Serious Head, Neck and Spine Injuries in Rear Impacts: Frequency and Sources.

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Abstract. 1999–2015 NASS-CDS data were used to investigate the risk for Maximum Abbreviated Injury Scale (MAIS) 3+F injury in rear crashes involving 2000+ model year vehicles. Front-outboard occupants 15 and older were included without ejection (ejection = 0). The frequency of serious-to-maximum injury was assessed by body region. The distribution of injury sources was then queried for AIS3-6 head, neck and spine injury. Overall, front-seat occupants had the lowest risk for serious injury in rear impacts compared to other crash types. The risk was 0.497 ± 0.120%. There were 2.76 AIS 3+ injuries per serious-to-fatally injured occupant on average. Most serious injuries occurred to the head from contact with front (44%), rear (36%) and side (12%) interior components. The B-pillar, head restraint and seatback were common sources.

An in-depth review of electronic cases was conducted involving front-seat occupants with serious head or spine (AIS3-6) injury from contact with the B-pillar, head restraint and/or seatback. The individual cases were reviewed for damage to the vehicle and interior. There were 4 unweighted cases involving a serious-to-maximum (AIS 3+) head injury due to seatback contact; all were from intrusion pushing rear structures forward into the front-seat occupant. Three of 4 occupants were belted. There were 18 unweighted front-seat occupants with a serious-to-maximum (AIS 3+) neck/spine injury related to the seat and seatback. Nine occupants were injured by intrusion of rear structures, which were deformed forward into the occupant. Three occupants were injured by "diving" into the rear seatback causing T-spine fractures.

While the risk of serious injury is low in rear impacts, there are injuries to the head, neck and spine. Intrusion was a significant source for AIS 3-6 head, neck and spine injuries. The B-pillar adjacent to the occupant was a common source of injury. NASS-CDS identified no case of AIS 3+ head injury by "diving" type motion but found AIS 3+ T-spine fractures by "diving" into the rear seatback by belted occupants.

This study provides insight into interior contacts associated with serious injury to front-seat occupants in rear crashes. It identified head restraint, seat and B-pillar as common injury sources. A majority of cases involved components lateral to or forward of the front occupant. Head injury from a "diving" mechanism was not observed, but T-spine fractures occurred with belted occupants.

Keywords: Rear crashes, front seat occupants, serious injury, head injury, spine injury.

I. INTRODUCTION

Head and spine injuries occur in rear impacts [1-2]. Parenteau et al. [3] queried 1994 to 2015 NASS-CDS data involving serious-to-fatally injured front seat occupant in a rear crash. The rate of AIS 3+ was highest for the head than other body regions. The AIS 3+ injury rate was 25.9% for head, 12.6% for chest and 3.5% for neck/spine in the 64+ km/h delta V range.

Head and spine injury generally occur in rear crashes from inertial loading [5-6] and from blunt impacts [7-8]. Occupant kinematics and biomechanical loads have been assessed in rear sled and crash tests using post-mortem human subjects (PMHS), anthropomorphic test devices (ATDs) and mathematical models to better understand injury mechanisms. In a rear impact, the vehicle and seat are pushed forward. The occupant moves rearward relative to the vehicle interior due to inertial loading. The seatback rotates rearward with occupant loading. The loading occurs first from pelvis, then the torso, shoulders and the head. The gradual loading leads to straightening of the spine curvature along the seatback, in particular in the thoracic spine. Forces on the chest can lead to spine extension.

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Parenteau and Viano [4] evaluated NASS-CDS data and reported that the relative rate of severe head injury compared to severe spine injury was lowest in rear crashes than in other crash modes. This result implies that there was a higher association between head and spine injuries in rear crashes. The authors also noted that serious (AIS 3+) spine injuries were equally distributed to the cervical and thoracic area in rear crashes. Serious (AIS 3+) injury to the lumbar area were uncommon.

Blunt impacts can occur when the head and upper torso contact the vehicle interior [9-10] and/or intruded structures [11-12]. Various factors can affect the force magnitudes, including intrusion [13,27], crash severity [14], seat strength [15] and initial occupant postures [16].

