Restraint Effectiveness in Reducing Head/Face Injury-contacts with Interior Rail-like Surfaces

Daniel Blower
Kenneth Campbell

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The University of Michigan
Transportation Research Institute
Ann Arbor, Michigan 48109-2150

Disclaimer

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16. Abstract

The objective of this analysis is to evaluate the effectiveness of restraints in preventing head/face injury-contacts with interior rail-like surfaces, i.e., the front header, A-pillar, siderail, and B-pillar. In order to make comparisons by restraint use, an injury-contact rate is calculated as the number of injury-producing contacts per hundred involved occupants. Data are from the 1988-1992 National Accident Sampling System (NASS) Crashworthiness Data System (CDS). The analysis is limited to passenger vehicle drivers in towaway, frontal impacts.

Distributions of injury-producing contacts and injury-contact rates are presented for four restraint configurations: unrestrained, three-point belted, driver airbag alone, and driver airbag plus three-point belt. For each restraint configuration, distributions of contact points are presented and injury-contact rates are calculated. Special attention is given to head/face contacts with interior rail surfaces, particularly the front header and A-pillar. The fundamental finding is that the combination of airbags with three-point restraints substantially reduces the incidence of serious (AIS 2+) head/face injuries from contact with the front rail system. Drivers with airbags and three-point restraints received 0.007 AIS 2+ head/face injuries from the front rails per hundred drivers involved in frontal collisions. This compares with 0.577 per hundred for three-point restrained drivers and 1.165 for drivers with no restraints. In the cases where contact did occur, there was typically intrusion. Airbags and three-point restraints have much less impact on head/face injury-contact rates with the siderail and B-pillar in frontal collisions. It appears that head/face contact with the siderail or B-pillar in frontal collisions is relatively unaffected by restraint use.

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Table of Contents

Tables

Head/Face Injury-contacts in the National Accident Sampling System

Introduction

The National Highway Traffic Safety Administration (NHTSA) has issued a proposed rulemaking (Docket 92-28; Notice 2) to require automobile manufacturers to install padding on the upper interior components to mitigate head and face injuries in the event of a collision. The interior rail-like surfaces to be padded are the front header, A-pillar, roof siderail, and the B-pillar. If adopted, the rule will require that rail-like surfaces be padded possibly as early as the 1997 model year. At that time, airbags will be installed as standard equipment on all passenger vehicles.

Much of the research in support of the proposed rulemaking used accident data that did not include a substantial number of cars with airbags, and the analyses themselves did not consider the effect of airbags in protecting against head and face injuries.[1] This report specifically addresses the role of airbags and three-point manual restraints in protecting against head and face injuries from interior rail surfaces in frontal collisions.

Summary of findings

The fundamental finding is that the combination of airbags and three-point restraints significantly reduces the incidence of serious (AIS 2+) head/face injuries from contact with the front rail system (front header and A-pillar). Drivers with airbags and three-point restraints received 0.007 AIS 2+ head/face injuries from the front rails per hundred drivers involved in a frontal collision. This compares with 0.577 for belts-only drivers and 1.165 for drivers with no restraints.

Though airbags substantially reduce head/face contacts with the front rails, they do not eliminate them. However, in the cases where contact does occur, there is typically

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[1] The primary document is Partyka, S.C., *Serious head injury in light passenger vehicles from rail, header, and pillar contact.* Docket No. 88-06-GR-003. National Traffic Highway Safety Administration, Washington, D.C.

evidence of intrusion of the A-pillar/front header into the passenger compartment. Four cases were found in the analysis file (see below for a discussion of the data) where a driver in a vehicle with a deployed airbag suffered serious head/face injuries associated with the front rails. In three of the cases there was evidence of intrusion of the rail system into the passenger compartment. In the fourth case, the unbelted driver was thrown across the car and struck the *right* A-pillar.

Airbags and three-point restraints have much less impact on head/face injury-contact rates with the siderail and B-pillar in frontal collisions. Calculated injury-contact rates were similar for all restraint combinations. Small sample sizes are a concern, but it appears that head/face contact with the siderail or B-pillar is relatively unaffected by restraint use. This is not surprising, since only frontal collisions are considered in this analysis.

Data

Five years of data from the National Accident Sampling System Crashworthiness Data System (NASS CDS) were combined to produce the analysis data file. Since sample sizes for crashes involving a deployed airbag are a concern, the data file included as many years of NASS as was feasible. The 1992 NASS CDS file is the most current file available. The earliest practical year of NASS is the 1988 file, which is the first year of the current data format and data collection protocol.

The analysis file consisted of data from two groups of crash-involved vehicles. The first group is all vehicles in which an airbag deployed. The second group consisted of vehicles in which an airbag did not deploy, but which matched the airbag group on vehicle type, accident type, and collision severity. Cases chosen for the non-airbag comparison group met the following criteria:

1. Vehicle type limited to passenger cars and light passenger vehicles.
2. Direction of force 10 o'clock to 2 o'clock.
3. Vehicle towed from the scene.
4. Cases with calculated delta-V under 10 excluded.

The purpose of these restrictions was to select a group of crash-involved vehicles that were not equipped with airbags, but which nevertheless matched the airbag-deployed group of cases in vehicle type, accident type, and crash severity. Although the match between the airbag and non-airbag group was satisfactory and probably the best achievable under the circumstances, it was not perfect. The groups compared very well on the distribution of the direction of force, but the airbag group had somewhat more larger cars. Also, despite excluding cases with a calculated delta-V under 10mph from the non-airbag group, average delta-Vs for the non-airbag group were slightly lower than for the airbag-deployed group, 15.7 versus 16.3. While not desirable, these are not

insurmountable problems and, in fact, taken together result in somewhat understating the effect of airbags in reducing head/face injury-contacts. A full discussion of case selection and the a comparison of the two groups is presented in appendix A.

Weights in NASS

The NASS CDS file is a sample file of police-reported accidents. Weight variables are included in the file so that population totals can be estimated. For the 1988 and 1989 NASS files, the raw cases are weighted with the "national inflation factor." In 1990, NASS data collection procedures were changed to smooth out investigators' workloads. Investigators worked on a fixed number of cases per week, rather than a fixed proportion of cases. At the same time, a new weight variable, the "ratio inflation factor," was added to the file to adjust for the new case selection procedure and to lower associated variances. Unfortunately, case weights still vary widely. For the airbag population, case weights range from 1.735 to 7,673.250. The range is even greater for the non-airbag population–1.804 to 23,407.286. Consequently, the variances of estimates made using the file are also large.

Method

The focus in this analysis is on injuries associated with interior vehicle components, in particular, the front header, A-pillar, siderail, and B-pillar. Accordingly, the method adopted here counts the most severe injury associated with each vehicle component of interest. The first step in generating these "injury-contact" counts is to aggregate the variable for injury source into the twelve categories listed in table 1. Then, for each of the twelve contact points, the AIS classification of the most severe injury is determined. For example, a driver may have received four injuries from components of the instrument panel. The original NASS CDS injury source variable breaks the instrument panel down into three areas: left, center, and right. The recoded injury source variable combines the three areas into one for the instrument panel as a whole. If one of the driver's injuries was attributed to the center of the panel and three to the left panel, in the *file* with the recoded variable, he would have four injuries from the instrument panel. The single injury with the highest AIS level among these four would be counted in the *tables*. An identical procedure is followed for the other eleven contact points. Some of the tables focus on injuries to the head or face. For these tables, injury records for all other body parts are discarded and then the procedure described here is followed.

