Lateral Impacts in Australia, Germany and the United States

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Abstract – Side impacts, both nearside and farside, have been indicated by research to be responsible for a large proportion of serious injuries from road crashes. This study aimed to compare and contrast the characteristics of nearside and farside crashes in Australia, Germany and the U.S., using the ANCIS, GIDAS and NASS/CDS in-depth-databases, in order to establish the impact and injury severity associated with these crashes, and the types of injuries sustained. The analyses revealed some interesting similarities, as well as differences, between both nearside and farside crashes, and the emergent trends between the three investigated countries. More specifically, it was indicated that whilst the severity of injury sustained in nearside crashes was slightly greater overall than that found for farside crashes, careful consideration of struck and non-struck side occupants must be made when considering aspects such as vehicle design and occupant protection.

NOTATION

AIS Abbreviated Injury Scale: An internationally-recognised scale for coding traumatic injuries, with AIS severities ranging from 1 (minor) to 6 (catastrophic).

CDC Collision Deformation Code: A coding system for vehicle collision damage, whereby the first two digits represent the principal direction of force (PDOF) 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.

Delta-V Vector difference between impact velocity and separation velocity.

EBS Equivalent Barrier Speed: 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.

ISS Injury Severity Score: A measure of overall injury severity. Equal to the sum of 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 AIS 6 injury automatically resulting in a score of 75.

MAIS Maximum AIS: The highest AIS score in any body region.

INTRODUCTION

Side impact collisions are a particularly severe and harmful type of crash for vehicle occupants. Depending on the severity of the crash, side impacts are involved in up to 35 percent of road trauma and are particularly noteworthy in fatal crashes [1,2]. Nearside impacts are commonly associated with side impact trauma, yet farside occupants can also be seriously injured in these crashes [1,3]. While some inroads have been made in improved frontal crash protection for occupants, the same cannot be said about side impacts and suitable countermeasures to address this trauma.

Furthermore, while there has been some research attention and government regulations addressing the protection of nearside (or struck side) occupants of the vehicle, there has been much less emphasis placed on farside (or non-struck side) occupants [3]. Farside occupants, for example, have been found to account for 43 percent of seriously injured persons and 30 percent of the Harm in U.S. side impact crashes, using NASS/CDS and FARS data from 1997 to 2002 [4]. In addition, Gabler and colleagues [5] also observed, using 1993 to 2002 Australian MUARC in-depth data (MIDS), that farside occupants accounted for 20 percent of the seriously injured persons and 24 percent of the Harm in Australian side impact crashes.

Aims of study

Given the level of road trauma associated with side impact crashes for occupants in both nearside and farside crashes, the aim of this study was to compare the characteristics of these two crash types, primarily in regards to their crash and injury severity, as well as the types of injuries that are sustained in these crashes and their sources. In addition, given the likely differences across continents, the study also set out to compare side impact in-depth crash data from Australia, Germany and the U.S. to examine trends of lateral impact between nations.

Database investigated

Three databases were available to investigate side impact crashes in this study – the Australian National Crash In-depth Study (ANCIS), the German In-Depth investigation Accident Study (GIDAS) and the U.S. National Automotive Sampling System Crashworthiness Data System (NASS/CDS). A brief description of these databases follows.

ANCIS has collected retrospective in-depth real-world crashes cases since 2000, with more than 500 cases collected to-date across Victoria and New South Wales in Australia. It is a collaborative research program involving the automotive manufacturing industry, State and Federal Government agencies, the insurance industry and Australian automobile organisations. The main entry criterion is severe crashes whereby at least one occupant has been hospitalised as a result of the crash. Participants in the study are administered a structured interview, their medical records examined, the crash vehicle inspected and photographed, and the crash site inspected in detail. This retrospective examination of the crash enables a '*best evidence*' approach to be taken in determining the crash circumstances and sources of occupant injury [6,7]. There were 111 nearside and 30 farside cases available for analysis in the ANCIS system from 2000 to 2007.