Field accidents have also been analyzed to identify factors influencing injury risks. Occupant characteristics such as age [17], sex, weight and BMI [18-19] can influence injury outcomes. Viano [15] identified 4 cases involving severe thoracic spine fracture with complete transection. The author reported that the fractures occurred when the upper body hyper-extended around the seatback frame. The inertial loading on the spine may be more severe in heavier occupant because of greater weight of the head and upper torso [15, 20].

Pre-existing medical conditions have also been observed in occupant with serious spine injury in rear crashes [5, 6, 17]. Viano and Parenteau [17] analyzed rear crashes involving a seriously injured front seat occupants in low-to-moderate (<24 km/h) rear crashes and noted an association between spine injury and age. They noted that stenosis was listed in the medical records.

Viano et al. [6] and Davis et al. [5] observed severe spine injuries occurring as the back of the occupant straightens along the seatback due to the crash forces. The authors from both studies noted that this mechanism often involved older occupants and/or occupants with spine pathologies. The pathologies such as DISH and AS stiffened spines which are less flexible under these forces. Some of the injuries occurred at moderate speed.

Few studies have examined specific risk factors associated with serious head and spine injury in rear crashes. Most studies were limited by small sample sizes and resulted in imprecise measures of association. The objective of this study was to provide insight into head and spine injury mechanisms in rear crashes through in-depth review of field-accident cases to quantify and prioritize the sources and mechanisms of injury.

II. METHODS

Field accident data

NASS-CDS data: NASS-CDS is the National Automotive Sampling System, Crashworthiness Data System (www.nhtsa.dot.gov). It is a stratified multiphase, unequal selection probability sample of motor vehicle crashes that are prospectively selected for in-depth investigation. Most of the vehicles were towed from the scene because of damage. The data includes information from crash investigation teams that gather information from the crash site, vehicle, medical records, police accident report and personal interviews. NASS-CDS data for calendar years 1999-2015 was evaluated for light vehicles with 2000+ model year (MY).

Definitions

Impact types: Crash types were defined using the general area of damage with the most deformation (GAD1) and rollover variables:

- Frontal impacts: vehicles with frontal impact location (GAD1=’F’) and no rollover (rollover ≤ 0).
- Side impacts: vehicles with side impact location (GAD1=’L’ or ‘R’) and no rollover (rollover ≤ 0).
- Rear impacts: vehicles with rear impact location (GAD1=’B’) and no rollover (rollover ≤ 0).
- Other impacts: vehicles with other impact location GAD1 in ('T','U') and no rollover (rollover ≤ 0).
- Rollovers: vehicles with a rollover (rollover > 0).

Front-outboard seat occupants were determined as non-ejected (EJECTION = 0) drivers (SEATPOS =11) or right-front passengers (SEATPOS =13) and older than 14 years-old (age>=15 and age<=110).

MAIS was assessed using the Maximum Abbreviated Injury Scale (MAIS). MAIS ranges from 0 to 6 and 9, where MAIS 9 is an injury with unknown severity.

Fatality: “TREATMNT” and “INJSEV” variables were analyzed. Fatality was recorded if the occupant died within 30 days of the crash. Fatality (F) was defined by:

- TREATMNT = 1 since it means that the occupant was fatally injured and not transported to the hospital.
- Police injury severity: INJSEV = 4 represents a fatality from police rating.

Exposed occupants were defined as those with known MAIS (MAIS 0-6) or with a fatality. The shorthand notation is MAIS 0+F. Seriously injured occupants were defined as those with MAIS 3-6 or fatality, because fatalities can occur at any MAIS level. The shorthand notation is MAIS 3+F.

Body regions: Region90 was used to identify body regions.

AIS 3+ injury: AIS 3+ injuries were classified as serious-to-maximum (AIS 3–6) injuries.

Injury sources: Injury sources were identified using the INJOU variable. For example, B-pillar was identified as INJOU = 54 or 104 and seat/seatback as INJOU =151, which includes the front and rear seats/seatbacks.

