delta-V (km/h)	EBS (km/h)
Mean	51.1	48.2
Median	50.0	46.0
Minimum	20.4	7.9
Maximum	117.0	127.0
Number of cases	84	144
Missing / Unknown	84	24

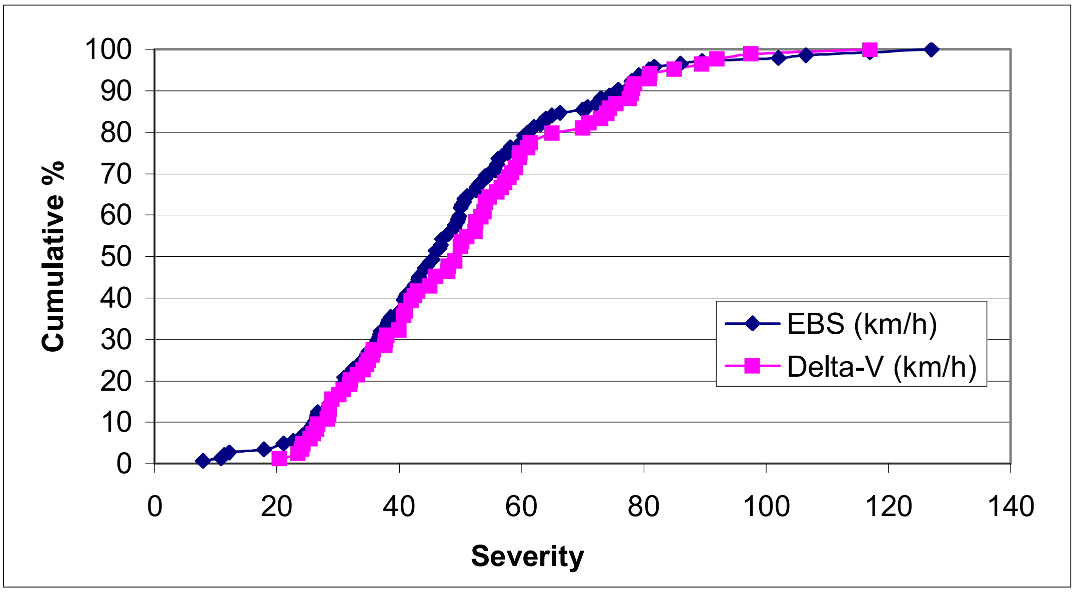

Figure 16. Delta-V and EBS Cumulative distribution for frontal impacts (N=84 and N=144 respectively).

Table 35. Occupant distribution by primary frontal impact location of the vehicle in which each occupant was travelling.

Impact Location	Freq.	%
Left	14	8.3
Left and Centre	21	12.5
Centre	9	5.4
Right and Centre	26	15.5
Right	27	16.1
Distributed	71	42.3
Total	168	100

As might be expected in a country where oncoming vehicles generally come from the right side of the road, impacts to the 'Right' and 'Right and Centre' of the vehicle made up 32% of frontal impacts in contrast to 21% to the 'Left' and 'Left and Centre'.

Table 36. Occupant distribution by Principal Direction of Force of the primary collision of the vehicle in which each occupant was travelling, frontal impacts.

PDOF	Freq.	%
10	6	3.6
11	22	13.1
12	95	56.5
01	39	23.2
02	6	3.6
Total	168	100

PDOF is based on clockface directions, with 12 o'clock representing the crash force from the front, 3 o'clock from the right side and 9 o'clock from the left side.

The Principal Direction of Force (PDOF) for frontal impacts was biased toward direct head-on crashes, with more than half being assigned 12 o'clock by the vehicle inspectors.

Table 37. Occupant distribution by vehicle type, frontal impacts.

Vehicle Type	Number of Vehicles		Number of Cases	
	Freq.	%	Freq.	%
Sedan	102	60.7	112	61.2
Hatchback	30	17.9	30	16.4
Station Wagon	22	13.1	26	14.2
Utility	8	4.8	8	4.4
Offroad	3	1.8	4	2.2
Sports / Convertible	2	1.2	2	1.1
MPV	1	0.6	1	0.5
Total	168	100	183	100

4.2.3 Frontal Impact Injury Outcomes

Table 38. Occupant Injury Severity Score, summary statistics, frontal impacts.

ISS Profile	Male	Female	Total
Mean	13.2	11.7	12.4
Median	10	9	9
Minimum	1	1	0
Maximum	75	75	75
Number of cases	91	91	183
Missing / Unknown	Nil	Nil	Nil

Case 104-1AVC (sex unknown) died of multiple uncodeable injuries

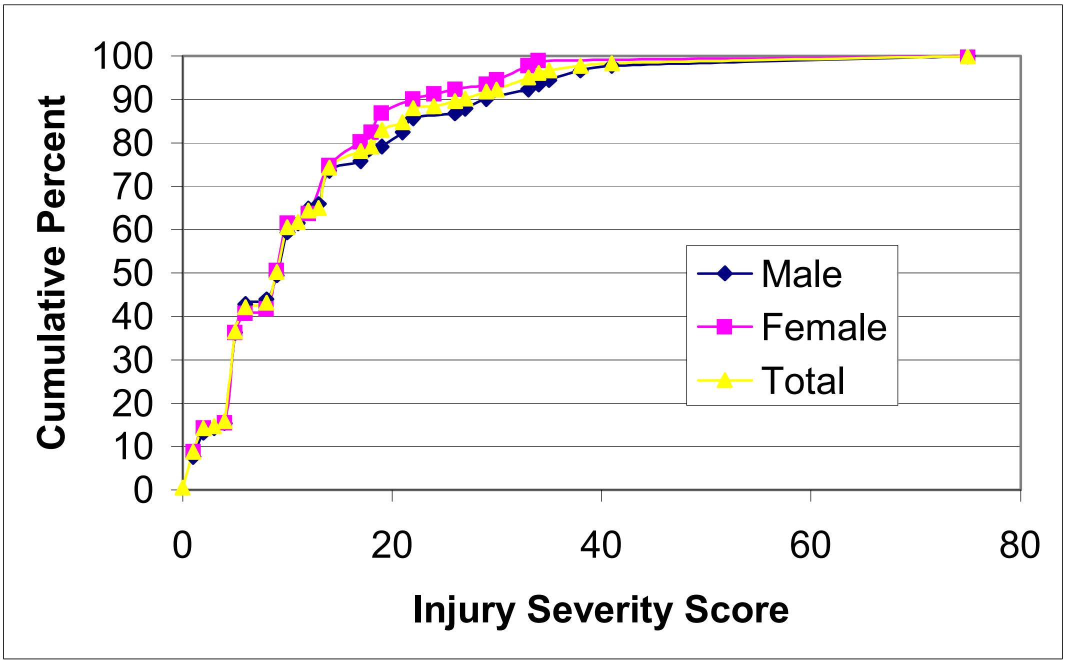

Figure 17. Cumulative ISS distribution for males and female cases in which the primary impact was a frontal impact (N=183).

Table 39. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and gender, frontal impacts

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
No codeable injury (0)	Nil	Nil	Nil	Nil	Nil	Nil
Minor (1)	12	13.2	13	14.3	25	13.7
Moderate (2)	36	39.6	34	37.4	70	38.5
Serious (3)	28	30.8	33	36.3	61	33.5
Severe (4)	9	9.9	6	6.6	15	8.2
Critical (5)	4	4.4	4	4.4	8	4.4
Maximum (6)	2	2.2	1	1.1	3	1.6
Total	91	100	91	100	182	100

Table 40. Distribution of occupants by AIS body region and injury severity, frontal impacts.

AIS Body Region	All AIS		AIS3+	
	Number of cases	% of frontal cases	Number of cases	% of frontal cases
Head	49	26.8	15	8.2
Face	97	53.0	3	1.6
Neck	29	15.8	3	1.6
Chest	132	72.1	41	22.4
Abdomen / Pelvis	85	46.4	18	9.8
Spine	38	20.8	6	3.3
Upper Extremity	126	68.9	17	9.3
Lower Extremity	137	74.9	30	16.4
External	Nil	Nil	2	1.1

Table 41. Occupant distribution by injury contact point, AIS 1+ and AIS 3+ injuries, frontal impacts (N=183). Sorted by AIS3+ incidence.

Injury Contact Source	All AIS		AIS3+	
	Number of persons	Percentage	Number of persons	Percentage
Seat belt	129	70.4	27	14.8
Instrument panel	105	17.3	25	13.7
Steering assembly	67	36.6	23	12.6
Floor & toe pan	62	33.9	11	6.0
Other Non-Contact Source	33	18.0	6	3.3
Windscreen / Header rail	20	10.9	5	2.7
Seats & head rest	20	10.9	4	2.2
Exterior of other vehicle	4	2.2	4	2.2
Door panel	34	18.6	3	1.6
Roof surface	4	2.2	3	1.6
Airbag (+cover + gases)	31	16.9	2	1.1
Window + frame	7	3.8	1	0.5
Other occupant	5	2.7	1	0.5
Other vehicle or exterior object	2	1.1	1	0.5
A-pillar	1	0.5	1	0.5
Child Seat / Restraint	1	0.5	1	0.5
Flying Glass	17	9.3	Nil	Nil
B-pillar	3	1.6	Nil	Nil
Roof Side Rail	1	0.5	Nil	Nil
Rear Screen	1	0.5	Nil	Nil
Other + Unknown	61	33.3	6	3.3

While the primary contact source assigned in frontal impacts was the seatbelt, it should be noted that the seatbelt is preventing far worse injuries than would have been sustained had the occupants been unbelted.