GIDAS is a joint initiative between FAT (Forschungsvereinigung Automobiltechnik or Automotive Industry Research Association) and BASt (Bundesanstalt für Straßenwesen, the Federal Road Research Institute), that began in July 1999. The Medical University of Hannover and the Technical University of Dresden have specialist teams that go directly to the crash scene to collect the necessary information for completing detailed accident reconstructions, and medical data about how the crash victims were injured and treated is also collected. A target of 1000 accidents per year has been set as the basis for performing future evaluations, with a statistical sample plan used for selecting crashes for investigation. Various aspects of the pre-crash, crash, and post-crash phases are collected and then compiled into the database which can be seen as representative for the situation of traffic accidents with injured persons in Germany [8]. There were 88 nearside and 51 farside cases available for analysis in the GIDAS system from 2000 to 2007.

NASS/CDS represents a sample of police-reported crashes that occur in the U.S. every year. It is a nationwide crash data collection program sponsored by the U.S. Department of Transportation, and is operated by the National Center for Statistics and Analysis (NCSA) of the National Highway Traffic Safety Administration (NHTSA). NASS/CDS provides an automated, comprehensive national traffic crash database. The data collected from each of the Primary Sampling Units (PSU's) across the U.S. are weighted to represent all police-reported motor vehicle crashes occurring during the year involving passenger cars, light trucks and vans that were towed due to damage. Detailed information regarding the crash, the vehicle(s) involved and its occupant(s) are collected from a variety of sources, including police and hospital reports [9]. There were 351 nearside and 159 farside cases available for analysis in the NASS/CDS system from 1997 to 2006.

Study challenges

Anyone who has ever attempted a comparative study of databases from different regions and from different data collection agencies will appreciate the challenges that lay in store for the analyst. First, entrance criteria for the study often varies, the level of detail collected by the various data collection agencies differs, the motivation for the study may be quite different and the representativeness of the data sample can be quite unique for the database under investigation.

Nevertheless, these data have the potential to highlight important details of crashes not available elsewhere and can provide additional information on crashes. Causal information is more likely from these samples as many mass databases lack sufficient detail to illustrate these important features for identifying new opportunities for injury intervention. Moreover, understanding the variations of crash types and injuries to occupants across regions is highly important for governments and the automotive industry in attempting to optimise road safety.

To overcome any sampling bias, data collection agencies often *weight* each of the cases they collect in terms of how representative they are across the whole system. However, even this attempt to make these sample data more representative of the whole system is complex and cannot always be taken to be an accurate reflection of the extent of crashes in their regions. One should question the merits of weighting small samples, as the resultant outcome can be quite misleading. In addition, weighting criteria, usually based on large state and national crash statistics, varies considerably across time and often involves various estimates, thereby potentially introducing another bias in interpretation.

Data from these three countries were chosen for the comparative study as they seemed to be reasonably consistent in their data systems and legitimate to compare. For reasons expressed above, it was decided to conduct the analysis using unweighted data. However, it must be stressed that many of the findings of difference could be explained by differences in the data collection procedure and care needs to be taken in interpreting these findings. Furthermore, not all of the reported variables were directly corresponding between all three datasets, although every effort was made to utilise the most similar variable available.

METHOD

Inclusion criteria

In each of the three databases, there was a number of selection criteria applied to these data, so that the key characteristics of the databases were as closely matched as possible for comparative purposes. These criteria were as follows:

- Side impacts only (identified using the CDC), with nearside or farside clearly stipulated depending on the seating position of the vehicle occupant;
- The case must have been hospitalized for at least one day;
- The case must have been wearing a seat belt at the time of the crash;
- The crash must have involved a passenger vehicle;
- The crash vehicle model year should be from approximately the mid-1980's to the present

Procedure

Each of the three databases were analysed separately, following an agreed analysis strategy. The ANCIS and NASS/CDS databases were analysed by researchers from the Monash University Accident Research Centre while analysts from the Medical University of Hannover provided similar aggregate findings from the GIDAS database. In analysing these data, an emphasis was placed on identifying the crash and occupant injury severity of both nearside and farside impacts, including identifying the injury contact sources and the prevalence of injury for the various body regions. An attempt was also made to examine whether there were any significant statistical differences between the databases. These analyses are not presented in the Results section; however, key differences between the three databases are highlighted in the Discussion.