The analysis, then, addresses injuries associated with particular vehicle components, rather than a count of individual injuries or of injured persons. This approach has certain advantages. It avoids over-counting injuries. There are instances in the file where multiple injuries are coded for a single body part and a single contact point. For a facial fracture produced by contact with the A-pillar, there can be injury records for each of the broken bones. Counting each such fracture may skew the results by over-counting some injuries. On the other hand, taking only the maximum AIS injury for each *occupant* understates the injuries sustained. For example, an AIS-6 from the steering

wheel could mask an AIS-5 from the front header. The approach adopted here focuses on the main issue at hand, which is the injury-producing potential of specific interior surfaces.

Table 1: Injury-contact points

Contact point	NASS injury source code
Front header/A-pillar	3,22,32,50
Siderail/B-pillar	23,33,52,53
Steering assembly	4-7
Instrument panel	8-13
Side window	25,26,35,36
Windshield	1,2,14,15
Side door	20,21,27,28,30,31,37,38
Roof	54
Belt restraint	41-43
Airbag	45
Other interior	16,24,34,40,44,46-49,51, 56-62
Exterior	65-86

One additional correction is made to the data. About 10% of the unweighted airbag contacts and 13% of the unweighted non-airbag contacts are of an "unknown" injury source. The injury-producing contact point could not be determined for these cases. Since the proportion of unknowns was higher for the airbag than the non-airbag groups, injury totals and injury-contact rates would be biased such that airbag rates would be overestimated relative to non-airbag rates. To correct for this bias, it was assumed that the unknown injury source contacts had the same distribution as the known source contacts, and they were distributed among the known cases accordingly. This adjustment was made separately within each AIS level.

The body of the paper presents percentage distributions of injury-contacts and injury-contact rates. Injury-contact rates are a convenient way of comparing the absolute magnitude of injuries associated with different restraint combinations. Injury rates are calculated by dividing the number of the most severe injury-producing contacts by the number of exposed drivers. The result is then scaled to produce a rate of injury-contacts per 100 exposed drivers (deployed driver airbag or matched non-airbag driver). The following equation was used:

$$(\text{injury rate}) = \frac{\#\ \text{injury contacts}}{\#\ \text{exposed drivers}} * 100$$

A complete set of tables can be found in appendix B. These tables show the distribution of injury-contacts across various vehicle components for vehicles in which an airbag deployed and for comparable vehicles in comparable collisions where no airbag

deployed. The tables present raw counts, column percentages, and weighted totals of driver injury-contacts for the airbag and non-airbag groups, and within each group, for the situation where the driver used three-point manual restraints and where the driver was unbelted. In the discussion below, tables are presented which summarize the main results from the full set of tables found in appendix B.

Discussion of results

In the final 1988-1992 NASS file prepared for this project, there were 489 vehicles in which an airbag deployed. The drivers of those vehicles experienced 794 injury-producing contacts, using the method for counting contacts described above. The comparison group of vehicles, chosen as involved in similar accidents of similar severity, included 12,606 cases (vehicles) in which drivers suffered 19,344 injury-producing contacts. This is ample data for the non-airbag group, but the airbag group still has relatively few cases, especially when looking at specific contact points and specific injury severities. In five years of NASS, there are only 37 contacts of any sort with the rail surfaces for drivers of airbag-deployed vehicles. Only 19 of these contacts were the most severe (maximum AIS) for the driver.

Distributions of injury-contacts

The distribution of injury-producing contacts with interior surfaces of passenger cars in frontal collisions is significantly changed by the use of airbags and safety belt restraints. Drivers of vehicles with airbags, particularly when three-point restraints are used, have lower proportions of injury-contacts with the vehicle components in front of the driver and higher proportions of contacts with components of the restraint system. Contacts with components on the sides of the car are relatively unaffected. Table 2 shows the distribution of contacts for all types of injuries across the interior of the vehicle.

Since all the cases considered here are frontal collisions, most of the contacts are with vehicle components in front of the driver. For drivers of cars without airbags, the steering assembly, instrument panel, and windshield account for most of the injury-contacts. Together these three contact points account for 52% of belted drivers' contacts and 78% of unbelted drivers' contacts. The difference between the belted and unbelted proportions is largely accounted for by the dramatic drop in injury-contacts with the windshield when three-point belts are used. Unbelted drivers receive 28.2% of injury-contacts from the windshield, compared with 9.0% for drivers using three-point restraints. Note also that almost 20% of injury-contacts for belted drivers are with the restraint system itself. For drivers without airbag restraint systems, contacts with rail components—front header, A-pillar, siderail, B-pillar—are similar regardless of belt use: 3.2% for unbelted and 3.8% for belted drivers.

Table 2: Distribution of all injury contacts by contact point

	airbag			no airbag		
Injury source	belt	no belt	all	belt	no belt	all
Front hdr/A pillar	0.28	0.89	0.48	3.77	3.19	3.47
Siderail/B pillar	0.50	0.09	0.37	0.66	0.65	0.66
Steer assembly	8.55	5.38	7.52	20.72	25.66	23.26
Instrument panel	15.24	17.56	15.97	22.60	23.98	23.31
Side window	0.27	4.65	1.61	3.46	2.48	2.96
Windshield	6.10	14.28	8.59	9.02	28.20	18.86
Side door	7.18	7.32	7.20	8.79	5.57	7.14
Roof	0.16	1.87	0.69	0.56	0.60	0.58
Belt restraint	17.41	0.07	12.12	19.64	0.35	9.74
Airbag	34.31	37.22	35.23	0.02	0.00	0.01
Other interior	9.82	7.41	9.13	10.44	8.59	9.49
Exterior	0.18	3.25	1.09	0.33	0.72	0.53
Total	100.00	100.00	100.00	100.00	100.00	100.00

In passenger vehicles equipped with airbags, a high proportion of injury-contacts are with the airbags themselves. This is particularly true when airbags are used in combination with three-point belt restraints. Injury-contacts with frontal components are not eliminated, but they are substantially reduced as a proportion of total contacts. The steering assembly, instrument panel, and windshield account for only 29.9% of the injury-contacts of drivers restrained by both airbags and belts, and 37.5% of the contacts for drivers restrained by airbags alone. Contact with the rail system is also substantially reduced in relation to drivers without airbags. Front header and A-pillar injury-contacts are reduced to only 0.3% for drivers who had both three-point belts and an airbag and 0.9% for drivers with only an airbag. The comparable proportions are 3.8% and 3.2% for drivers with belts-only and no restraints, respectively. These are reductions by factors of 12 for the airbag-belt group over belts alone and 3.5 for the airbag-only group over no restraints. In contrast, 51.7% of injury-contacts are associated with the restraint system, either the belt or the airbag, for drivers with both deployed airbags and three-point restraints. Airbags are associated with 37.2% of the injury-contacts for drivers with airbags alone.