4.3 Side Impacts – Struck Side

Struck side impacts involve the occupant being subjected to a side impact to their side of the vehicle. For example, a struck side impact to a driver (in Australia) is to the right-hand side. Struck, or near, side impacts currently constitute just over one-fifth of crashes (22%) in the ANCIS database, slightly fewer than in the previous analysis (28%).

4.3.1 Basic Struck Side Crash and Case Information

Table 42. Occupant distribution by seating position, struck side impacts

Position	Freq.	%
Driver	72	77.4
Front Left Passenger	17	18.3
Rear Left	2	2.2
Back Left	2	2.2
Total	93	100.0

Table 43. Occupant distribution by seating position and belt use, struck side impacts.

Position	No Evidence of Belt Use		Belted - Used or Claimed		Unknown		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Driver	1	1.4	71	98.6	0	0.0	72	100.0
Front Left	2	11.8	15	88.2	0	0.0	17	100.0
Rear Left	1	50.0	1	50.0	0	0.0	2	100.0
Back Left	0	0.0	1	50.0	1	50.0	2	100.0
Total	4	4.3	88	94.6	1	1.1	93	100

There was no evidence of seat belt use for only one driver involved in a struck side impact. While evidence of belt use is relatively easily obtainable in frontal crashes due to direct loading, side impact forces rarely impose significant loads on the belt system and therefore evidence of use is more difficult to obtain.

4.3.2 Struck side crash characteristics and vehicle information

Table 44. Occupant distribution by the primary collision partner of the vehicle in which they were travelling, struck side impacts.

Collision Partner	Freq.	%
Car or ute	27	29.0
Tree	20	21.5
Pole or Post	19	20.4
Van / Truck / Bus	9	9.7
Unknown Vehicle	8	8.6
4WD / MPV	5	5.4
Other Vehicle	3	3.2
Rollover	1	1.1
Embankment / Ditch / Culvert	1	1.1
Total	93	100

Struck side impacts with narrow objects made up 42% of this impact type.

Table 45. Airbag fitment and deployment by occupant position, struck side impacts.

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	23	31.9	46	63.9
	Fitted and deployed	21	29.2	3	4.2
	Fitted and not deployed	28	38.9	Nil	Nil
	Unknown	Nil	Nil	23	31.9
	Total	72	100	72	100
FLP	Not fitted	14	82.4	13	76.5
	Fitted and deployed	1	5.9	2	11.8
	Fitted and not deployed	2	11.8	Nil	Nil
	Unknown	Nil	Nil	2	11.8
	Total	17	100	17	100

Table 45 shows that side airbag fitment is still relatively rare, with only five injured struck side occupants in the database having a side-mounted airbag in their seating position. However, all side airbags present deployed during the crash. The incidence of frontal airbag deployments (22 out of 52 fitted) indicates that there is a significant longitudinal component in many struck side impacts.

Table 46. Crash severity, summary statistics, struck side impacts.

Severity statistic	Delta-V (km/h)	EBS (km/h)
Mean	34.0	32.5
Median	33.1	30.0
Minimum	14.2	9.9
Maximum	72.0	84.0
Number of cases	52	85
Missing / Unknown	41	8

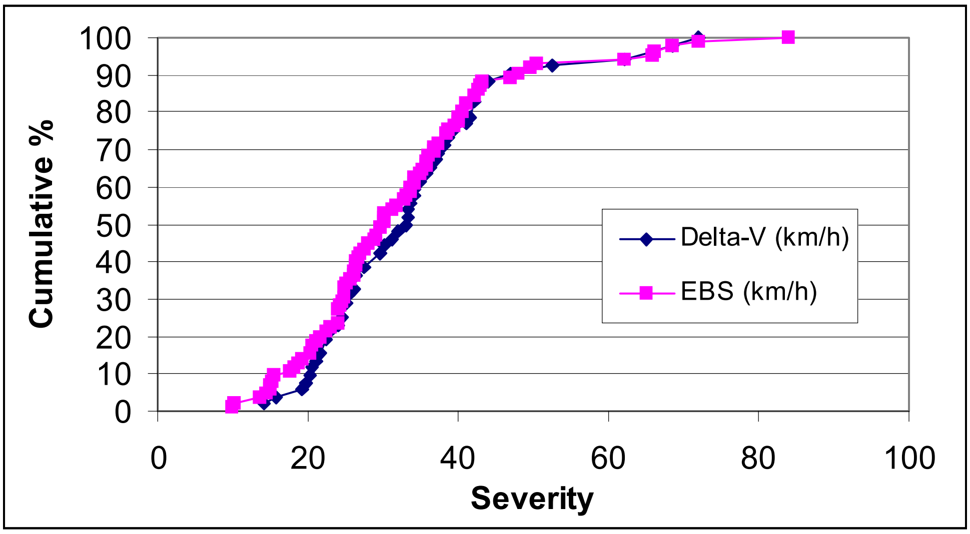

Figure 18. Delta-V and EBS Cumulative distribution for struck side impacts (N=52 and N=85 respectively)

Table 47. Occupant distribution by longitudinal impact location, struck side impacts.

Longitudinal Impact Location	Freq.	%
Side Front	4	4.3
Side Front and Centre	27	29.0
Side Centre	45	48.4
Side Rear and Centre	10	10.8
Side Rear	1	1.1
Distributed	5	5.4
Multiple	1	1.1
Total	93	100

As would be expected in an injured sample, the vast majority (94%) of side impacts involve the passenger compartment (locations involving Centre or Distributed in Table 47).

Table 48. Occupant distribution by Principal Direction of Force of the primary collision of the vehicle in which each occupant was travelling, struck side impacts.

Direction of Force	Freq.	%
01 or 11	7	7.5
02 or 10	33	35.5
03 or 09	38	40.9
04 or 08	9	9.7
05 or 07	5	5.4
Multiple (02 & 03)	1	1.1
Total	93	100

Table 49. Occupant distribution by vehicle type, struck side impacts.

Vehicle Type	Number of Vehicles		Number of Cases	
	Freq.	%	Freq.	%
Sedan	59	66	61	65.6
Hatchback	18	20	18	19.4
Station Wagon	8	9	9	9.7
Utility	3	3.3	3	3.2
Sports / Convertible	1	1	1	1.1
Offroad	1	1.1	1	1.1
Total	90	100	93	100

4.3.3 Struck side Injury Outcomes

Table 50. Occupant Injury Severity Score, summary statistics, struck side impacts.

ISS Profile	Male	Female	Total
Mean	18.3	15.9	17.2
Median	11	11	11
Minimum	0	1	0
Maximum	75	75	75
Number of cases	52	41	93
Missing / Unknown	0	0	0

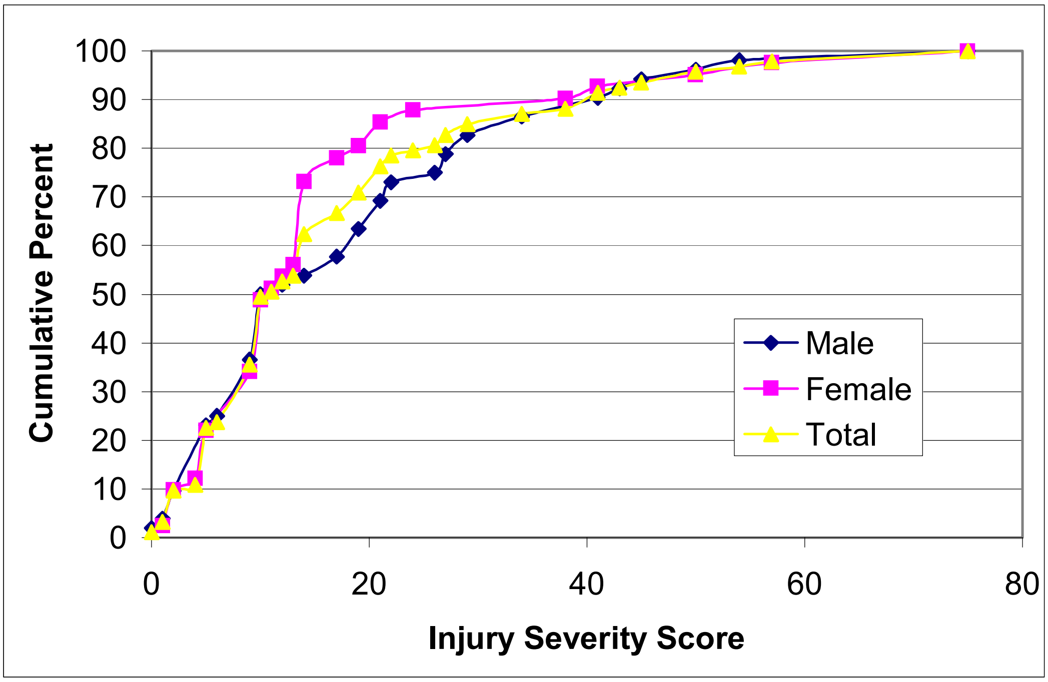

Figure 19. Cumulative ISS distribution for males and female cases in which the primary impact was a struck side impact (N=93).

Table 51. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and gender, struck side impacts.