RESULTS

The findings from this analysis were separated into the following categories: occupant and vehicle characteristics; the crash environment; and injuries and source of injury, and are reported individually as follows.

Occupant & vehicle characteristics

Various results from the analysis of the occupant and vehicle characteristics of the three investigated databases are presented below in Tables 1 to 4.

Table 1: Occupant characteristics across the ANCIS, GIDAS & NASS/CDS databases

Vehicle Damage	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Drivers	79.3%	67.7%	73.5%	73.3%	59.5%	64.8%
Front passengers	18%	18.5%	22.5%	23.3%	28.7%	27.7%
Rear passengers	2.7%	13.8%	3.9%	3.3%	11.7%	7.5%
Age (years)	39.2	39.6	43.1	44.4	35.5	46.6
Height (cm)	171.3	172.3	168.8	170	170.7	164.4
Weight (kg)	73.5	75.1	73.5	69.4	76.9	69.2
Male gender	56.8%	54.6%	41.6%	60%	45.7%	69.8%

These data are remarkably similar across the three databases. Of particular note, there were many more rear passengers in the GIDAS database, possibly because of the On-The-Spot procedure used by them, compared with the retrospective nature of the other two databases. There was also more female drivers in the NASS/CDS data compared to the others.

Table 2: Extent of vehicle damage across the ANCIS, GIDAS & NASS/CDS databases

Vehicle Damage	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Driver-side damage	73.9%	71.9%	76.3%	33.3%	33.5%	28.6%
Passenger-side damage	26.1%	28.1%	23.7%	66.7%	66.5%	71.4%
Damage Location – P*	47.7%	40.8%	13.1%	40.0%	38.1%	14.5%
Damage Location – Y*	28.8%	24.7%	43.0%	33.3%	24.7%	42.1%
Damage Location – Z*	11.7%	11.1%	13.7%	10.0%	11.1%	14.5%
Damage Location – D*	6.3%	4.5%	12.8%	3.3%	8.6%	14.5%
PDOF - perpendicular	35.1%	32.0%	39.7%	33.3%	42.5%	13.3%
Maximum Crush (mm)	452	375	450	542	369	431

* As coded by the Collision Damage Classification (CDS) of the NASS/CDS coding system

The results of Table 2 show good similarity between these data across the 3 databases. Of particular note, NASS/CDS crashes involved fewer pure compartment impacts and more partial overlaps than either ANCIS or GIDAS. The substantial reduction in the number of perpendicular impacts highlights the importance of oblique impacts for injury to farside occupants in the U.S. database, over the others.

Table 3: Average crash severity and pre-crash speed across the 3-databases

Average Crash Severity & Pre-crash Speed	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
EBS (km/h) – EES (GIDAS)	32.3	35.9	33.8	39.6	39.6	37.8
Delta-V (km/h)	31.2	35.2	31.1	30.3	37.1	33.2
Approx. pre-crash speed	37.9	60.2	40.2	39.2	62.0	44.5

Table 3 shows good similarity between all data on the crash severity measures, although estimates of pre-crash speed tended to be higher for GIDAS than either ANCIS or NASS/CDS.

Table 4: Collision partner across the ANCIS, GIDAS & NASS/CDS databases

Collision Partner	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Passenger car	27.0%	39.2%	95.9%*	43.3%	44.2%	97.2%*
Tree or pole	36.0%	38.8%	3.1%	40.0%	30.9%	2.1%
Other vehicle	21.6%	14.6%	-	13.3%	20.7%	-
Other	15.3%	7.4%	0.9%	3.3%	4.2%	0.7%

* NASS/CDS did not distinguish between vehicle types for this variable; hence, these figures represent all vehicle types

It was not possible to fully compare the data from the three databases on collision partners from these data. Of particular note, the lack of tree or pole collisions in NASS/CDS crashes is a bit surprising, given the frequency of these crash types in ANCIS and GIDAS.