Individual reviews were completed for 84 cases involving serious-to-maximum head and/or spine/neck injured front seat-occupants in rear crashes where the injury source was coded as either seat/seatback, B-pillar or head restraint. The case summary, coded variables and photos were reviewed to identify the factors that most likely influenced the injury outcome.

Analysis

Weighted data: National estimates for the number of crashes and occupant injuries were made using the inflation ratio (RATWGT) variable in the NASS-CDS. All calculations were based on weighted values. Cases with an inflation ratio equal to 0 or with a negative inflation ratio were excluded from the analysis.

The analysis of rear impact injury by body regions and sources is based on weighted data. The unweighted data is provided in the Appendices. Some numbers in the tables are highlighted in grey. The highlight was used to identify weighted numbers that were based on an unweighted sample ≤ 10. While these samples are small and there should be caution, the numbers represent the best national estimates from the NASS-CDS.

Calculations

Injury rates: The rate that a serious injury was determined by dividing the number of serious-to-maximum injury (AIS 3+) by the number of exposed occupants (MAIS 0+F).

III. RESULTS

Injury risks were determined by crash type using 1999-2015 NASS-CDS. Only non-ejected, front-seat outboard occupants, 15+ years old in 2000+ model year vehicles were considered.

Table 1 summarizes 16 years of NASS-CDS by impact type. It includes the unweighted and weighted sample with standard errors. For example, there were 1,355,747 front occupants in rear impacts with known injury outcome (MAIS 0+F) in the weighted sample. There were 6,734 occupants with MAIS 3+F injury in rear impacts.

TABLE I

FRONT-OUTBOARD OCCUPANTS BY INJURY SEVERITY AND CRASH TYPE IN 2000+ MODEL YEAR VEHICLES (NASS-CDS 1999-2015)

	MAIS 0+F			MAIS 3+F			Risk for MAIS 3+F (%)	
Impact types	unwgt	wgt	se	unwgt	wgt	se	wgt	se
Front	24,030	9,915,097	1,163,295	2,488	219,220	31,695	2.21	0.202
Side	10,400	4,600,486	708,766	1,308	95,839	16,701	2.08	0.149
Rear	3,155	1,355,747	206,725	116	6,734	1,592	0.497	0.120
Rollover	4,774	1,529,765	297,458	812	64,195	15,265	4.20	0.311
Other	307	129,053	38,604	62	3,685	591		
Unknown	9,967	4,528,828	666,543	614	41,506	11,309		
Total	52,633	22,058,976	2,691,567	5,400	431,178	69,543	1.95	0.118

Figure 1 shows the risk of serious-to-fatal injury by crash type based on the weighted sample. The risk for MAIS 3+F was 0.497% ± 0.120% in rear impacts, which was lower than the risk for other impact types. It was highest for rollovers at 4.20% ± 0.311%.