MAIS	Male		Female		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
No codeable injury (0)	1	1.9	Nil	Nil	1	1.1
Minor (1)	4	7.7	4	9.8	8	8.6
Moderate (2)	12	23.1	11	26.8	23	24.7
Serious (3)	18	34.6	17	41.5	35	37.6
Severe (4)	10	19.2	5	12.2	15	16.1
Critical (5)	5	9.6	3	7.3	8	8.6
Maximum (6)	1	1.9	1	2.4	2	2.2
Uncodeable (9)	1	1.9	Nil	Nil	1	1.1
Total	52	100	41	100	93	100

Table 52. Distribution of occupants by AIS body region and injury severity, struck side impacts. (N=93)

AIS Body Region	All AIS		AIS3+	
	Number	**%**	**Number**	**%**
Head	44	47.3	18	19.4
Face	38	40.9	4	4.3
Neck	5	5.4	Nil	Nil
Chest	61	65.6	35	37.6
Abdomen / Pelvis	33	35.5	12	12.9
Spine	17	18.3	4	4.3
Upper Extremity	55	59.1	6	6.5
Lower Extremity	65	69.9	25	26.9
External	4	4.3	Nil	Nil

Table 53. Occupant distribution by injury contact point, AIS 1+ and AIS 3+ injuries, struck side impacts (N=93). Sorted by AIS3+ incidence.

Injury Contact Source	All AIS		AIS3+	
	Number of persons	Percentage	Number of persons	Percentage
Door panel	66	71.0	37	39.8
B-pillar	24	25.8	9	9.7
Instrument panel	22	23.7	7	7.5
Other vehicle or exterior object	10	10.8	6	6.5
Steering assembly	9	9.6	6	6.5
Seat Belt	18	19.4	4	4.3
Exterior of other vehicle	5	5.4	3	3.2
Window + frame	21	22.6	2	2.2
Floor & toe pan	17	18.3	2	2.2
Airbag (+cover + gases)	6	6.5	2	2.2
Roof surface	5	5.4	2	2.2
Roof Side Rail	4	4.3	2	2.2
Other occupant	3	3.2	2	2.2
Other Non-Contact Source	9	9.7	1	1.1
Windscreen / Header rail	4	4.3	1	1.1
A-pillar	4	4.3	1	1.1
Seats and Head Rest	2	2.2	1	1.1
Flying Glass	15	16.1	Nil	Nil
Fire in vehicle	2	2.2	Nil	Nil
Other + Unknown	22	23.7	1	1.1

4.4 Side Impacts – Non-Struck Side

Conversely to struck side impacts, non-struck side (also known as 'far side') impacts are known to be problematic, as modern vehicle belt systems are not designed to restrain the occupant in such impacts. The ANCIS database currently only comprises 5% non-struck side occupants.

4.4.1 Basic Non-Struck Side Crash and Case Information

Table 54. Occupant distribution by seating position, non struck side impacts.

Position	Freq.	%
Driver	20	64.5
Front Left Passenger	7	22.6
Rear Left	2	6.5
Rear Centre	2	6.5
Total	31	100.0

Table 55. Occupant distribution by seating position and belt use, non struck side impacts.

Position	No Evidence of Belt Use		Belted - Used or Claimed		Unknown		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Driver	Nil	Nil	20	100	Nil	Nil	20	100
Front Left	Nil	Nil	6	85.7	1	14.3	7	100
Rear Left	1	50	1	50	Nil	Nil	2	100
Rear Centre	Nil	Nil	2	100	Nil	Nil	2	100
Total	1	3.2	29	93.5	1	3.2	31	100

4.4.2 Non-Struck Side Crash Characteristics and Vehicle Information

Table 56. Occupant distribution by the primary collision partner of the vehicle in which they were travelling, non struck side impacts.

Collision Partner	Freq.	%
Car or Ute	11	35.5
Tree	9	29.0
Pole or Post	4	12.9
Unknown Vehicle	3	9.7
Concrete Barrier / Wall	1	3.2
Other/Unknown Object	1	3.2
4WD / MPV	1	3.2
Van/Truck/Bus	1	3.2
Total	31	100

Table 57. Airbag fitment and deployment by occupant position, non struck side impacts.

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	8	40	11	55
	Fitted and deployed	7	35	Nil	Nil
	Fitted and not deployed	5	25	2	10
	Unknown	Nil	Nil	7	35
	Total	20	100	20	100
FLP	Not fitted	4	57.1	3	42.9
	Fitted and deployed	1	14.3	Nil	Nil
	Fitted and not deployed	1	14.3	1	14.3
	Unknown	1	14.3	3	42.9
	Total	7	100	7	100

Table 58. Crash severity, summary statistics, non struck side impacts.

Severity statistic	Delta-V (km/h)	EBS (km/h)
Mean	37.7	40.9
Median	32.0	39.3
Minimum	6.4	6.4
Maximum	71.0	84.0
Number of cases	16	26
Missing / Unknown	14	4

One outlier crash, with a delta-V/EBS of 124.7 km/h, was not been included in this table, as it was biasing the results upwards.

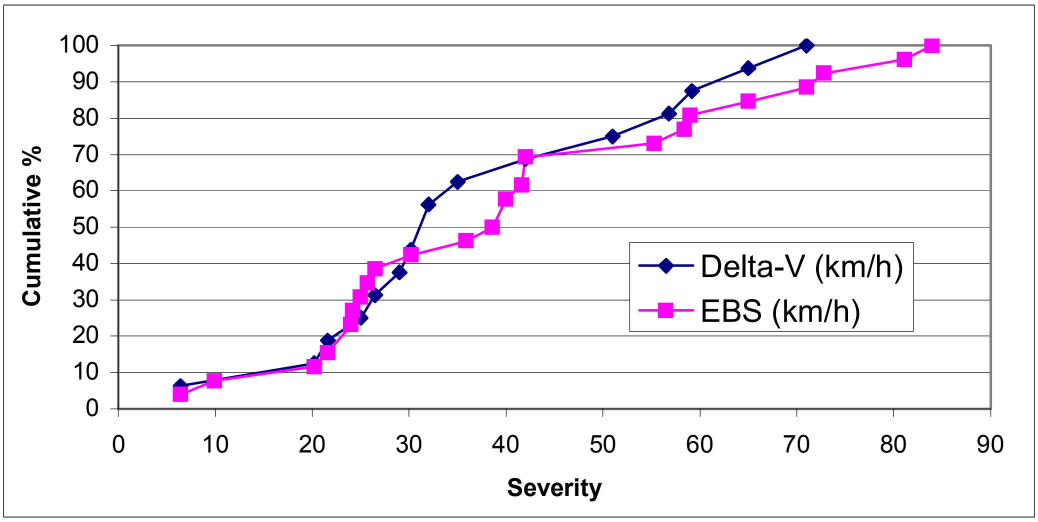

Figure 20. Delta-V and EBS Cumulative distribution for non-struck side impacts (N=16 and N=26 respectively)

Table 59. Occupant distribution by longitudinal impact location, non struck side impacts.

Longitudinal Impact Location	Freq.	%
Side Front	3	9.7
Side Front and Passenger	10	32.3
Side Passenger	11	35.5
Side Rear and Passenger	5	16.1
Side Rear	1	3.2
Distributed	1	3.2
Total	31	100

Table 60. Occupant distribution by Principal Direction of Force of the primary collision of the vehicle in which each occupant was travelling, non-struck side impacts.

Direction of Force	Freq.	%
03 or 09	15	48.4
02 or 10	7	22.6
04 or 08	4	12.9
01 or 11	4	12.9
05 or 07	1	3.2
Total	31	100

Table 61. Occupant distribution by vehicle type, non struck side impacts.

Vehicle Type	Number of Vehicles		Number of Cases	
	Freq.	%	Freq.	%
Sedan	19	76	23	74.2
Hatchback	2	8	3	9.7
Station Wagon	2	8	3	9.7
Sports / Convertible	2	8	2	6.5
Total	25	100	31	100

4.4.3 Non-Struck Side Case Injury Outcomes

Table 62. Occupant Injury Severity Score, summary statistics, non struck side impacts.

ISS Profile	Male	Female	Total
Mean	17.5	17.3	17.4
Median	9	5.5	9
Minimum	1	0	0
Maximum	75	66	75
Number of cases	19	12	31
Missing / Unknown	Nil	Nil	Nil

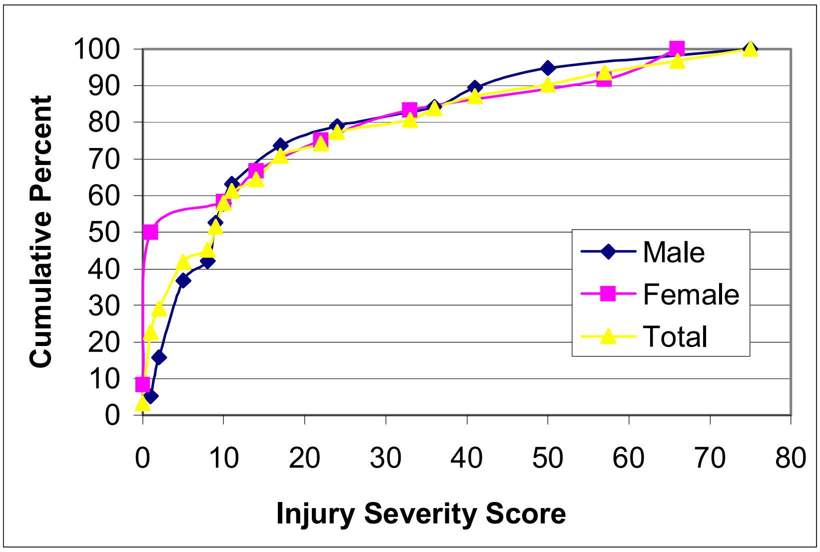

Figure 21. Cumulative ISS distribution for males and female cases in which the primary impact was a non-struck side impact (N=31)

Table 63. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and gender, non struck side impacts.