Summary: these findings show remarkable similarity across most of the measures analysed. Of some concern was the apparent lack of pole collisions in the U.S. database, which might reveal a bias in the sample to these crash types. The increase in partial overlaps, combined with fewer perpendicular crashes in the NASS/CDS data highlights the importance of considering oblique side impact collisions in measures aimed at protecting farside occupants in these crashes.

The crash environment

The environmental conditions that existed at the time of these nearside and farside crashes in the three databases are analysed in Tables 5 through to 10 below.

Table 5: Crash location across the ANCIS, GIDAS & NASS/CDS databases

Crash Location	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS*	ANCIS	GIDAS	NASS*
Urban	66.7%	46.8%	-	63.6%	52.2%	-
Rural	22.8%	53.2%	-	36.4%	47.8%	-
Mixed	10.5%	0.0%	-	0.0%	0.0%	-

* NASS/CDS does not provide information regarding whether the crash occurred in an urban or rural area

The under-representation of rural crashes in ANCIS, compared to GIDAS reflects differences in the sample strategy behind these two data collection activities. This is likely to be the result of the on-the-spot nature of GIDAS, compared to the retrospective nature of ANCIS, as well as limits imposed on travel distance in the ANCIS study. Clearly, ANCIS needs to consider ways of increasing its rural crash population to ensure it is more representative of all Australian crashes.

Table 6: Road class of crashes across the ANCIS, GIDAS & NASS/CDS databases

Road Class	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Mid-block	50.9%	50.4%	-	54.5%	56.9%	-
Crossing	42.1%	27.0%	-	36.4%	28.1%	-
Junction	0.0%	18.9%	-	0.0%	15.0%	-
Roundabout	7.0%	2.8%		9.1%	0.0%	
Undivided road	-	-	74.6%	-	-	81.1%
Divided road	-	-	17.1%	-	-	11.9%
One-way road	-	-	8.3%	-	-	6.9%

It was not possible to obtain data on road class to compare NASS/CDS with the other two databases, given that this database only specifies whether the crash occurred on a divided or undivided road.

However, the other two databases appear to have similar distribution of mid-block and crossing crashes, although there were some variations for junction and roundabout collisions. It is also worthy of note, however, that this variable was coded slightly differently between the ANCIS and GIDAS databases (e.g. ANCIS does not specify junctions), making direct comparisons slightly difficult.

Table 7: Road topography of crash sites across the ANCIS, GIDAS & NASS/CDS databases

Road Topography	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Flat surface	60.5%	99.0%	79.2%	43.8%	100%	83.0%
Uphill grade	23.3%	1.0%	12.3%	25.0%	0.0%	8.8%
Downhill grade	12.8%	0.0%	8.0%	25.0%	0.0%	6.9%

There was little consistency in road topography across the three databases. GIDAS cases in particular predominantly involved flat roads, whereas the others (particularly ANCIS) had more uphill and downgrades. This may reflect differences in sampling strategies, especially across urban/rural crash locations.

Table 8: Road curvature at crashes across the ANCIS, GIDAS & NASS/CDS databases

Road Curvature	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Straight road	59.6%	79.9%	94.3%	54.5%	83.0%	96.9%
Curved bend	40.4%	20.1%	5.7%	45.5%	17.0%	3.1%

Straight roads were more predominant among GIDAS and NASS/CDS crashes, compared to the higher distribution of curved roads in the Australian sample.