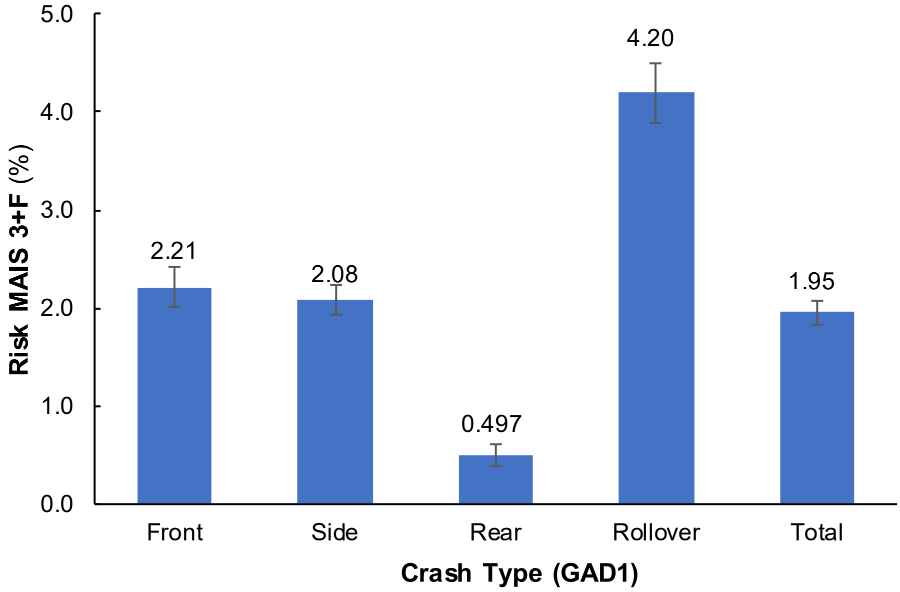

Fig. 1. Risk of serious-to-fatally injured front-seat occupants in rear impacts (weighted data).

Table II shows the weighted number of injuries to front occupants in rear impacts. There were 18,593 AIS 3+ injuries to 6,734 occupants with serious injury (MAIS 3+F) in the weighted sample. There were 2.76 AIS 3+ injuries per serious-to-fatally injured occupant, on average. There were 10,629 AIS 3+ head injuries out of 18,593 AIS 3+ injuries occurring in rear impacts. 57.2% of AIS 3+ injuries were to the head. There were 1,487 AIS 3+ neck/spine injuries. 8.0% of AIS 3+ injuries were to the neck/spine.

TABLE II

FRONT-OUTBOARD AIS 3+ INJURIES BY BODY REGION IN REAR IMPACTS

Rear Impacts	Wgt sample	Distri-bution
MAIS 3+F occupants	6,734	
AIS 3+ by body regions		
Head	10,629	57.2%
Face	0	0.0%
Neck	58	0.3%
Spine	1,429	7.7%
Thorax	3,744	20.1%
Abdomen	890	4.8%
Upper extremity	792	4.3%
Lower extremity	871	4.7%
Unspecified	180	1.0%
Total	18,593	100%
Rate of AIS3+ injury per MAIS 3+F	2.76	
<10 unweighted		

Table III shows the weighted number of contact sources for AIS 3+ head and neck/spine injuries in rear impacts. Table A2 provides additional information including unweighted and se data. The pillars, head restraint and seatback were common sources of serious (AIS 3-6) head injury to front occupants in rear impacts. For example, NASS-CDS identified 1,183 (27 unweighted) cases with AIS 3+ head injury from contact with the B-pillar. Injury sources were grouped by interior impact area. Most serious-to-maximum head injury occurred from contact with a front component (44%), rear component (36%), side component (12%).

TABLE III

FRONT-SEAT OCCUPANT SERIOUS-TO-MAXIMUM (AIS 3-6) HEAD/NECK/SPINE INJURY BY INJURY SOURCE IN REAR IMPACTS.

	AIS 3+ Injuries			
	Head		Neck/Spine	
	Wgt sample	Distri-bution	Wgt sample	Distri-bution
All injuries	10,629		1,451	
Injury sources				
Rear components	3,826	36%	1,324	91%
Seatback	258		571	
Head restraint	2,736		742	
Other pillar	155		11	
Rear header	360			
Other rear objects	295			
Other veh rear surface	21			
Side components	1,244	12%	91	6%
B-pillar	1,183		81	
Door - forward UQ	42			
Door - rear UQ	19		10	
Frontal components	4,686	44%	14	1%
Windshield	4,471			
Sunvisor reinforced	155			
Steering wheel	20		14	
Instrument panel	40			
Other	660	6%	0	2%
Other restraint comp	143			
Other occupants	19			
Other interior object	446			
Roof/convertible	52			
Floor/transmission			36	
Unknown	213	2%	21	1%

UQ: upper quadrant

<10 unweighted

Each case involving a head or a neck/spine injury where the injury source was coded as head restraint, seatback and B-pillar was downloaded. Photos were reviewed to help identify factors that most likely influenced the injury outcome. Table IV summarizes serious-to-maximum (AIS 3-6) head injury to front-seat occupants where the coded injury source was as either seatback, head restraint and B-pillar. Similarly, table V summarizes serious-to-maximum (AIS 3-6) neck and spine injury. The associated injury factor is also identified.