Contacts with the siderail or B-pillar are fairly similar for all restraint-use categories. This is not unexpected, since the collisions are all frontal.

The distribution of head/face contacts is also significantly altered by restraint use. Head/face injury-contacts naturally are primarily with surfaces in front of the driver. Drivers without airbags receive most of their head/face injury-contacts with the windshield, steering assembly, and front header/A-pillar. For these drivers, belt use decreases the proportion of contacts with the windshield and increases the proportion of contacts with the steering assembly, instrument panel, and front header/A-pillar complex. The front header or A-pillar account for over 12% of the head/face injury-contacts of belts-only drivers, compared with 6% for unbelted drivers. It appears that the reason unbelted drivers have a lower proportion of front rail contact is because they

were hitting the windshield. Almost 56% of the head/face injuries of unbelted drivers were associated with contacting the windshield.

Table 3: Distribution of head/face injury contacts by contact point

	airbag			no airbag		
Injury source	belt	no belt	all	belt	no belt	all
Front hdr/A pillar	0.94	3.22	1.70	12.11	6.01	8.17
Siderail/B pillar	1.71	0.32	1.39	1.89	1.10	1.38
Steer assembly	1.10	1.64	1.27	37.29	22.20	27.53
Instrument panel	0.00	0.49	0.16	1.45	6.69	4.83
Side window	1.04	11.27	4.32	10.26	4.19	6.34
Windshield	13.37	40.88	22.19	28.74	55.80	46.22
Side door	0.16	0.00	0.08	1.85	1.02	1.32
Roof	0.53	6.90	2.55	1.78	0.88	1.19
Belt restraint	10.01	0.00	6.83	0.28	0.01	0.10
Airbag	68.30	28.79	55.81	0.06	0.00	0.02
Other interior	2.17	0.00	1.48	3.67	1.17	2.06
Exterior	0.66	6.50	2.24	0.62	0.93	0.83
Total	100.00	100.00	100.00	100.00	100.00	100.00

Drivers restrained by airbags have much lower percentages of head/face injuries associated with the front rail system (front header or A-pillar). All drivers of airbag-deployed vehicles have only 1.7% of their head/face injuries from the front rails, compared with 8.2% for drivers without airbags. Drivers restrained by both belts and airbags have less than 1% of their contacts with the front rails, while drivers restrained only by airbags suffered 3.2% of their head/face injury-contacts from the front rails. These drivers also have lower proportions of contacts with the windshield, particularly drivers with both belts and airbags. In contrast, a high proportion of their injury-contacts were with the restraint system itself. This is particularly true for the belts-and-airbags group. Almost 70% of their head/face injuries are associated with the airbag, and a further 10% with the belt system.

In a sense, these distributions show that the restraint system is working correctly. In order to have an effect, restraints must interpose between the driver, in this case, and the vehicle components. Contact that would otherwise be with the interior of the vehicle instead occurs with the restraint system. The driver of a vehicle with both safety belts and an airbag is held in place by the safety belts so that his forward momentum can be absorbed by the airbag. In contrast, note the high proportion of injury-contacts with the windshield and front rail system for drivers who used airbags without safety belts. The force of impact in some cases apparently threw these drivers around the airbag so their heads could collide with the other surfaces.

Changes in percentage distributions is like squeezing a balloon—a decrease in one category necessarily requires an increase in another. Thus changes in percentages do not mean that injuries are literally *shifted* from one source to another, with the total

number of injuries remaining the same. Injury-contact rates help sort out how restraint types affect the total number of injury-contacts received.

Overall injury-contact rates

Table 4 shows injury-contact rates by restraint use calculated as the number of injury-contacts per hundred involved drivers for each of the restraint categories. All contact points on the vehicle and all body regions are included. Overall, the group with airbags actually has a higher injury-contact rate than the group without airbags, 118.4 versus 98.9. The group with the lowest injury-contact rate is the group restrained only by three-point safety belts, with 78.4 injury-contacts per hundred involved drivers. The airbag-only group has an injury-contact rate similar to that of unrestrained drivers. Across AIS level, the two belted categories look similar, as do the two unbelted groups. The major difference between the injury-contact rates of the two belted groups (with an airbag and without an airbag) is in the injury-contact rate for AIS 1 injuries, where drivers restrained by both airbags and three-point restraints have higher rates of AIS 1 injuries. The rates for AIS 2 and AIS 3+ injuries are similar between the two belted groups.

Table 4: Injury rate per hundred drivers by AIS level and restraint type

	AIS level			
Restraint type	1	2	3+	Total
Airbag & belt	102.460	7.982	2.376	112.818
Airbag only	104.002	20.851	8.425	133.277
All Airbag	102.878	11.471	4.015	118.365
3-point belt only	67.952	8.274	2.149	78.375
No restraints	105.676	19.047	7.539	132.263
All non-airbag	82.354	12.387	4.206	98.947

Table 5: Head/face injury rate per hundred drivers by AIS level and restraint type

	AIS level			
Restraint type	1	2	3+	Total
Airbag & belt	25.617	2.267	0.303	28.187
Airbag only	23.984	8.983	1.752	34.719
All Airbag	25.174	4.087	0.696	29.957
3-point belt only	17.709	3.389	0.493	21.591
No restraints	48.910	10.735	1.885	61.530
All non-airbag	29.621	6.193	1.024	36.838

The airbag group as a whole looks better than the non-airbag group when head/face contacts are considered, though three-point restraints alone still have the lowest overall injury-contact rate. Table 5 shows injury-contact rates for head/face injuries by restraint type. All contact-points on the vehicle are included, though injuries are limited to those of the head and face. Again, restraint type has a large effect on the total

number of head/face injury-contacts sustained. Unrestrained drivers have the highest total rate and the highest rate at each AIS level. Drivers using three-point safety belts alone, with no airbags, have the lowest overall rate, though the airbag-and-belt group has the lowest rates of AIS 2 and AIS 3+ injury-contacts. Differences with the three-point-belt-only group are not marked however, other than at the AIS 1 level. Note that all head/face injury-contacts are included in this table, not just contacts with the rail system.

Injury-contact rates by vehicle component

An unexpected result shown in table 4 was that airbags do not seem to reduce the overall number of injury-contacts when all body regions and all contact points are considered. Three-point restraints alone have the lowest rates of injury-contacts, while the rates are about the same for airbags alone and no restraints at all. Overall, drivers with airbags experience about 20 more injury-contacts per hundred drivers than drivers without airbags. It should be emphasized that *all* injuries and all vehicle contact points, including restraint systems, are counted here.

For drivers with no restraints, the steering assembly, instrument panel and windshield together account for about 100 injury-contacts out of the total of 132 injury-contacts per hundred drivers (table 6). The major contact points for drivers with three-point belts are the steering assembly, instrument panel, and belt restraints themselves, which together account for about 50 injury-contacts, out of a total of 78.4. The use of three-point restraints reduces the rate of injury-contact with the front header/A-pillar about 40%, from 4.2 to 3.0. The largest reduction is in contact with the windshield, from over 37.3 to 7.1.