Table 9: State of road surface across the ANCIS, GIDAS & NASS/CDS databases

Road Surface	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Wet road	40.4%	52.9%	12.5%	28.6%	52.4%	13.5%
Dry road	59.6%	47.1%	87.5%	71.4%	47.6%	86.5%

Of some surprise was the lack of wet roads involved in NASS/CDS cases, compared to the other two. As it is unlikely to reflect differences in weather patterns in this region, this could reflect a bias in the data collection activities in the U.S., and policies behind crash investigation activities between them.

Table 10: Light conditions for crashes across the ANCIS, GIDAS & NASS/CDS databases

Light Conditions	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Daytime	40.4%	68.7%	66.7%	42.9%	61.0%	62.3%
Night-time	31.8%	24.0%	30.5%	39.3%	29.9%	33.4%
Other/unknown	27.8%	7.3%	2.8%	17.8%	9.1%	4.3%

There tended to be a higher proportion of night-time crashes among the ANCIS data. As this is a retrospective study, it could also be explained by differences in procedures across the three studies.

Summary - This analysis has highlighted a number of differences in the crash environments between the ANCIS, GIDAS and NASS/CDS cases. For the most part, it seems that these reflect differences in data collection activities, rather than fundamental differences in side impact crashes in the different regions. The degree to which these differences might impact on the other analyses needs further consideration.

Injuries and source of injury

The third and final set of results relate to the injuries, their severity and the major causes of these injuries for occupants injured in nearside and farside crashes for the three databases (ANCIS, GIDAS and NASS/CDS) analysed, as shown in Tables 11 through to 15 below.

Table 11: Injury severity for occupants in Nearside and Farside crashes

Injury Severity	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Average ISS	18.7	10.2	15.3	13.7	7.3	9.5
Days spent in hospital	14.4	10.4	6.9	6.4	4.9	4.9

There were differences observed in the injury severity of the occupants involved in the nearside and farside collisions, with the severity of injury from nearside impacts tending to be higher than that for farside crashes. While the GIDAS cases tended to be less severe than the others in terms of the Injury Severity Score, of interest was the fact that most of these crashes had an ISS less than 20 and in many, less than 15, considered to be a critical threshold between minor and the more severe outcomes for patients. Differences in days spent in hospital, while somewhat correlated to threat-to-life, is also likely to reflect differences in hospital policies across the three countries.

Table 12: Total injuries of all severity* for occupants in Nearside and Farside crashes

Vehicle Damage	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Head	88.3%	97.7%	122.2%	103.3%	60.8%	99.4%
Face	107.2%	39.8%	99.1%	76.7%	37.3%	73.6%
Neck	12.6%	1.1%	7.1%	6.7%	0%	6.9%
Thorax	126.1%	115.9%	101.7%	66.7%	64.7%	73.6%
Abdomen	66.7%	27.3%	56.4%	70.0%	9.8%	56.0%
Spine	50.5%	79.5%	36.2%	30.0%	58.8%	39.6%
Upper extremity	131.5%	84.1%	97.7%	100.0%	35.3%	79.9%
Lower extremity	188.3%	131.8%	179.2%	110.0%	43.1%	103.1%

* Multiple injuries for each body region included in the analysis

The frequency of injury by body region shown in Table 12 reveal a high number of injuries to the head, face, thorax and extremities in both nearside and farside crashes. Notably though, the frequency of injury for farside crashes was generally less than nearside crashes, particularly for body regions such as the thorax and upper and lower extremities.

Table 13: AIS3+ injuries for occupants involved in Nearside and Farside crashes

Vehicle Damage	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Head	16.2%	17.0%	16.5%	20.0%	21.6%	15.1%
Face	3.6%	1.1%	1.1%	0%	0%	0.6%
Neck	1.8%	0%	1.0%	0%	0%	0%
Thorax	37.8%	26.1%	2.3%	16.7%	35.3%	18.9%
Abdomen	9.9%	3.4%	1.9%	3.3%	5.9%	3.8%
Spine	3.6%	2.3%	1.7%	6.7%	2.0%	2.5%
Upper extremity	3.6%	2.3%	1.3%	0%	2.0%	2.5%
Lower extremity	24.3%	17.0%	1.8%	33.3%	27.5%	5.7%