MAIS	Male		Female		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
No codeable injury (0)	Nil	Nil	1	8.3	1	3.2
Minor (1)	3	15.8	4	33.3	7	22.6
Moderate (2)	6	31.6	1	8.3	7	22.6
Serious (3)	3	15.8	3	25	6	19.4
Severe (4)	5	26.3	1	8.3	6	19.4
Critical (5)	1	5.3	2	16.7	3	9.7
Maximum (6)	1	5.3	Nil	Nil	1	3.2
Total	19	100	12	100	31	100

Table 64. Distribution of occupants by AIS body region and injury severity, non struck side impacts. (N=31)

AIS Body Region	All AIS		AIS3+	
	Number of cases	% of non-struck side cases	Number of cases	% of non-struck side cases
Head	16	51.6	10	32.3
Face	14	45.2	Nil	Nil
Neck	3	9.7	1	3.2
Chest	18	58.1	9	29.0
Abdomen / Pelvis	11	35.5	4	12.9
Spine	10	32.3	3	9.7
Upper Extremity	18	58.1	1	3.2
Lower Extremity	20	64.5	3	9.7
External	Nil	Nil	Nil	Nil

Despite the small number of cases collected to date, it is worth noting that AIS3+ head injuries were sustained by 32% of occupants in non-struck side impacts, compared with 19% of struck side crash victims.

Table 65. Occupant distribution by injury contact point, AIS 1+ and AIS 3+ injuries, non struck side impacts (N=31). Sorted by AIS3+ incidence.

Injury Contact Source	All AIS		AIS3+	
	Number of persons	%	Number of persons	%
B-pillar	7	22.6	5	16.1
Other Non-Contact Source	8	25.8	3	9.7
Seats and head rest	6	19.4	3	9.7
Steering assembly	5	16.1	2	6.5
Console	2	6.5	2	6.5
Seat Belt	16	51.6	1	3.2
Instrument panel	8	25.8	1	3.2
Door panel	6	19.4	1	3.2
Floor & toe pan	5	16.1	1	3.2
Other occupant	3	9.7	1	3.2
Roof side rail	2	6.5	1	3.2
Roof surface	2	6.5	1	3.2
Other vehicle or exterior object	1	3.2	1	3.2
Window + frame	1	3.2	1	3.2
Airbag (+cover + gases)	5	16.1	Nil	Nil
Flying glass	4	12.9	Nil	Nil
Windscreen / Header Rail	1	3.2	Nil	Nil
Other + Unknown	16	51.6	3	9.7

4.5 Rear Impacts

The ANCIS database consists of relatively few rear impacts, with less than 4% of injured participants being admitted for this crash type.

4.5.1 Basic Rear Impact Crash and Case Information

Table 66. Occupant distribution by seating position, rear impacts.

Position	Freq.	%
Driver	10	71.4
Front Left Passenger	2	14.3
Rear Left	1	7.1
Rear Centre	1	7.1
Total	14	100

Table 67. Occupant distribution by seating position and belt use, rear impacts.

Position	No Evidence of Belt Use		Belted Used or Claimed		Total	
	Freq.	%	Freq.	%	Freq.	%
Driver	Nil	Nil	10	100	10	100
Front Left	Nil	Nil	2	100	2	100
Rear Left	Nil	Nil	1	100	1	100
Rear Centre	Nil	Nil	1	100	1	100
Total	Nil	Nil	14	100	14	100

4.5.2 Crash Characteristics and Vehicle Information

Table 68. Occupant distribution by the primary collision partner of the vehicle in which they were travelling, rear impacts.

Collision Partner	Freq.	%
Car or Ute	5	35.7
Van / Truck / Bus	3	21.4
Other / Unknown Vehicle	3	21.4
Tree	2	14.3
Pole or Post	1	7.1
Total	14	100

Table 69. Airbag fitment and deployment by occupant position, rear impacts.

Occupant Position	Airbag status	Forward Airbag (front)		Side Airbag	
		Freq.	%	Freq.	%
Driver	Not fitted	6	60	10	100
	Fitted and deployed	1	10	Nil	Nil
	Fitted and not deployed	3	30	Nil	Nil
	Total	10	100	10	100
FLP	Not fitted	1	50	2	100
	Fitted and deployed	Nil	Nil	Nil	Nil
	Fitted and not deployed	1	50	Nil	Nil
	Total	2	100	2	100

Table 70. Crash severity, summary statistics, rear impacts.

Severity statistic	Delta-V (km/h)	EBS (km/h)
Mean	39.8	51.8
Median	40.1	56.0
Minimum	27.8	16.7
Maximum	51.3	112.0
Number of cases	4	11
Missing / Unknown	10	3

Table 71. Occupant distribution by lateral impact location, rear impacts.

Lateral Impact Location	Freq.	%
Distributed	8	57.1
Right	4	28.6
Left and Centre	1	7.1
Right and Centre	1	7.1
Total	14	100

Table 72. Occupant distribution by Principal Direction of Force of the primary collision of the vehicle in which each occupant was travelling, rear impacts.

Direction of Force	Freq.	%
05	5	35.7
06	7	50
07	2	14.3
Total	14	100

Table 73. Occupant distribution by vehicle type, rear impacts.

Vehicle Type	Number of Vehicles		Number of Cases	
	Freq.	%	Freq.	%
Sedan	6	46.1	7	50
Station Wagon	4	30.8	4	28.6
Sports / Convertible	2	15.4	2	14.3
Hatchback	1	7.7	1	7.1
Total	13	100	14	100

The number of vehicles involved in rear impacts was equal to the number of occupants involved.

4.5.3 Rear Impact Injury Case Outcomes

Table 74. Occupant Injury Severity Score, summary statistics, rear impacts.

ISS Profile	Male	Female	Total
Mean	14.9	7.0	10.9
Median	14	5	10.5
Minimum	2	1	1
Maximum	27	17	27
Number of cases	7	7	14
Missing / Unknown	Nil	Nil	Nil

Mean ISS was quite low for rear impacts, compared with the other impact types.

Table 75. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and gender, rear impacts.

MAIS	Male		Female		Total	
	Freq.	%	Freq.	%	Freq.	%
No codeable injury (0)	Nil	Nil	Nil	Nil	Nil	Nil
Minor (1)	2	28.6	2	28.6	4	28.6
Moderate (2)	Nil	Nil	2	28.6	2	14.3
Serious (3)	4	57.1	2	28.6	6	42.9
Severe (4)	1	14.3	1	14.3	2	14.3
Critical (5)	Nil	Nil	Nil	Nil	Nil	Nil
Maximum (6)	Nil	Nil	Nil	Nil	Nil	Nil
Total	7	100	7	100	14	100

Table 76. Distribution of occupants by AIS body region and injury severity, rear impacts. (N=14)

AIS Body Region	All AIS		AIS3+	
	Number of cases	% of rear impact cases	Number of cases	% of rear impact cases
Head	5	35.7	2	14.3
Face	5	35.7	Nil	Nil
Neck	4	28.6	2	14.3
Chest	8	57.1	5	35.7
Abdomen / Pelvis	3	21.4	1	7.1
Spine	4	28.6	1	7.1
Upper Extremity	8	57.1	1	7.1
Lower Extremity	5	35.7	Nil	Nil
External	Nil	Nil	Nil	Nil

Table 77. Occupant distribution by injury contact point, AIS 1+ and AIS 3+ injuries, rear impacts (N=14). Sorted by AIS3+ incidence.

Injury Contact Source	All AIS		AIS3+	
	Number of persons	Percentage	Number of persons	Percentage
Seat Belt	9	64.3	3	21.4
Other Non-Contact Source	7	50	2	14.3
Seats and head rest	4	28.6	1	7.1
Door Panel	3	21.4	1	7.1
Other vehicle or exterior object	1	7.1	1	7.1
Roof Surface	1	7.1	1	7.1
Exterior of Other Vehicle	1	7.1	1	7.1
Steering assembly	1	7.1	Nil	Nil
Flying Glass	1	7.1	Nil	Nil
Airbag (+cover + gases)	1	7.1	Nil	Nil
Other + Unknown	4	28.6	Nil	Nil

4.6 Multiple Impacts (Including Rollover)

This report is the first ANCIS report to consider multiple impacts as a separate category. Rollover events have also been incorporated, as rollover frequently occurs in conjunction with either a pre- or post-rollover linear impact. Refer to Table 18 and surrounding text for a full description of the method by which impacts have been categorised in this report. The goal of this analysis is to understand how multiple and rollover impacts differ from single impacts in terms of the injury outcomes of the occupants, the contact sources for injuries and the damage sustained by the vehicle. In many tables in this section, single impact statistics are presented for comparison. For more in-depth information, refer to Logan, Scully and Fildes (2004).

4.6.1 Basic Crash and Case Information

Table 78. Occupant distribution by seating position, multiple impact crashes.