There were 568 (11 unweighted) cases associated with 1,183 (27 unweighted) AIS 3+ head injury from contact with the left B-pillar. Because of the small sample, the unweighted number of cases are discussed. Of the 11 unweighted cases, one case was unavailable for review. Seven out of the remaining 10 cases were related to B-pillar intrusion; one cases involved a fire. One case (2007-11-89J involved three severe head injuries including a cerebrum bilateral subdural hematoma (AIS 4), a cerebrum hematoma on the left (AIS 5) and right-side (AIS 5). It also involved 2 serious (AIS 3) cervical injuries included posterior fractures of the C1 and C2 pedicles. The case involved multiple events including a rear impact and a left-side impact. The intrusion was 35 cm in the left second-row area along the longitudinal axis. There was 13 cm lateral intrusion at the B-pillar.

TABLE IV
FRONT-SEAT OCCUPANT SERIOUS-TO-MAXIMUM (AIS 3-6) HEAD INJURY WITH SEATBACK, HEAD RESTRAINT AND B-PILLAR AS THE CODED INJURY SOURCE IN REAR IMPACTS.

	MAIS 3+F Occupants		AIS 3+ Injuries	
	wgt	unwgt	wgt	unwgt
Head			10,629	143
Side component				
B-pillar	568	11	1,183	
Factors				
Intrusion	250	7		27
Direct contact	317	4		
Rear component				
Seatback	117	4	258	
Factors				
Intrusion	117	4		10
"Diving"	0	0		
Head restraint	1,492	22	2,736	
Factors				
Intrusion	393	10		47
Inrtrusion & Oblique loading	110	3		
Other/unk	989	9		
<10 unweighted				

TABLE V
FRONT-SEAT OCCUPANT SERIOUS-TO-MAXIMUM (AIS 3-6) NECK/SPINE INJURY WITH SEATBACK, HEAD RESTRAINT AND B-PILLAR AS THE CODED INJURY SOURCE IN REAR IMPACTS.

	MAIS 3+F		AIS 3+ Injuries	
	wgt	unwgt	wgt	unwgt
Neck/spine			1,487	39
Side component				
B-pillar	41	1		
Factors				
Intrusion	41	1	81	2
Rear component				
Seatback	571	18	571	18
Factors				
Intrusion	252	9		
"Diving"	61	3		
Other/unk	259	6		
Head restraint	449	9	742	14
Factors				
Intrusion	282	4		
2nd row comp	79	3		
ABTS	55	1		
Other/unk	33	1		
<10 unweighted				

Individual cases were also reviewed where seatback was coded by NASS-CDS investigator as the injury source for AIS 3+ head, neck or spine injury. There were 258 head and 571 neck/spine AIS 3+ injuries with seat or seatback as the source in the weighted sample. This involved 117 weighted (4 unweighted) occupants with serious head injury and 571 (18 unweighted) occupants with injuries to the neck/spine. The individual cases were reviewed for the damage to the vehicle and interior. For the head AIS3+ injuries, the occupants were injured by intrusion pushing rear structures forward into the front occupant. There was no case of a "diving" type impact into the rear seatback causing AIS 3+ head injury. Diving impacts are when the front-seat occupant moves head-first into the second-row area.

For the neck/spine AIS3+ injuries, there were 571 weighted (18 unweighted) occupants related to the seat and seatback. The majority were spine injuries were to the thoracic spine (76.6%). 252 weighted (9 unweighted) occupants were injured by intrusion of the rear structures, which were deformed forward into the occupant. Sixty-one (3 unweighted) occupants were injured by "diving" type impacts into the rear seatback. The other occupants were injured by the front seatback or an unknown source based on the case review.