Table 13 shows the more severe (AIS3+) injury distribution of the three databases for both nearside and farside collisions. The pattern of severity is clearer in these data, revealing the predominance of head, chest (thorax) and lower extremity injuries in both nearside and farside crashes. Differences in the absolute numbers can be explained by the differences in crashes reported in the first two sections. However, the pattern of injuries across these databases is clear and illustrates why side impact collisions can be life-threatening and why injury prevention in side impacts should be prioritised.

Table 14: Mean AIS value for occupants injured in Nearside and Farside crashes

Vehicle Damage	Nearside Crashes			Farside Crashes		
	ANCIS	GIDAS	NASS	ANCIS	GIDAS	NASS
Head	2.6	2.2	2.4	2.8	2.3	2.3
Face	1.1	1.1	1.1	1.3	1.3	1.1
Neck	1.5	1.0	1.0	2.0	0	1.0
Thorax	2.5	2.5	2.3	2.4	2.0	1.9
Abdomen	2.1	2.3	1.9	1.7	1.4	1.5
Spine	2.1	1.5	1.7	2.3	1.5	1.7
Upper extremity	1.3	1.3	1.3	1.0	1.5	1.2
Lower extremity	1.9	1.8	1.8	1.2	1.3	1.4

Table 14 again reinforces the findings of the previous two tables. Head, chest, abdominal and spinal injuries had the highest average AIS values in these databases for both nearside and farside crashes.

Table 15: Major sources of injury for occupants injured in nearside and farside crashes across the ANCIS, GIDAS and NASS/CDS databases.

ANCIS – Nearside		GIDAS – Nearside		NASS/CDS - Nearside	
Windscreen	19.8%	Nearside interior	12.7%	Nearside interior	14.8%
Nearside interior	9.0%	Seatbelt system	11.0%	Door h'ware & armrest	14.0%
Nearside B-Pillar	6.3%	Nearside B-Pillar	10.5%	Nearside B-Pillar	10.0%
Front header	6.3%				
Seatbelt system	6.3%				
ANCIS – Farside		**GIDAS – Farside**		**NASS/CDS - Farside**	
Seatbelt system	30.0%	Body motion (whiplash)	18.5%	Seatbelt system	20.1%
Farside B-Pillar	6.7%	Seatbelt system	7.3%	Transmission lever	10.1%
				Farside interior	8.8%

The final analysis in Table 15 illustrates the most common sources of injury across the three databases. While there are some database differences in these major sources, the nearside of the car, the B-Pillar and seatbelt were consistent sources of injury to nearside occupants, while the seatbelt system and the farside of the car (the impacted surface) were the major causes of injury to farside occupants in these crashes.

Summary: The injury analysis showed considerable consistency in the types of injuries most common to nearside and farside occupants in lateral impacts, and clearly illustrates the priorities for injury prevention in side impacts for those seated on both sides of the vehicle. Earlier differences in occupant and vehicle characteristics and the crash environment do not seem to have unduly influenced the injury patterns observed in the three databases, apart from possible differences in absolute numbers.

DISCUSSION

Nearside and farside crashes in the ANCIS database

Overall, there were not many significant differences between nearside and farside crashes in relation to both crash and injury severity within the ANCIS database. More specifically, the conducted analyses indicated that there were no significant variations between the two crash types for variables such as the maximum crush depth, delta-V, the estimated speed prior to the crash, ISS, and the mean AIS for injuries sustained to the various body regions. Significant differences were found, however, for EBS, the number of days spent in hospital and AIS 3+ lower extremity injuries. Whilst the mean EBS was significantly higher for farside crashes, the number of days spent in hospital and the number of AIS 3+ lower extremity injuries were significantly higher for nearside crashes. One possible explanation for this result is that given that ANCIS only involves hospitalized cases, farside crashes may require a higher impact severity in order for hospitalization to occur.