Position	Single		Multiple		Rollover with other impact		Rollover, no other impact		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Driver	239	74.0	16	66.7	29	78.4	6	75	290	74
Front left	57	17.6	7	29.2	8	21.6	1	12.5	73	18.6
Front centre	2	0.6	Nil	Nil	Nil	Nil	Nil	Nil	2	0.5
Rear left	11	3.4	1	4.2	Nil	Nil	1	12.5	13	3.3
Rear centre	5	1.5	Nil	Nil	Nil	Nil	Nil	Nil	5	1.3
Rear right	6	1.9	Nil	Nil	Nil	Nil	Nil	Nil	6	1.5
Back left	2	0.6	Nil	Nil	Nil	Nil	Nil	Nil	2	0.5
Other	1	0.3	Nil	Nil	Nil	Nil	Nil	Nil	1	0.3
Total	323	100	24	100	37	100	8	100	392	100

4.6.2 Crash Characteristics and Vehicle Information

Table 79. Occupant distribution by crash type and belt use, multiple impact crashes.

Type of crash	No Evidence of Belt Use		Belted - Used or Claimed		Unknown		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Single	13	4.0	305	94.4	5	1.5	323	100
Rollover with other impact	Nil	Nil	37	100	Nil	Nil	37	100
Multiple	1	4.2	23	95.8	Nil	Nil	24	100
Rollover no other impact	2	25.0	6	75.0	Nil	Nil	8	100
Total	16	4.1	371	94.6	5	1.3	392	100

The 24 cases involved in multiple non-rollover impacts were occupants of 21 separate vehicles. Table 80 shows the distribution of impact partners for the 21 different case vehicles as well as the 24 different case occupants.

Table 80. Occupant (case) and vehicle distribution by collision partner sequence, multiple impact crashes with no rollover.

Multiple impact crash collision partner sequence, no rollover	# of Cases		# of Vehicles	
	Freq.	%	Freq.	%
Car → Pole/Post	3	12.5	2	9.5
Car → Car	2	8.3	2	9.5
Pole/Post → Barrier/wall/fence	2	8.3	2	9.5
4WD → Unknown Vehicle	2	8.3	1	4.8
Tram → Unknown Fixed Object	2	8.3	1	4.8
Animal → Unknown Vehicle → Barrier/wall/fence	1	4.2	1	4.8
Barrier/wall/fence → Pole/Post	1	4.2	1	4.8
Car → Barrier/wall/fence	1	4.2	1	4.8
Car → Ground/Ditch/Kerb/Embankment	1	4.2	1	4.8
Car → Unknown Fixed Object,	1	4.2	1	4.8
Pole/Post → Barrier/wall/fence → Pole/Post	1	4.2	1	4.8
Pole/Post → Tree → Tree	1	4.2	1	4.8
Tree → Tree	1	4.2	1	4.8
Truck → Truck	1	4.2	1	4.8
Truck → Van	1	4.2	1	4.8
Unknown Vehicle → Car	1	4.2	1	4.8
Unknown Vehicle → Tree	1	4.2	1	4.8
Unknown Vehicle → Tree → Unknown Vehicle	1	4.2	1	4.8
Total	24	100	21	100

All of the 37 cases in which a rollover occurred along with an impact with another object were occupants of different vehicles (that is there were 27 cases travelling in 27 different vehicles).

Table 81. Occupant (case) and vehicle distribution by collision partner sequence, multiple impact crashes with rollover.

Multiple impact crash collision partner sequence, rollover	**# of Cases/ Vehicles**	
	Freq.	**%**
Rollover → Tree	6	16.2
Tree → Rollover	5	13.5
Ground/Ditch/Kerb/Embankment → Rollover	4	10.8
Car → Rollover	3	8.1
Unknown Vehicle → Rollover	3	8.1
Pole/Post → Pole/Post → Rollover	2	5.4
4WD → Rollover	1	2.7
Ground/Ditch/Kerb/Embankment → Ground/Ditch/Kerb/Embankment → Ground/Ditch/Kerb/Embankment → Rollover	1	2.7
Ground/Ditch/Kerb/Embankment → Rollover → Pole/Post	1	2.7
Ground/Ditch/Kerb/Embankment → Rollover → Tree	1	2.7
Ground/Ditch/Kerb/Embankment → Tree → Tree → Rollover	1	2.7
Pole/Post → Ground/Ditch/Kerb/Embankment → Rollover	1	2.7
Rollover → Ground/Ditch/Kerb/Embankment	1	2.7
Rollover → Ground/Ditch/Kerb/Embankment → Tree	1	2.7
Rollover → Tree → Tree	1	2.7
Unknown Fixed Object → Rollover	1	2.7
Unknown Vehicle → Rollover → Ground/Ditch/Kerb/Embankment	1	2.7
Unknown Vehicle → Rollover → Pole/Post	1	2.7
Sequence unknown	2	5.4
Total	37	100

Table 82. Airbag fitment and deployment by crash configuration.

Crash Type	Airbag Status	Forward Airbag (Front)		Side Airbag	
		Freq.	%	Freq.	%
Single	Not fitted	176	54.4	235	72.8
	Fitted and activated	101	31.3	5	1.5
	Fitted and not activated	45	13.9	7	2.2
	Unknown	1	0.3	76	23.5
	Total	323	100	323	100
Multiple	Not fitted	16	66.7	21	87.5
	Fitted and activated	6	25.0	1	4.2
	Fitted and not activated	2	8.3	1	4.2
	Unknown	Nil	Nil	1	4.2
	Total	24	100	24	100
Rollover with other impact	Not fitted	27	73.0	36	97.3
	Fitted and activated	4	10.8	Nil	Nil
	Fitted and not activated	5	13.5	1	2.7
	Unknown	1	2.7	Nil	Nil
	Total	37	100	37	100
Rollover, no other impact	Not fitted	4	50	7	87.5
	Fitted and activated	1	12.5	Nil	Nil
	Fitted and not activated	3	37.5	Nil	Nil
	Unknown	Nil	Nil	1	12.5
	Total	8	100	8	100

In Table 83 below, summary statistics of crash severity (in terms of EBS and delta-V) are only given for single and multiple vehicle crash types. This is because delta-V and EBS could not be calculated for the majority of cases that involved a rollover.

Table 83. Crash severity, summary statistics, single and multiple impact crashes.

Crash Type		Delta-V (km/h)	EBS (km/h)
Single	Mean	44.7	43.1
	Median	40.85	40
	Minimum	6.4	6.4
	Maximum	124.7	127
	Number of cases	152	258
	Missing / Unknown	146	40
Multiple	Mean	38.8	36.7
	Median	38.5	35.6
	Minimum	18.2	7.1
	Maximum	60.6	64
	Number of cases	13	18
	Missing / Unknown	8	3

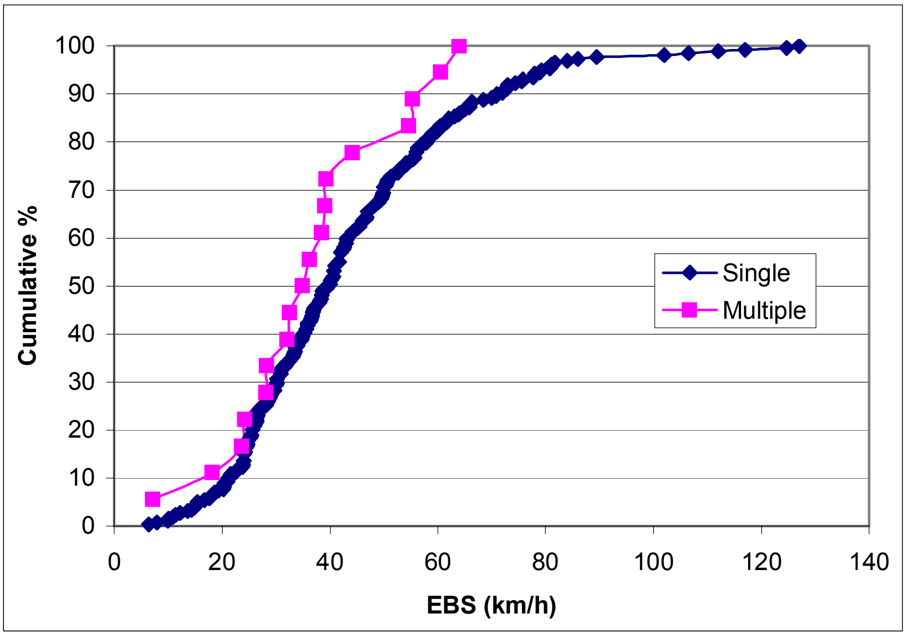

Figure 22. Cumulative percent of EBS for single and multiple impacts

Table 84. Occupant distribution by vehicle type, multiple impact crashes.

Vehicle Type	Single		Multiple		Rollover with other impact		Rollover, no other impact		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Sedan	186	62.4	13.0	61.9	18	48.6	2	33.3	219	60.5
Hatchback	52	17.4	6.0	28.6	6	16.2	Nil	Nil	64	17.7
Station Wagon	36	12.1	2.0	9.5	7	18.9	Nil	Nil	45	12.4
Utility	11	3.7	Nil	Nil	3	8.1	1	16.7	15	4.1
Offroad	5	1.7	Nil	Nil	1	2.7	3	50	9	2.5
Sports/ Convertible	7	2.3	Nil	Nil	1	2.7	Nil	Nil	8	2.2
MPV	1	0.3	Nil	Nil	1	2.7	Nil	Nil	2	0.6
Total	298	100	21	100	37	100	6	100	362	100

4.6.3 Rollover and Multiple Impact Injury Case Outcomes

Table 85. Occupant Injury Severity Score, summary statistics, by crash type.