Table 6: Injury rate for all injuries per hundred drivers by injury source and restraint use

	airbag			no airbag		
Injury source	belt	no belt	all	belt	no belt	all
Front hdr/A pillar	0.317	1.189	0.564	2.953	4.219	3.434
Siderail/B pillar	0.560	0.115	0.435	0.517	0.865	0.650
Steer assembly	9.651	7.175	8.905	16.239	33.944	23.016
Instrument panel	17.194	23.399	18.902	17.710	31.716	23.065
Side window	0.303	6.193	1.909	2.708	3.285	2.925
Windshield	6.882	19.032	10.171	7.068	37.293	18.663
Side door	8.099	9.760	8.527	6.891	7.363	7.061
Roof	0.177	2.497	0.815	0.440	0.798	0.578
Belt restraint	19.646	0.095	14.346	15.392	0.468	9.635
Airbag	38.705	49.609	41.695	0.014	0.002	0.009
Other interior	11.081	9.881	10.801	8.181	11.362	9.388
Exterior	0.203	4.331	1.294	0.261	0.948	0.523
Total	112.818	133.277	118.365	78.375	132.263	98.947

Drivers with airbags have much lower contact rates with vehicle components in front of the driver, except for the instrument panel. For drivers using both an airbag and a three-point restraint, injury-contact rates with the front header/A-pillar are only 0.317 per hundred drivers, or about 1 contact per 315 drivers involved in a frontal collision. Where only an airbag is used, the rate is 1.189, or 1 contact per 84 involved drivers. Still, these rates are substantially lower than the rates for drivers with three-point restraints only or no restraints, which are 2.953 (1 per 34) and 4.219 (1 per 24) respectively.

Head/face contacts in frontal collisions with the forward rail components—the front header and A-pillar—are almost eliminated by the combination of airbags and three-point restraints. Airbags alone, without three-point restraints, also substantially reduce head/face contact with the front header/A-pillar, though the rate is higher than for the combination of airbag-three-point restraint. There were 0.266 head/face injury-contacts per hundred drivers with the front header/A-pillar for drivers with airbags and three-point restraints (table 7). Drivers with airbags alone experienced 1.12 head/face injury-contacts with the front header/A-pillar. Both of these rates are substantially lower than the rates for three-point restraints only (2.614) and no restraints (3.696).

Table 7: Injury rate for head/face injuries per hundred drivers by injury source and restraint use

	airbag			no airbag		
Injury source	belt	no belt	all	belt	no belt	all
Front hdr/A pillar	0.266	1.120	0.508	2.614	3.696	3.010
Siderail/B pillar	0.482	0.111	0.416	0.409	0.679	0.508
Steer assembly	0.310	0.571	0.379	8.051	13.659	10.142
Instrument panel	0	0.169	0.047	0.312	4.117	1.780
Side window	0.294	3.911	1.294	2.216	2.580	2.336
Windshield	3.768	14.192	6.646	6.204	34.331	17.027
Side door	0.045	0	0.023	0.399	0.628	0.485
Roof	0.149	2.396	0.763	0.384	0.542	0.440
Belt restraint	2.823	0	2.047	0.060	0.005	0.038
Airbag	19.252	9.994	16.718	0.014	0.002	0.009
Other interior	0.613	0	0.444	0.793	0.722	0.759
Exterior	0.186	2.256	0.672	0.135	0.570	0.304
Total	28.187	34.719	29.957	21.591	61.530	36.838

Head/face contacts with the siderail/B-pillar system are much less affected by restraint type. The injury-contact rates, as shown in table 7, are somewhat lower for cars equipped with airbags, but they are low for all restraint types. This is not unexpected since only frontal collisions are considered in this analysis. The extremely low rate for the airbag-only cell is probably not accurate and reflects the small sample size for this group.

Table 7 also shows how efficient the restraint system is at bearing the brunt of the impact in a frontal collision. Head/face injury-contacts with the steering assembly are

almost eliminated by the combination of an airbag and three-point restraint. In fact, both of the airbag groups have very low rates of head/face injury-contacts in comparison with the belts-only and no-restraints groups. In contrast, a large proportion of the injury-contact rate for both airbag-restrained groups is accounted for by the restraint system itself. This is particularly true for the airbag-three-point belt group, where over two-thirds of the head/face injury-contacts are associated with the restraint system, primarily the airbag. Where the driver is restrained only by the airbag, about 30% of his injuries are associated with the airbag.

The rates shown in table 7 include all AIS levels. As is clear from tables 4 and 5, AIS 1 injuries dominate these rates. Eighty to 90% of head/face injury-contacts are at the AIS 1 level. Focusing on more serious head/face injuries, defined as AIS 2+, gives a clearer picture of the effect of restraint use on head/face injuries from contact with the rail system. Table 8 is restricted to just head/face injuries associated with the front header, A-pillar, siderail, and B-pillar. This table presents most succinctly the findings of the present analysis on the effect of restraint use on head/face contacts with the rail system.

Table 8: AIS 2+ head/face injury rate per hundred drivers by rail component and restraint use

	airbag			no airbag		
Injury source	belt	no belt	all	belt	no belt	all
Front hdr/A pillar	0.007	0.611	0.181	0.577	1.165	0.798
Siderail/B pillar	0.198	0	0.180	0.203	0.261	0.222

The combination of an airbag with three-point restraints almost eliminates serious head/face injury associated with contacting the front header or A-pillar. There are only 0.007 serious (AIS 2+) head/face injuries per hundred drivers, or 1 per 14,286 drivers involved in a frontal collision. There is a "confidence interval" associated with this rate, since it is made using a sample file, so the real rate could be somewhat larger or smaller. But it is clear that the combination of an airbag with three-point restraints reduces head/face injury-contacts with the front rail system to a very low, albeit non-zero level. For drivers restrained by an airbag alone, the rate is 0.611 (1 per 163 drivers). The airbag-only rate is comparable to that for drivers with three-point belts only, so it is also clear that the greatest benefit comes from neither restraint system alone, but by their joint use.

There appears to be little benefit from the airbag-three-point belt restraint system in protecting against serious head/face injuries from contact with the siderail or B-pillar. Injury-contact rates are about the same for all restraint combinations, and only somewhat higher for the no-restraint category.[2] Again, this is unsurprising, since this analysis is restricted to frontal collisions.

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[2]The zero rate for the airbag-only category is very likely an artifact of small sample sizes. The rates for all the other restraint categories are low; there are only 40 AIS 2+

Case review of serious (AIS 2+) head/face injuries from front header/A-pillar contact

Although airbags substantially reduce the incidence of serious head/face injury-contacts with the front header/A-pillar in frontal collisions, they do not eliminate them. In the 5 years of NASS cases examined, of the 489 cases in which an airbag deployed, there were four instances where a driver received an AIS 2+ head/face injury associated with the front header/A-pillar. (See Tables B-7 and B-8 for the raw number of cases.) Three of these cases involved an unbelted driver. Intrusion was noted in three of the cases.