There were 1,492 (22 unweighted) front-seat occupants associated with the 2,736 weighted (47 unweighted) AIS 3+ head injuries from contact with the head restraint. 503 cases (13 unweighted) involved significant intrusion that supported the seatback; 110 (3 unweighted) of these involved an oblique impact. There were 742 (9 unweighted) front-seat occupants with AIS 3+ spine injury; 282 (4 unweighted) were related to significant intrusion, 55 (one unweighted) to an ABTS seat and 79 (3 unweighted) cases to second-row components including an empty child seat, a folded down seatback and an occupant.

IV. DISCUSSION

This study provides insight into rear impact injury frequency, risk and injury mechanisms. NASS-CDS data was queried from 1999 to 2015. The 17 years of accident investigation involved 1,355,747 weighted (3,155 unweighted) number of front-seat occupants with trained investigator review and in-depth evaluation of the vehicle and injuries.

The risk of serious-to-fatal injury was lowest in rear impacts consistent with prior studies [3,17,21]. Most serious injuries were to the head and the thorax consistent as previously reported [3,27]. This study was focused on head and spine injury mechanisms as these types of injuries can lead to long term consequences [28]. Head injuries in rear crashes were most commonly associated with impact with a frontal or rear component. Neck injuries were most commonly from contact with rear components. Digges et al. [22] analyzed rear field accidents and found that contact injuries were most commonly attributed to the seat and frontal components. More than half of the occupants in severe crashes received injuries from frontal contact, and some were in seats that did not deform during the crash. Partyka [23] reported similar findings. She also found that secondary frontal impacts contributed to rebound injuries.

Of the coded injury sources, seatbacks, head restraints and B-pillar were most common. NASS-CDS cases were reviewed individually for rear cases involving serious head and spine injury associated with these sources. The case review identified no case of AIS 3+ head injury by "diving" type motion into the rear seatback in rear impacts. NASS-CDS identified 61 weighted cases (3 unweighted) of AIS 3+ spinal injuries by "diving" type impact on the rear seatback. Diving kinematics has been reported in high-speed rear-end sled tests, however, the tests were conducted with vintage seats [9]. Burnett et al. [9] noted high biomechanical responses when the seatback deflected rearward and the front-seat occupant moved to the second-row area. The head contacted the second-row seatback in 40 km/h rear sled tests with two seats. Both seats had a stiffness less than 27 kN/mm and a model year older than 1995. Seat stiffness and strength has increased with model years [24,25].

In this study, there were 571 occupants (8 unweighted) where the most significant spine injury source was coded as seatback. More than 75% of the occupants had injury to the T-spine. Most cases were related to intrusion pushing rear structures forward into the occupant's seatback. The effect of intrusion on occupant responses has been studied with rear crash tests [12-13]. Parenteau et al. [13] analyzed high-speed rear crash tests. They noted that the head and neck biomechanical responses were above injury reference values when a 4-door sedan was struck in the rear by a heavy truck at 58 km/h. The delta V for the sedan was 53 km/h. The impact resulted in significant second-row intrusion. The second-row area was pushed forward and was rigidized by the front of the truck. The intrusion was severe and supported the front seatback.

Head restraint was the coded injury sources for 449 (9 unweighted) occupants with serious spine injury and for 1,492 (22 unweighted) with serious head injury. In many cases, the second-row intrusion supported the front seatback and limited seatback rotation. Of these, 110 (3 unweighted) involved an oblique impact. Viano [26] studied fatalities of belted occupants and identified several cases of a driver involved in a 4 or 5 o'clock impact with excursion of the driver toward the PDOF with a head impact on the right-rear intrusion. The cases involved the upper body sliding off the seatback toward the intrusion. The motion was away from the shoulder belt.

For spine injury with head restraint contact, all occurred to the cervical spine. There was one case where the front seatback contacted an empty child seat. There was another case where the front seatback contacted the folded-down second-row seatback. In both cases, the contact from the rear supported the front seatback and limited seatback rotation. Viano et al. [16] identified a case with an ABTS seat with thoracic injury from the stiff seatback and cervical injury from the head restraint. ABTS seats are stronger than conventional seats.