ISS Profile	Single	Multiple		
		No rollover	Rollover, no other impact	Rollover with other impact(s)
Mean	14.2	15.8	14.6	17.6
Median	10	10	16.5	14
Minimum	0	1	2	1
Maximum	75	50	24	59
Number of cases	323	24	8	37
Missing / Unknown	Nil	Nil	Nil	Nil

There is a trend toward more severe injury outcomes in multiple compared with single impacts.

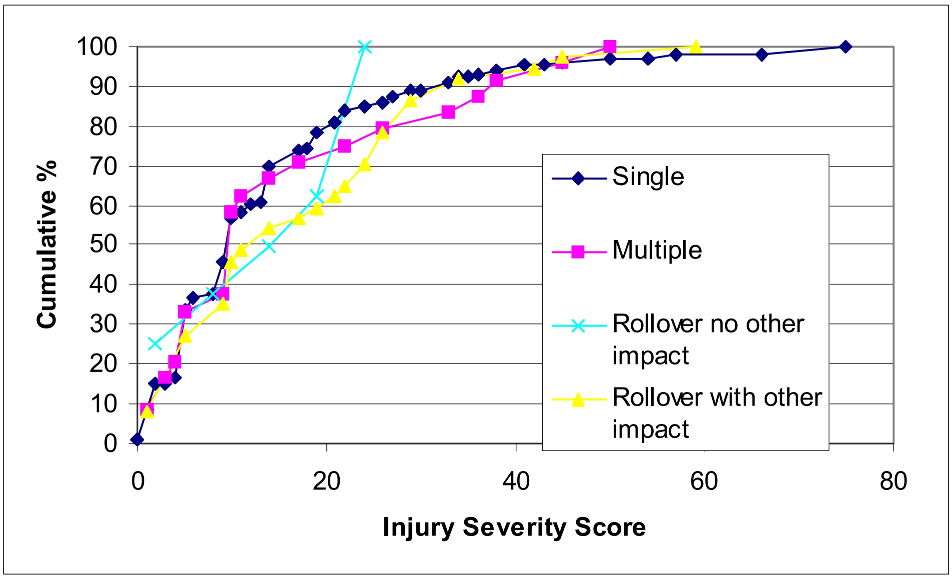

Figure 86. Cumulative ISS distribution for ANCIS cases by crash type

Table 87. Occupant injury severity by Maximum Abbreviated Injury Scale (MAIS) severity and crash type.

MAIS	Single		Multiple		Rollover with other impact		Rollover, no other impact		Total	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
No codeable Injury (0)	2	0.6	Nil	Nil	Nil	Nil	Nil	Nil	2	0.5
Minor (1)	44	13.7	4	16.7	3	8.1	2	25	53	13.6
Moderate (2)	103	32.0	4	16.7	8	21.6	1	12.5	116	29.7
Serious (3)	108	33.5	9	37.5	12	32.4	3	37.5	132	33.8
Severe (4)	39	12.1	4	16.7	10	27.0	2	25	55	14.1
Critical (5)	19	5.9	3	12.5	4	10.8	Nil	Nil	26	6.6
Maximum (6)	6	1.9	Nil	Nil	Nil	Nil	Nil	Nil	6	1.5
Uncodeable (9)	1	0.3	Nil	Nil	Nil	Nil	Nil	Nil	1	0.3
Total	322	100	24	100	37	100	8	100	391	100

Table 88. Distribution of occupants by AIS body region and injury severity and crash type. Numbers and percentages of occupants with AIS3+ injuries are in brackets

AIS Body Region	Single AIS1+ (AIS3+)		Multiple AIS1+ (AIS3+)		Rollover with other impact AIS1+ (AIS3+)		Rollover, no other impact AIS1+ (AIS3+)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Head	115 (46)	35.6 (14.2)	9 (5)	37.5 (20.8)	21 (9)	56.8 (24.3)	8 (3)	100 (37.5)
Face	155 (7)	48.0 (2.2)	9 (0)	37.5 (0)	27 (0)	73.0 (0)	6 (0)	75 (0)
Neck	41 (6)	12.7 (1.9)	4 (1)	16.7 (4.2)	5 (0)	13.5 (0)	3 (0)	37.5 (0)
Chest	220 (90)	68.1 (27.9)	12 (8)	50 (33.3)	23 (13)	62.2 (35.1)	5 (1)	62.5 (12.5)
Abdo/Pelvis	133 (35)	41.2 (10.8)	11 (1)	45.8 (4.2)	14 (1)	37.8 (2.7)	0 (0)	0 (0)
Spine	69 (14)	21.4 (4.3)	2 (2)	8.3 (8.3)	9 (6)	24.3 (16.2)	5 (1)	62.5 (12.5)
Upper Ext.	208 (25)	64.4 (7.7)	17 (4)	70.8 (16.7)	33 (5)	89.2 (13.5)	7 (1)	87.5 (12.5)
Lower Ext.	228 (58)	70.6 (18)	18 (5)	75 (20.8)	25 (8)	67.6 (21.6)	3 (1)	37.5 (12.5)
External	6 (0)	1.9 (0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (0)	12.5 (0)

The 323 occupants involved in single impact crashes suffered a total of 2,717 injuries, while the 24 occupants involved in multiple impact crashes suffered a total of 177 injuries. The 37 occupants involved in rollovers plus another type of impact suffered 427 injuries while the 8 occupants involved in rollover-only impacts suffered a total of 104 injuries. The percentages in brackets in the columns of Table 89 represent the percentage of occupants involved in a particular type of crash who received an injury due to contact with the particular contact sources. These percentages relate to all injuries as well as to AIS3+ injuries.

Table 89. Occupant distribution by injury contact point, AIS 1+ and AIS 3+ injuries and crash type. Sorted by overall AIS3+ injury incidence.

Injury Contact Source	Single		Multiple		Rollover + other impacts		Rollover no other impact	
	AIS1+ (AIS3+)		AIS1+ (AIS3+)		AIS1+ (AIS3+)		AIS1+ (AIS3+)	
	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Door panel	110 (42)	34.1 (13.0)	10 (7)	41.7 (29.2)	16 (4)	43.2 (10.8)	5 (2)	62.5 (25)
Seat Belt	173 (35)	53.6 (10.8)	9 (1)	37.5 (4.2)	19 (6)	51.4 (16.2)	2 (1)	25 (12.5)
Instrument panel	135 (33)	41.8 (10.2)	12 (3)	50 (12.5)	10 (1)	27.0 (2.7)	Nil	Nil
Steering assembly	82 (31)	25.4 (9.6)	7 (2)	29.2 (8.3)	12 (4)	32.4 (10.8)	1 (Nil)	12.5 (Nil)
Floor & toe pan	84 (14)	26.0 (4.3)	5 (1)	20.8 (4.2)	13 (6)	35.1 (16.2)	1 (Nil)	12.5 (Nil)
Other vehicle or exterior object	16 (10)	5.0 (3.1)	2 (Nil)	8.3 (Nil)	13 (10)	35.1 (27.0)	4 (Nil)	50 (Nil)
B-pillar	34 (14)	10.5 (4.3)	2 (1)	8.3 (4.2)	4 (2)	10.8 (5.4)	Nil	Nil
Other non-contact source	57 (12)	17.6 (3.7)	4 (2)	16.7 (8.3)	2 (1)	5.4 (2.7)	2 (Nil)	25 (Nil)
Roof Surface	12 (7)	3.7 (2.2)	1 (1)	4.2 (4.2)	9 (5)	24.3 (13.5)	5 (2)	62.5 (25)
Seats and head rest	32 (9)	9.9 (2.8)	3 (Nil)	12.5 (Nil)	5 (Nil)	13.5 (Nil)	Nil	Nil
Exterior of other vehicle	10 (8)	3.1 (2.5)	1 (1)	4.2 (4.2)	1 (Nil)	2.7 (Nil)	1 (Nil)	12.5 (Nil)
Windscreen / Header rail	25 (6)	7.7 (1.9)	3 (2)	12.5 (8.3)	5 (Nil)	13.5 (Nil)	1 (Nil)	12.5 (Nil)
Roof Side Rail	7 (3)	2.2 (0.9)	Nil	Nil	5 (4)	13.5 (10.8)	1 (Nil)	12.5 (Nil)
Airbag (+cover + gases)	43 (4)	13.3 (1.2)	2 (1)	8.3 (4.2)	1 (Nil)	2.7 (Nil)	Nil	Nil
Window + frame	29 (4)	9.0 (1.2)	2 (Nil)	8.3 (Nil)	4 (Nil)	10.8 (Nil)	2 (Nil)	25 (Nil)
Other occupant	11 (4)	3.4 (1.2)	Nil	Nil	3 (Nil)	8.1 (Nil)	Nil	Nil
A-pillar	5 (2)	1.5 (0.6)	1 (1)	4.2 (4.2)	Nil	Nil	Nil	Nil
Console	2 (2)	0.6 (0.6)	Nil	Nil	Nil	Nil	Nil	Nil
Child Seat / Restraint	1 (1)	0.3 (0.3)	Nil	Nil	Nil	Nil	Nil	Nil
Exterior of occupant's vehicle	Nil	Nil	Nil	Nil	Nil	Nil	1 (1)	12.5 (12.5)
Flying Glass	37 (Nil)	11.5 (Nil)	3 (Nil)	12.5 (Nil)	7 (Nil)	18.9 (Nil)	2 (Nil)	25 (Nil)
Fire in Vehicle	2 (Nil)	0.6 (Nil)	Nil	Nil	Nil	Nil	Nil	Nil
Rear Screen	1 (Nil)	0.3 (Nil)	1 (Nil)	4.2 (Nil)	Nil	Nil	Nil	Nil
Other + Unknown	104 (10)	32.2 (3.1)	4 (Nil)	16.7 (Nil)	14 (Nil)	37.8 (Nil)	4 (1)	50 (12.5)

4.7 Crash Site Information

Multiple vehicle crashes are any crashes in which one of the collision partners (maximum of three) was some type of vehicle, independent of the severity of the impact. Case vehicles that struck parked vehicles were counted as multiple impact crashes. Using this method of classification, 173 (44%) of the 392 cases were involved in single vehicle crashes, while the remaining 217 were involved in multiple vehicle crashes.