The most severe head/face injury was an AIS 6 associated with the left A-pillar. The driver was an 18-year old male, driving a 1990 Chevrolet in a head-on crash with a total delta-V of 59mph. Crush of the passenger compartment was extensive. The toe pan was moved back 18 to 24 inches; the A-pillar, front header, and left side of the instrument panel intruded 12 to 18 inches; and the steering assembly intruded 6 to 12 inches. The driver was belted, but essentially the A-pillar and front header moved back into the driver's head. The driver sustained fatal injuries.

The three other cases of AIS 2+ head/face injuries from front rail contacts involved unbelted drivers, and in two of them there was intrusion of the front structure of the car. In the case of an AIS 4 head injury, there was intrusion of 3 to 6 inches on both the left A- and B-pillars, and 12 to 18 inches of the instrument panel. The other intrusion came in a case of an AIS 2 head injury, also from the left A-pillar. Both the toe pan and the windshield were pushed back 6 to 12 inches. Given the displacement of the windshield, it is likely that the A-pillar was moved back as well.

The final case of serious head/face injuries associated with front rails is somewhat anomalous, because the contact to the driver's head came from the right A-pillar. The vehicle went off the road to the right and struck a roadside object at 1 o'clock. The airbag deployed but since the driver was unbelted, he was able to slide across and strike the right side of the vehicle's interior, sustaining, among other injuries, an AIS 3 head injury. There was some intrusion (1 to 3 inches) of the floor pan, but none related to the head injuries.

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head/face injuries from *all* vehicle components for airbag-only drivers in the analysis file; and a zero rate makes no mechanical sense. See table B-9 in appendix B for the raw counts.

Appendix A

Overview of data file used in the analysis

Case selection

As a first step, the injury records for drivers in all cases in which an airbag deployed were selected for the file. Cases in which an airbag did not deploy were also selected as a comparison group. The ideal comparison group would match the airbag-deployed cases on all relevant characteristics, except for lacking an airbag restraint system. Three characteristics were chosen to match the airbag-deployed cases as closely as possible: 1) vehicle type; 2) accident severity as measured by towaway and delta-V; and, 3) direction of force.

Airbags are currently installed primarily in passenger cars and light passenger vans. Accordingly, case vehicles in the non-airbag group were restricted to these vehicle types. Figure A-1 shows the distribution by vehicle type of the two groups. The two distributions match reasonably well. Almost 50% of airbag cases were 4-door sedans, compared with about 35% of the non-airbag cases. The non-airbag cases have a higher proportion of 2-door sedans, 3-door sedans, 5-door (hatchback) sedans, and stationwagons. But in general, the match is reasonable.

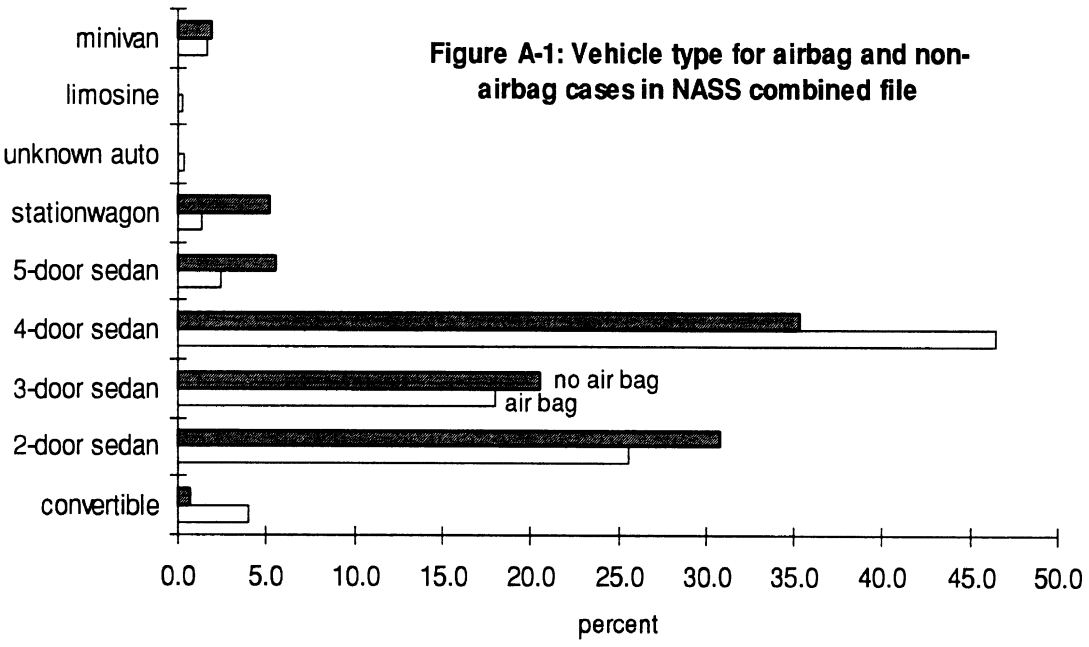


Figure A-1: Vehicle type for airbag and non-airbag cases in NASS combined file

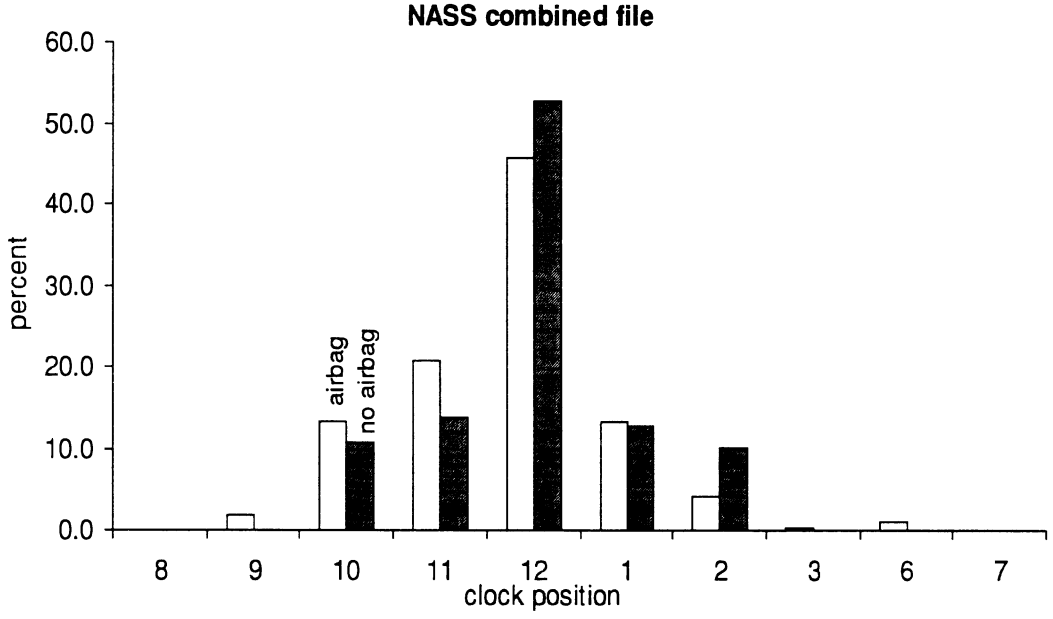
Almost all the airbag-deployed cases were towaways. There were 489 vehicles in 1988-92 NASS CDS where an airbag deployed and only seven were not towed. When these raw totals are properly weighted, over 98% of the airbag-deployed vehicles were towed

from the scene. Accordingly, only towed vehicles were included in the comparison, non-airbag group of cases. The purpose of this filter was to provide some control for accident severity. Airbags are designed to be triggered only in relative severe collisions. It therefore meets expectations that, in almost all cases in the NASS CDS file, the vehicle was towed when the airbag deployed.