Nearside and farside crashes in NASS/CDS and comparison to the ANCIS database

Within the NASS/CDS database there were several significant differences between nearside and farside crashes, particularly in regards to injury severity. More specifically, the conducted analyses indicated that were significant variations between the two crash types for mean ISS, number of days spent in hospital and MAIS, with near-side crashes obtaining higher scores on average than farside impacts. In addition, when individually investigating the various body regions, it was also found that the mean AIS was significantly higher in nearside crashes for the thorax, abdomen, upper extremity and lower extremity. Further analyses revealed that AIS 3+ (i.e. higher severity) injuries were also significantly more common for the thoracic, abdominal and lower extremity body regions in nearside crashes. In relation to crash severity, however, there were not as many significant differences between nearside and farside crashes, with the only significant difference being a higher mean EBS for farside crashes. Similarly to ANCIS, a possible explanation for this result is that given that only hospitalized cases were selected, farside crashes may require a higher impact severity in order for hospitalization to occur. These results for crash severity also indicate that the higher levels of injury severity that were associated with nearside crashes cannot be attributed to the severity of the crash, given that, if anything, the analysed farside crashes tended to be more severe than the nearside ones.

Overall, there were some similarities, as well as some interesting differences, between ANCIS and NASS/CDS. The two databases were relatively similar in regards to occupant characteristics (i.e. age, height and weight), although female occupants were more prevalent in NASS/CDS for both nearside and farside crashes. The crash vehicle characteristics were also relatively similar (i.e. passenger vehicles with closely corresponding model years), but frontal airbags were more common in the NASS/CDS database. In addition, nearside and farside crashes in NASS/CDS were more likely to occur on dry roads and in during the day-time, with the road also more likely to be level and straight than what was the case in ANCIS. It must also be noted that side impact crashes in NASS/CDS were more likely to involve multiple impacts, as opposed to ANCIS cases, which tended to only involve one impact. NASS/CDS crashes were less likely than ANCIS, however, to involve other objects aside from passenger vehicles as collision partners, such as poles and trees.

In regards to the crash severity of both nearside and farside impacts, there were no significant differences between ANCIS and NASS/CDS, with the investigated variables being crush depth, EBS, delta-V and the approximate speed before the crash. Furthermore, within each of these two databases, EBS was the only crash severity measure to significantly differ between nearside and farside crashes, with a higher mean found for farside impacts. Despite these similarities for crash severity, there were a number of key areas in which the databases differed in relation to injury severity. More specifically, in NASS/CDS, there was a larger discrepancy observed between nearside and farside crashes in terms of injury severity (i.e. with nearside crashes being higher in severity according to ISS, the number of days spent in hospital, MAIS, and the number of AIS 3+ injuries sustained to the thoracic, abdominal and lower extremity body regions) than what was the case in ANCIS. When directly comparing the injury severity levels between ANCIS and NASS/CDS, however, there was not a great deal of difference between the two databases for the mean levels of ISS, number of days spent in hospital and MAIS. For nearside crashes, ISS and number of days spent in hospital were significantly higher in

ANCIS than in NASS/CDS, but there were no significant differences in injury severity between the databases for farside crashes.

The final area of comparison between ANCIS and NASS/CDS was the injury contact sources for nearside and farside crashes. In nearside crashes, the interior surface (right side for ANCIS and left side for NASS/CDS, due to the driving sides being opposite in Australia and the U.S.) was a common contact source in both databases, but the windscreen was much more prevalent in ANCIS, whilst the (left side) hardware or armrest was more common in NASS/CDS. In farside crashes, the seat belt restraint webbing/buckle was the main injury contact source for both databases, although the (left side) B-pillar was more common in ANCIS and the floor or console-mounted transmission lever was more prevalent in NASS/CDS.