There were 133 cases in which the crash occurred in a 'Mixed' location or it was not possible to determine whether the crash occurred in a rural or urban setting. These 133 cases were not included in the analyses in this section. A chart of DCA codes, used to categorise vehicle pre-crash movements in this section, can be found in the Appendix, on page 82).

4.7.1 Single Vehicle Crashes

Table 90. Case distribution by vehicle movement at time of crash.

Vehicle Movement	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Off Path - Straight	33	49.3	31	72.1	64	58.2
Off Path - Curve	26	38.8	11	25.6	37	33.6
Manoeuvring	2	3	1	2.3	3	2.7
On Path	3	4.5	Nil	Nil	3	2.7
Unknown	3	4.5	Nil	Nil	3	2.7
Total	67	100	43	100	110	100

Table 91. Case distribution by primary impact type and location.

Impact Type	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Front	26	38.8	17	39.5	43	39.1
Struck side	11	16.4	10	23.3	21	19.1
Rollover with single impact	10	14.9	4	9.3	14	12.7
Non-struck side	3	4.5	6	14.0	9	8.2
Rollover with multiple impacts	6	9.0	2	4.7	8	7.3
Rollover with no other impacts	7	10.4	Nil	Nil	7	6.4
Multiple impact	3	4.5	3	7.0	6	5.5
Rear	Nil	Nil	1	2.3	1	0.9
Unclassifiable	1	1.5	Nil	Nil	1	0.9
Total	67	100	43	100	110	100

The only obvious differences between crashes in rural and urban environments were that non-struck side impacts were more prevalent in urban areas and rollover crashes (either alone or in conjunction with one or more other impacts) were twice as common in rural areas (34% cf. 14%).

Table 92. Case distribution by primary collision partner and location for single vehicle crashes.

Collision Partner	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Tree	31	46.3	12	27.9	43	39.1
Pole or Post	4	6	18	41.9	22	20
Rollover	16	23.9	5	11.6	21	19.1
Multiple Impact	9	13.4	5	11.6	14	12.7
Embankment / Ditch / Culvert / Gutter	4	6	Nil	Nil	4	3.6
Concrete Barrier / Wall / Bridge / Barrier	Nil	Nil	2	4.7	2	1.8
Other or Unknown Object	3	4.5	1	2.3	4	3.6
Total	67	100	43	100	110	100

Not surprisingly, collisions with trees were more prevalent in rural areas, while poles and posts constituted a similar proportion of impacts (~44%) in urban areas.

Where the speed limit was not noted on the scene form, it is taken from the driver interview form.

Table 93. Case distribution by speed zone and location for single vehicle crashes.

Estimation of Speed Limit	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
50	Nil	Nil	7	16.3	7	6.4
60	3	4.5	19	44.2	22	20.0
70	3	4.5	3	7.0	6	5.5
80	7	10.4	8	18.6	15	13.6
90	3	4.5	1	2.3	4	3.6
100	45	67.2	3	7.0	48	43.6
110	3	4.5	Nil	Nil	3	2.7
Unknown	3	4.5	2	4.7	5	4.5
Total	67	100	43	100	110	100

Table 94. Case distribution by road surface and location for single vehicle crashes.

Road Surface	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Sealed	38	56.7	37	86	75	68.2
Sealed with gravel shoulder	20	29.9	6	14	26	23.6
Unsealed	9	13.4	Nil	Nil	9	8.2
Total	67	100	43	100	110	100

Table 95. Case distribution by intersection type and location for single vehicle crashes.

Intersection type	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Mid-block	60	89.6	38	88.4	98	89.1
3-leg intersection	2	3.0	4	9.3	6	5.5
Multi-leg intersection	2	3.0	Nil	Nil	2	1.8
Roundabout	1	1.5	1	2.3	2	1.8
Unknown	2	3.0	Nil	Nil	2	1.8
Total	67	100	43	100	110	100

While it might be expected that the majority of rural crashes occur mid-block (90%), it is somewhat surprising that a similar proportion of urban crashes also occur away from intersections.

Table 96. Case distribution by median separation and location for single vehicle crashes.

Median Separation	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
None	56	83.6	26	60.5	82	74.5
Divided by median/barrier	7	10.4	14	32.6	21	19.1
Not Applicable*	2	3.0	Nil	Nil	2	1.8
Unknown	2	3.0	3	7.0	5	4.5
Total	67	100	43	100	110	100

* Two cases, occupants in the same vehicle, were travelling in a vehicle that was not on a public road when it crashed.

Table 97. Case distribution by road curvature and location for single vehicle crashes.

Alignment	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Straight	31	46.3	27	62.8	58	52.7
Curved	32	47.8	16	37.2	48	43.6
Unknown	4	6.0	Nil	Nil	4	3.6
Total	67	100	43	100	110	100

Table 98. Case distribution by lighting conditions at the time of the crash and location for single vehicle crashes.

Light conditions	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Day	36	53.7	16	37.2	52	47.3
Night – no streetlights	24	35.8	4	9.3	28	25.5
Night – streetlights on	Nil	Nil	13	30.2	13	11.8
Night – streetlights unknown	1	1.5	8	18.6	9	8.2
Dusk – no streetlights	4	6.0	Nil	Nil	4	3.6
Dawn – street lights not on	1	1.5	Nil	Nil	1	0.9
Dusk – streetlights unknown	1	1.5	Nil	Nil	1	0.9
Unknown	Nil	Nil	2	4.7	2	1.8
Total	67	100	43	100	110	100

Table 99. Case distribution by weather conditions at the time of the crash and location for single vehicle crashes.

Weather Conditions	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Fine	31	46.3	13	30.2	44	40
Raining	7	10.4	8	18.6	15	13.6
Dust or Smoke	1	1.5	Nil	Nil	1	0.9
Unknown	28	41.8	22	51.2	50	45.5
Total	67	100	43	100	110	100

Multiple Vehicle Crashes

There were 217 ANCIS cases involved in multiple vehicle impacts. Of these 217 cases, 49 (23%) occurred in rural areas and 99 (46%) occurred in urban areas. The type of location where the crash occurred could not be determined for the remaining 69 cases. These twenty cases were not included in the following analyses.

Table 100. Case distribution by vehicle movement at the time of the crash and location for multiple vehicle crashes.

Vehicle Movement (DCA code[6])	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Opposing (12x)	24	49	35	35.4	59	39.9
Adjacent (11x)	5	10.2	29	29.3	34	23.0
Same direction (13x)	12	24.5	14	14.1	26	17.6
Adjacent then Off Path (11x, 17x/18x)	Nil	Nil	7	7.1	7	4.7
Off Path – Straight (17x)	Nil	Nil	5	5.1	5	3.4
Manoeuvring (14x)	3	6.1	1	1	4	2.7
On Path (16x)	Nil	Nil	4	4	4	2.7
Same direction then Off Path (13x, 17x/18x)	1	2	3	3	4	2.7
Overtaking (15x)	2	4.1	Nil	Nil	2	1.4
Unknown	2	4.1	1	1	3	2.0
Total	49	100	99	100	148	100

Table 101. Case distribution by primary impact type and location for multiple vehicle crashes.

Primary Impact Type	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Front	30	61.2	42	42.4	72	48.6
Near side	5	10.2	30	30.3	35	23.6
Multiple impact	5	10.2	9	9.1	14	9.5
Rear	4	8.2	6	6.1	10	6.8
Far side	2	4.1	6	6.1	8	5.4
Rollover with single impact	2	4.1	4	4.0	6	4.1
Rollover with multiple impacts	1	2.0	2	2.0	3	2.0
Total	49	100	99	100	148	100

As was the trend for single impact crashes, side impacts were more common in urban than rural areas.

[6] See DCA code chart, p. 39.

Table 102. Case distribution by primary collision partner and location for multiple vehicle crashes.

Collision Partner	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Car or ute	16	32.7	34	34.3	50	33.8
Van / Truck / Bus	9	18.4	13	13.1	22	14.9
Multiple impact	7	14.3	10	10.1	17	11.5
4 by 4 / MPV	7	14.3	9	9.1	16	10.8
Rollover	1	2.0	3	3.0	4	2.7
Other vehicle	2	4.1	2	2.0	4	2.7
Other or unknown object	0	0	2	2.0	2	1.4
Pole or post	0	0	1	1.0	1	0.7
Unknown vehicle	7	14.3	25	25.3	32	21.6
Total	49	100	99	100	148	100

Where the speed limit was not noted on the scene form, it was taken from the driver interview form.