Since airbags are designed not to deploy when delta-V is less than 10 to 15mph, airbag deployment effectively filters out collisions with delta-V under 10mph. In the NASS file, only 7% of the airbag deployment cases had calculated delta-Vs under 10mph. In order to better match the accident severity of the airbag deployment cases, cases with delta-V under 10mph were removed from the non-airbag cases.

The final filter to identify a similar accident population was direction of force. Almost all airbag deployments occur in frontal impacts. Figure A-2 shows the distribution of direction of force for airbag and non-airbag cases. The airbag cases fall almost entirely between 10 and 2 o'clock. There were a few cases with 6 o'clock (rearend) impacts and 9 o'clock (driver's side), but virtually all cases fall between 10 and 2. Taking only cases falling between 10 and 2 o'clock for the non-airbag cases produces a remarkably similar distribution, as figure A-2 illustrates.

Figure A-2: Direction of force for airbag and non-airbag vehicles in NASS combined file



To summarize: The data file constructed for this analysis consists of two groups. The first group is all vehicles in the 1988-92 NASS CDS file in which an airbag deployed. The second group consists of vehicles in which an airbag did not deploy, with the following further restrictions designed to select vehicles and accidents comparable to the airbag-deployed group:

1. Vehicle type limited to passenger cars and light passenger vans. (NASS body_type variable code levels 1-9, 12, and 20.)

2. Direction of force limited to 10 o'clock to 2 o'clock.

3. Vehicle towed from the scene.

4. Cases with calculated delta-V under 10 are excluded.

Comparison of airbag and non-airbag populations

Table A-1 shows the distribution of the maximum AIS injury for the driver by restraint use. Cases with deployed airbags are shown separately from those without airbags, and within those two groups, three-point manual restraints are shown separately from all other, including no restraints. Within the airbag group, "all other" includes some cases with lap belts only. Within the non-airbag group, "no belts" means no restraints of any kind.

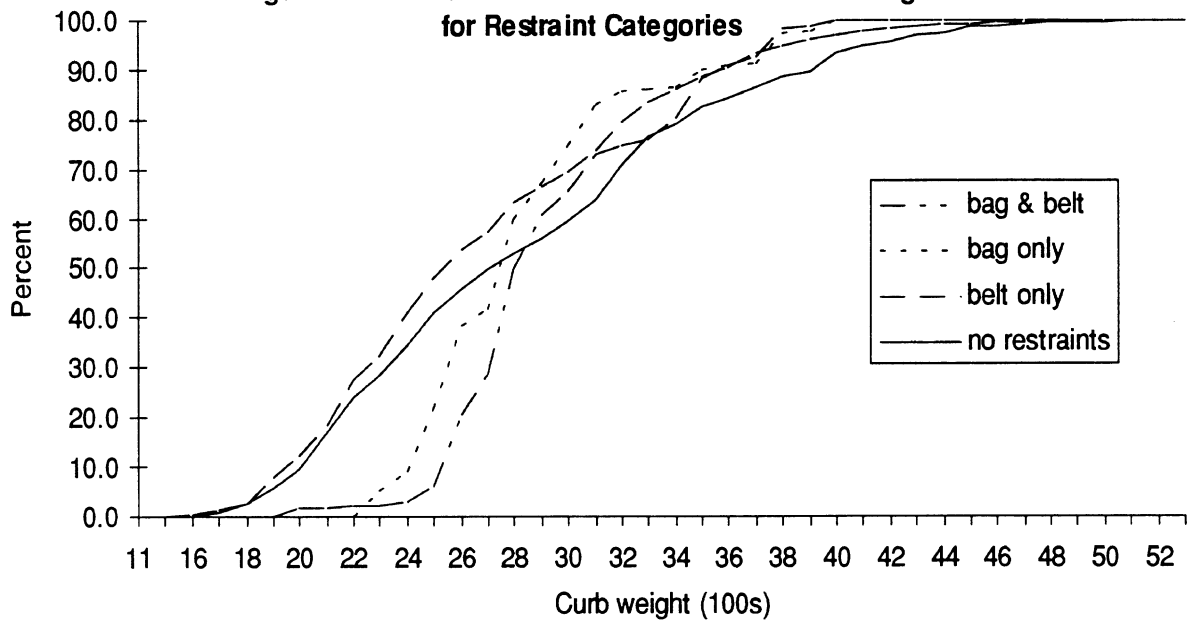
The purpose of table A-1 is to compare the injury severity of drivers with and without airbags in the analysis file. In this population of accidents, airbags do not appear to lower overall injury severity. A higher proportion of drivers without airbags have no injury than drivers with deployed airbags. Much of this difference is due to a higher proportion of AIS-1 injuries for the airbag population. These are minor injuries, skin abrasions and contusions, caused by contact with the airbag. However, the airbag population does not have a lower proportion of the most severe injuries than the non-airbag population. For AIS-6 (maximum) injuries, the proportions are about the same. The same is true for AIS-4 and 5. There are very few cases where the maximum AIS for the driver was 4-6, so statistically the findings are not significant. Nevertheless, we would have expected to find lower proportions for the highest maximum-AIS. These findings suggest problems with the match between the two comparison groups, despite the effort described above to find a comparable non-airbag population.

Table A-1: Maximum AIS for the Driver by Restraint Use, 1988-1992 NASS

	Air bag deployed			No air bag			
AIS level	3 pt belt	All other	All	3 pt belt	No belt	All	Grand total
Not injured	35.8	16.9	31.1	51.6	28.4	43.1	42.8
Minor	55.2	58.4	56.0	40.0	50.0	43.7	44.0
Moderate	6.7	15.5	8.9	6.6	14.9	9.6	9.6
Serious	1.6	6.9	3.0	1.4	4.1	2.4	2.4
Severe	0.0	0.9	0.2	0.2	0.7	0.4	0.4
Critical	0.0	0.3	0.1	0.1	0.2	0.1	0.1
Maximum	0.6	1.2	0.7	0.2	1.6	0.7	0.7
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Though the match by vehicle type is satisfactory, it is not perfect. In general, the airbag group is somewhat heavier. Figure A-3 shows cumulative percentages of vehicle curb weight for the different combinations of restraint use in the analysis file. There are more light vehicles in the non-airbag groups than among the vehicles equipped with airbags. About 50% of the non-airbag group weighed 2,500 pounds or less. The 50th percentile for the airbag-equipped group of cars is 2,800. It would be preferable that the weight profiles of all restraint groups be similar, but it is not surprising that airbag-equipped vehicles are somewhat heavier. Most of the vehicles come from production years when airbags were offered on selected models only. These differences in curb weight probably bias driver injuries with respect to whether or not their vehicles are equipped with airbags; that is, drivers of heavier cars should have less severe injuries, all other things being equal. That the drivers of airbag-deployed vehicles have more minor injuries and about the same number of serious injuries could mean that they were in more serious collisions.