This study included 2000+ model year vehicles, because ~~se~~at strength has increased with over-time [24,25]. Rear structure stiffness has also increased in response to new FMVSS 301 test requirements [29]. Viano and Parenteau [30] compared injury risks of front seat occupants in older vehicles (1996–2001 MY vehicles) to modern vehicle (2008+ MY vehicle) and found a reduction. The authors concluded that the revision to FMVSS 301 was effective in reducing the risks for fatal and severe injury in vehicles compliant with the revision.

In this study, 1999 to 2015 NASS-CDS data was analyzed. In 2016, the Crash Investigation Sampling System

(CISS) replaced NASS-CDS and became publicly available in 2017. Like NASS-CDS, the database is based on police crash reports randomly selected from areas across the country to reflect the geography, population, miles driven, and crashes in the United States. Similar to CDS, CISS has a stratified multiple-stage sample design. CISS data was not analyzed in this study because of differences in some of the variables.

V. CONCLUSIONS

This study was conducted to provide insight into injury mechanisms in rear crashes. The analysis indicated that serious head injuries were commonly associated with front and rear interior components whereas spine injury most frequently occurred from contact with rear interior, indicating different kinematics. Understanding injury sources and causes is important to help guide future designs. The head injury data suggests that side curtains may be beneficial in rear crashes.

VI. LIMITATIONS

Some analysis reported in this study was based on a small number of unweighted data and should be used as trends.

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Appendix A: Weighted and unweighted data

TABLE A1
Front-outboard AIS 3+ injuries by body region in rear impacts

	Sample size		
Rear Impacts	unwgt	wgt	se
	MAIS 3+F		
Occupants	116	6,734	1,592
Body regions	AIS3-6 Injuries		
Head	143	10,629	5,219
Face	0	0	0
Neck	1	58	58
Spine	38	1,429	488
Thorax	116	3,744	1,279
Abdomen	19	890	635
Upper extremity	17	792	257
Lower extremity	17	871	515
Unspecified	10	180	80
Total	361	18,593	6,585

<10 unweighted

TABLE A2
FRONT-SEAT OCCUPANT SERIOUS-TO-MAXIMUM (AIS 3-6) HEAD/NECK/SPINE INJURY BY INJURY SOURCE IN REAR IMPACTS.

	AIS 3+ Injuries					
	Head			Neck/Spine		
	unwgt	wgt	**Distr**	unwgt	wgt	**Distr**
All injuries	143	10,629		39	1,487	
Injury sources						
Rear components			36%			89%
Seatback	10	258		18	571	
Head restraint	47	2,736		14	742	
Other pillar	10	155		1	11	
Rear header	6	360				
Other rear objects	1	295				
Other veh rear surface	1	21				
Side components			12%			6%
B-pillar	27	1,183		2	81	
Door - forward UQ	2	42				
Door - rear UQ	2	19		1	10	
Frontal components			44%			1%
Windshield	8	4,471				
Sunvisor reinforced	4	155				
Steering wheel	4	20		1	14	
Instrument panel	1	40				
Other			6%			2%
Other restraint comp	3	143				
Other occupants	1	19				
Other interior object	2	446				
Roof/convertible	2	52				
Floor/transmission				1	36	
Unknown	12	213	2%	1	21	1%

Notes
UQ: upper quadrant
<10 unweighted

TABLE A3

FRONT-SEAT OCCUPANT SERIOUS-TO-MAXIMUM (AIS 3-6) HEAD INJURY WITH SEATBACK, HEAD RESTRAINT AND B-PILLAR AS THE CODED INJURY SOURCE IN REAR IMPACTS.

		AIS 3+ Injuries		MAIS 3+F Occupants	
	%	unwgt	wgt	unwgt	wgt
Head		143	10629		
Front component	44%				
Side component	12%				
B-pillar		27	1183	11	568
Factors					
Intrusion				7	250
Direct contact				4	317
Rear component	36%				
Seatback		10	258	4	117
Factors					
Intrusion				4	117
"Diving"				0	
Head restraint		47	2736	22	1492
Factors					
Intrusion				10	393
Inrtrusion & Oblique loading				3	110
Other/unk				9	989
Other component	8%				
<10 unweighted					