Table 103. Case distribution by speed zone and location for multiple vehicle crashes.

Estimation of Speed Limit	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
50	Nil	Nil	8	8.1	8	5.4
60	Nil	Nil	51	51.5	51	34.5
70	Nil	Nil	14	14.1	14	9.5
80	6	12.2	21	21.2	27	18.2
90	1	2.0	Nil	Nil	1	0.7
100	37	75.5	3	3.0	40	27.0
110	5	10.2	Nil	Nil	5	3.4
Unknown	Nil	Nil	2	2.0	2	1.4
Total	49	100	99	100	148	100

Table 104. Case distribution by road surface and location for multiple vehicle crashes.

Road Surface	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Sealed	35	71.4	91	91.9	126	85.1
Sealed with gravel shoulder	11	22.4	7	7.1	18	12.2
Unsealed	3	6.1	1	1.0	4	2.7
Total	49	100	99	100	148	100

Table 105. Case distribution by intersection type and location for multiple vehicle crashes.

Intersection type	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Mid-block	37	75.5	32	32.3	69	46.6
4-leg intersection	4	8.2	30	30.3	34	23.0
3-leg intersection	8	16.3	25	25.3	33	22.3
Multi-leg intersection	Nil	Nil	6	6.1	6	4.1
Roundabout	Nil	Nil	6	6.1	6	4.1
Total	49	100	99	100	148	100

Table 106. Case distribution by median separation and location for multiple vehicle crashes.

Median Separation	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
None	40	81.6	43	43.4	83	56.1
Divided by Median/Barrier	8	16.3	51	51.5	59	39.9
Unknown	1	2.0	5	5.1	6	4.1
Total	49	100	99	100	148	100

Table 107. Case distribution by road curvature and location for multiple vehicle crashes.

Alignment	Rural		Urban		Total	
	Freq.	**%**	**Freq.**	**%**	**Freq.**	**%**
Straight	22	44.9	76	76.8	98	66.2
Curved	26	53.1	22	22.2	48	32.4
Unknown	1	2.0	1	1.0	2	1.4
Total	49	100	99	100	148	100

Table 108. Case distribution by lighting at the time of the crash and location for multiple vehicle crashes.

Light conditions	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Day	26	53.1	57	57.6	83	56.1
Night – streetlights on	Nil	Nil	15	15.2	15	10.1
Night – streetlights unknown	Nil	Nil	14	14.1	14	9.5
Night – no street lights	12	24.5	1	1.0	13	8.8
Dusk – streetlights unknown	2	4.1	8	8.1	10	6.8
Dusk – no street lights	4	8.2	Nil	Nil	4	2.7
Dawn – streetlights unknown	Nil	Nil	3	3.0	3	2.0
Dawn – no street lights	2	4.1	Nil	Nil	2	1.4
Dusk – streetlights on	Nil	Nil	1	1.0	1	0.7
Unknown	3	6.1	Nil	Nil	3	2.0
Total	49	100	99	100	148	100

Table 109. Case distribution by weather conditions at the time of the crash and location for multiple vehicle crashes.

Weather Conditions	Rural		Urban		Total	
	Freq.	%	Freq.	%	Freq.	%
Fine	23	46.9	37	37.4	60	40.5
Raining	1	2.0	8	8.1	9	6.1
Fog/Mist	1	2.0	1	1.0	2	1.4
Unknown	24	49.0	53	53.5	77	52.0
Total	49	100	99	100	148	100

5 CONCLUSIONS

The ANCIS study is a valuable adjunct to mass databases in that it provides much more detail on the cause and severity of individual crashes, as well as the injuries sustained by the vehicle occupants. These data are rich in terms of the amount of detail contained in each case and throw new light on the crashworthiness of the vehicles and aspects of crash involvement. Preliminary analyses have revealed interesting trends that will be able to be strengthened as the database continues to grow.

For example, a paper for the Road Safety Research, Policing and Education Conference in 2004, addressing the problem of multiple impact crashes, found that they tended towards having higher injury severity levels, with this trend being more pronounced when the most severe impact occurred later in the crash sequence. They also showed a significantly greater incidence of severe head and spinal injuries. In 2005 a paper was presented to the Canadian Multidisciplinary Road Safety Conference in Fredericton, New Brunswick relating to the differences between real-world crash outcomes in ANCIS compared with one of its predecessors, the Crashed Vehicle File. It demonstrated that a greater proportion of serious injury crashes in newer vehicles were occurring in higher speed zones than older vehicles and that newer vehicles were being more severely damaged but with a lower incidence of the most severe injury levels. This study also found a greater than expected incidence of rollover in the newer vehicles, but a lower incidence of serious head and abdominal injury. Finally, a paper for the 2005 Road Safety Conference in Wellington, New Zealand, showed a number of interesting characteristics relating to the important area of AIS3+ brain injury sustained by the occupants of vehicles in ANCIS. Brain injury was more likely to occur in rollover, as well as three times more likely when the collision partner was a narrow, rigid object such as a tree, pole or post. A higher than expected incidence of brain injury occurred in mid-block crashes compared with intersections. Logistic regression analysis found AIS3+ brain injury was three times more likely in 70-90 km/h zones compared with 40-60 km/h speed zones and nearly twice as likely again in 90-110 km/h zones.

Many analyses using these data, particularly those examining specific subsets, will demonstrate trends rather than statistically significant findings; nevertheless they are extremely important if we are to gain a greater understanding of the causal factors behind crashes in this country and new and innovative solutions to address the burdening road toll problem. More important then is an ongoing commitment to continue to collect these data to highlight emerging crash trends and new ways to address injury prevention on the road.

6 PUBLICATION LIST

Following are the publications generated from the ANCIS project since its inception in 2000.

2000 Publications

Morris, A.P., Begbie, J., Fildes, B., Barnes, J., Claessens, M. (2000), ANCIS- In-depth Crash Injury Research in Australia, 2000 Road Safety Research, Policing and Education Conference Proceedings, Brisbane.

2001 Publications

Begbie, J. & Morris, A.. P. (2001), Are Airbags Saving Lives in Australia? A Case Study of Analysis of Ten Real World Crashes in Victoria, Poster presentation at 2001 Trauma Conference, Sydney.

Morris, A. P., Begbie, J., Barnes, J. S., Fildes, B., Claessens, M. (2001), Vehicle Safety Research in Australia: Lessons Learnt From In-depth Crash Investigations, 2001 Trauma Conference Proceedings, Sydney.

Shields, B., Morris, A., Barnes, J., Fildes, B. (2001), Australia's National Crash In-depth Study Progress Report, 2001 Road Safety Research, Policing and Education Conference Proceedings, Melbourne.

2002 Publications

Logan D., Fitzharris M., Fildes, B. (2002) Australia's National Crash In-depth Study Progress Report, 2002 Road Safety Research, Policing and Education Conference Proceedings, Adelaide.

2003 Publications

Fildes, B., Logan, D., Fitzharris, M., Scully, J., Burton, D., (2003) ANCIS The First Three Years: The Australian National Crash In-depth Study 2000-2003, Report No. 207, Monash University Accident Research Centre, Melbourne.

Scully, J., Logan, D. & Fildes, B. (2003) 'ANCIS progress report, July 2003', Proceedings 2003 Road Safety Research, Policing and Education Conference, 24-26 September, Sydney, Roads and Traffic Authority, NSW, CD-ROM

2004 Publications

Logan, D. (2004) The First Three Years: The Australian National Crash In-depth Study 2000-2003, Presentation to Society of Automotive Engineers - Australasia Road Safety Seminar, 15th September, Melbourne.

Logan, D. (2004) ANCIS - The Australian National Crash In-depth Study, Presentation to Xth Accident Compensation Seminar, 29 November 2004, Institute of Actuaries of Australia, Qld.

2005 Publications

Logan, DB., Scully, J., Fildes, B. (2005) A comparison of crash and injury outcomes between older and newer vehicles in single and multiple impact crashes using Australian in-depth data (peer reviewed) Proceedings of the Canadian Multi-disciplinary Road Safety Conference XV June 5-8, 2005 Fredricton, NB, Canada.

Logan, DB., Scully, J., Fildes, B. (2005) An evaluation of the risk of brain injury for real world crashes involving occupants of passenger vehicles in ANCIS (peer reviewed) Proceedings of the **Australasian Road Safety Research Policing Education Conference** 2005 14-16 November, Wellington, NZ

Logan, DB., Fildes, B. (2005) The Benefits of In-Depth Data in Crash Prevention (peer reviewed), Proceedings of the Fourth International Forum of Automotive Traffic Safety 15-17 October, 2005. Hunan University, Changsha, China.

7 REFERENCES

Fildes B., Logan D.B., Fitzharris M., Scully J., Burton D., (2003) *ANCIS – The First Three Years: The Australian National Crash In-depth Study 2000-2003*, Report No. 207, Monash University Accident Research Centre, Melbourne.

Logan D.B., Scully J. & Fildes B. (2004) *Characteristics of Multiple Impact Crashes in ANCIS*, 2004 Road Safety Research, Policing and Education Conference, 14-16 September, Perth, Roads and Traffic Authority.

APPENDIX: DCA CODE CHART