Figure A-3: Cumulative Percent of Vehicle Curb Weight for Restraint Categories



The most direct measure of accident severity available in the NASS CDS file is "delta-V," the change in velocity of the vehicle as a result of the accident. Only 47% of the airbag cases have valid delta-Vs, and 54.6% of the non-airbag cases have valid delta-Vs. Though the proportion of missing data is high, calculating the mean delta-V for the airbag and non-airbag populations provides some evidence that the two populations had comparable accident severities, though the airbag vehicles may have been involved in slightly more severe collisions on average.

Table A-2 shows delta-V by restraint use for the four combinations of airbag deployment and three-point manual restraint use. Overall, delta-V, where known, for the airbag population is only slightly higher than for the non-airbag population. For all airbag

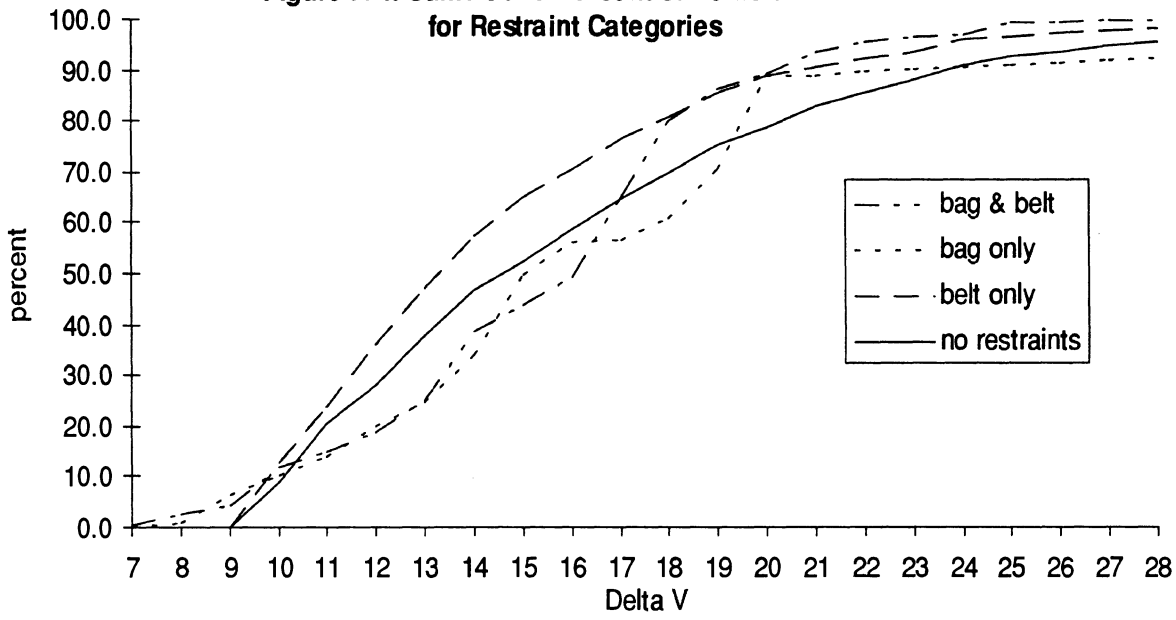
cases (with known delta-V) the average was 16.33. By excluding delta-Vs under 10 from the non-airbag group, the average delta-V is 15.67, only 0.6 less than the airbag group.

Table A-2: Delta V by restraint use 1988-1992 NASS

restraint use	n	mean	sd
air bag & belt	144	15.91	4.0053
air bag only	86	17.07	5.8081
all air bag	230	16.33	4.7627
3 point belt	3500	15.04	5.0291
no restraints	3377	16.65	6.1847
all non-air bag	6877	15.67	5.5518

Figure A-4 shows the cumulative distribution of delta-V for the various restraint categories. Even though cases with delta-V less than 10mph are excluded from the non-airbag group, that group still has somewhat more low delta-V cases than the group of cases with deployed airbags.

Figure A-4: Cumulative Percent of Vehicle Delta V for Restraint Categories



The airbag population of vehicles rolled over somewhat more frequently than the non-airbag population. Three point four percent (weighted) of the airbag population rolled over, compared with 1.7% of the non-airbag group. Clearly, rollover occurred in only a small proportion of both populations, but twice as often in the airbag population.

In sum, though every effort was made to chose a comparison group with vehicle, accident, and collision severity measures matching the vehicles with deployed airbags, success was mixed. The two files match well on the towaway criterion and direction of force. The match on vehicle types is reasonable, though there are somewhat more

smaller cars among the non-airbag group. On the other hand, the airbag group of vehicles appears to have been involved in somewhat more severe collisions. Mean delta-V is slightly higher, and the cumulative distribution of delta-Vs shows a higher proportion of non-airbag vehicles had lower delta-Vs. Finally, the distributions of the maximum-AIS injury sustained by the drivers are quite similar, except that a higher proportion of drivers without airbags sustained no injuries.

As a result, comparisons between groups should be made with caution. Nevertheless, it should be observed that if the airbag-deployed vehicles were involved in somewhat more serious collisions, this analysis would understate the benefit of airbags in preventing injury and, in particular, protecting against head/face contact with the front rail-like components.

Appendix B

Tables on injury-contacts with vehicle components

Organization of the tables

The leftmost section of each table shows the distribution of raw case frequencies, with the heading "unweighted." Cases with unknown injury-contacts are included. The middle section of the tables shows column percentages for the weighted cases. These percentages are calculated after the unknown cases have been distributed among cases with known injury sources. The percentages are shown to two decimal places. Some cells have no cases, and the percentage is given as just 0. Cells with a non-zero percentage smaller than 0.01 are shown as 0.00. The rightmost section of the tables shows the weight, adjusted frequencies.

Tables B-1 through B-6 show distributions of injury-contacts for all injuries. Tables B-7 through B-12 show head/face injuries by restraint use. There is one table for each combination of restraint use. Restraint uses represented are all permutations of airbag-deployment and three-point manual belt use. The table below provides a key to the tables. For example, Table B-1 covers all injuries to drivers of all airbag-deployed vehicles, whether belted or not.

Numbering of Injury Contact Tables						
	airbag			no airbag		
	all	**belted**	**other**	**all**	**belted**	**no belt**
All injuries	B-1	B-2	B-3	B-4	B-5	B-6
Head/face	B-7	B-8	B-9	B-10	B-11	B-12

Tables B-13 and B-14 show injury rates per hundred drivers. Table B-13 covers drivers of airbag-deployed vehicles; table B-14 covers the non-airbag-deployed group. Within each table there is a section for all drivers, belted drivers, and unbelted drivers. The left side of each section shows rates for all injuries, the right side of each section shows head/face injuries. It is particularly useful to line up columns of interest from table B-13 and table B-14 (airbag and no airbag) and see how the distributions change.