GIDAS compared with ANCIS and NASS/CDS

In the GIDAS dataset, it appeared that the crash severity tended to be slightly higher for farside crashes than for nearside crashes, in regards to delta-V, EBS (EES) and approximate speed before the crash. Alternatively, the injury severity was, on average, greater for nearside crashes than for farside crashes, with the mean levels of ISS and number of days spent in hospital (and to a lesser extent MAIS) being higher for nearside impacts. This was a trend which was also common to the other two databases (particularly in NASS/CDS, whereby there were greater discrepancies in injury severity between nearside and farside crashes than what were found in ANCIS). The possible explanation that was previously provided for this trend is that given that the databases only analysed hospitalized cases, it is likely that farside crashes require a higher impact severity in order for hospitalization to occur, even though the extent of injury tends to be greater in nearside impacts regarding the duration of hospitalisation and the patient’s injury severity score.

Implications of results

This study has indicated that whilst nearside crashes on average, may be associated with higher levels of injury severity (although this did vary to some extent between the databases), the number and severity of injuries sustained in farside crashes is still worthy of concern. Furthermore, whilst the frequency and severity of injury tended to be greater for nearside side crashes in some body regions (particularly the lower extremity), this was not the case for important body regions such as the head.

It is apparent through the investigation of the injuries and contact sources that there is still scope for improvements in vehicle design to better protect vehicle occupants in both nearside and farside crashes. Specifically, in nearside crashes, the interior surface was a common injury source for each of the databases examined, suggesting possibilities for targeting this area. In addition, in farside impacts, the seat belt system was consistently noted as a major injury source within each database. It is envisaged that in the future, however, the number of injuries sustained due to contact with the seat belt could be reduced, providing that various restraint technologies, such as motorized seat belts, pretensioners and adaptive load limiters, continue to become increasingly fitted to newly manufactured passenger vehicles. To this effect, the increasing presence of various airbag types in vehicles, particularly side airbags (e.g. door and cant-rail mounted), are also likely to assist in reducing the frequency and severity of injuries sustained in side impact crashes. Furthermore, other airbags, such as foot well and knee bolster airbags, could also make a valuable contribution in mitigating lower extremity injuries, which were found to be particularly prevalent in nearside crashes, as well as quite prominent in farside crashes.

Limitations

A number of limitations in comparing in-depth data across different countries and differing data collection procedures were alluded to earlier in this paper. These three databases were chosen for analysis because they were considered to be roughly equivalent and within the scope of this study. It would be useful though to include other databases in this analysis, should there be interest in pursuing this comparative analysis further.

The use of unweighted data for these analyses is always subject to some criticism. It was decided to use these data given the relatively small numbers of the sample (a maximum of 350 nearside cases from NASS/CDS to a minimum of only 30 farside cases in ANCIS). The extent to which this may have influenced the analyses is unclear, although other comparisons of nearside and farside crashes between ANCIS and NASS/CDS failed to show any severe differences in the outcome [5]. Nevertheless, it would be useful to conduct a similar analysis using weighted data in future.

CONCLUSION

This study has revealed a number of interesting similarities and differences in crash and injury severity patterns between nearside and farside crashes, as well as between the emerging trends for the Australian, German and U.S. in-depth crash databases. Overall, it appears that in hospitalized cases, the crash severity of nearside and farside impacts were relatively close, with the EBS (EES) of farside crashes tending to be slightly higher. The injury severity of nearside crashes tended to be slightly higher than for farside crashes, particularly in body regions such as the lower extremity. The results further indicated that serious injuries are frequently sustained in both nearside and farside lateral impacts, and future vehicle design measures should therefore address this trend. Care must be taken in interpreting the results of this study, however, given that generally small sample sizes were involved and there were limitations on the range of statistical analyses that could be performed with the data. Nevertheless, the richness of the available in-depth data has enabled several valuable findings regarding lateral impacts to emerge. The study provided a useful overview about the injuries sustained in side impact crashes across different countries. on the basis of detailed descriptions by in-depth-investigation.

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