Table B-1: Adjusted* distribution of maximum AIS injury by contact point
1988-92 NASS: Airbag deployment accidents, all drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	6	2	4	12	0.35	0.36	4.01	0.48	454	52	202	707
Siderail/B pillar	4	1	2	7	0.24	0.65	2.90	0.37	306	94	146	546
Steer assembly	51	13	8	72	7.02	12.51	6.18	7.52	9,054	1,799	311	11,164
Instrument panel	109	15	9	133	16.72	10.76	11.60	15.97	21,567	1,548	584	23,699
Side window	4	7	0	11	1.44	3.74	0	1.61	1,856	537	0	2,393
Windshield	39	14	3	56	6.56	22.39	21.36	8.59	8,457	3,220	1,075	12,752
Side door	34	8	12	54	6.69	7.36	19.98	7.20	8,627	1,059	1,006	10,691
Roof	5	2	1	8	0.69	0.71	0.49	0.69	895	103	25	1,022
Belt restraint	65	6	6	77	13.05	2.43	15.94	12.12	16,834	349	803	17,986
Airbag	183	14	3	200	38.65	15.76	3.05	35.23	49,855	2,266	154	52,275
Other interior	39	22	7	68	7.95	20.01	8.08	9.13	10,258	2,878	407	13,542
Exterior	6	3	8	17	0.64	3.32	6.42	1.09	822	478	323	1,623
Unknown	54	16	9	79	0	0	0	0	0	0	0	0
Total	599	123	72	794	100.00	100.00	100.00	100.00	128,984	14,382	5,034	148,400

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury.

Table B-2: Adjusted* distribution of maximum AIS injury by contact point 1988-92 NASS: Airbag deployment accidents, belted drivers												
	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	3	0	2	5	0.29	0	0.78	0.28	273	0	17	290
Siderail/B pillar	3	1	2	6	0.29	1.20	7.22	0.50	267	88	157	512
Steer assembly	38	6	2	46	8.79	6.99	3.63	8.55	8,231	510	79	8,820
Instrument panel	72	9	4	85	15.61	13.24	6.15	15.24	14,614	966	134	15,713
Side window	0	3	0	3	0	3.79	0	0.27	0	277	0	277
Windshield	18	4	0	22	5.17	19.89	0	6.10	4,838	1,451	0	6,289
Side door	18	3	8	29	6.44	7.00	39.83	7.18	6,026	511	865	7,402
Roof	1	2	1	4	0.04	1.32	1.13	0.16	41	96	24	162
Belt restraint	65	6	5	76	18.02	4.48	34.77	17.41	16,872	327	755	17,954
Airbag	124	7	2	133	36.46	15.91	3.16	34.31	34,142	1,161	69	35,371
Other interior	30	13	3	46	8.74	26.17	1.57	9.82	8,184	1,909	34	10,127
Exterior	3	0	2	5	0.16	0	1.76	0.18	147	0	38	186
Unknown	35	4	3	42	0	0	0	0	0	0	0	0
Total	410	58	34	502	100.00	100.00	100.00	100.00	93,636	7,295	2,171	103,101
*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury.												

Table B-3: Adjusted* distribution of maximum AIS injury by contact point
1988-92 NASS: Airbag deployment accidents, unbelted drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	3	2	2	7	0.51	0.79	5.87	0.89	180	56	168	404
Siderail/B pillar	1	0	0	1	0.11	0	0	0.09	39	0	0	39
Steer assembly	13	7	6	26	2.37	19.04	8.83	5.38	837	1,349	253	2,439
Instrument panel	37	6	5	48	19.65	7.82	15.84	17.56	6,945	554	454	7,953
Side window	4	4	0	8	5.22	3.67	0	4.65	1,845	260	0	2,105
Windshield	21	10	3	34	10.21	25.34	37.19	14.28	3,608	1,795	1,065	6,469
Side door	16	5	4	25	7.35	7.79	5.83	7.32	2,598	552	167	3,317
Roof	4	0	0	4	2.40	0	0	1.87	849	0	0	849
Belt restraint	0	0	1	1	0	0	1.12	0.07	0	0	32	32
Airbag	59	7	1	67	44.40	15.58	2.15	37.22	15,696	1,104	61	16,861
Other interior	9	9	4	22	5.88	12.72	13.16	7.41	2,080	902	377	3,359
Exterior	3	3	6	12	1.90	7.26	10.02	3.25	671	514	287	1,472
Unknown	19	12	6	37	0	0	0	0	0	0	0	0
Total	189	65	38	292	100.00	100.00	100.00	100.00	35,349	7,087	2,863	45,299

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury.

Table B-4: Adjusted* distribution of maximum AIS injury by contact point
1988-92 NASS: No airbag, all drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	339	165	105	609	3.17	5.11	4.59	3.47	110,702	26,901	8,200	145,802
Siderail/B pillar	59	50	35	144	0.44	1.91	1.30	0.66	15,226	10,069	2,322	27,616
Steer assembly	2,639	730	621	3,990	22.11	27.72	32.63	23.26	773,251	145,797	58,286	977,334
Instrument panel	3,255	464	355	4,074	25.17	12.10	19.90	23.31	880,228	63,646	35,542	979,416
Side window	329	97	24	450	3.10	2.69	0.92	2.96	108,444	14,135	1,645	124,224
Windshield	2,265	735	171	3,171	18.41	25.08	9.42	18.86	643,756	131,941	16,821	792,518
Side door	785	226	243	1,254	6.91	6.65	13.08	7.14	241,478	34,993	23,360	299,830
Roof	56	26	17	99	0.49	1.19	0.56	0.58	17,280	6,243	1,005	24,528
Belt restraint	1,166	138	38	1,342	10.63	6.10	3.04	9.74	371,610	32,088	5,427	409,125
Airbag	2	0	1	3	0.01	0	0.01	0.01	386	0	15	400
Other interior	917	361	195	1,473	9.30	10.12	11.29	9.49	325,240	53,251	20,175	398,666
Exterior	72	51	97	220	0.27	1.32	3.26	0.53	9,462	6,925	5,823	22,210
Unknown	1,873	395	247	2,515	0	0	0	0	0	0	0	0
Total	13,757	3,438	2,149	19,344	100.00	100.00	100.00	100.00	3,497,063	525,988	178,620	4,201,671

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury.
Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2 and the vehicle was towed.

Table B-5: Adjusted* distribution of maximum AIS injury by contact point
1988-92 NASS: No airbag, belted drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	155	56	31	242	3.53	5.93	3.10	3.77	62,893	12,874	1,746	77,513
Siderail/B pillar	31	28	8	67	0.42	2.61	0.65	0.66	7,534	5,665	368	13,567
Steer assembly	1,139	303	176	1,618	19.39	28.42	33.11	20.72	345,921	61,737	18,675	426,334
Instrument panel	1,425	161	87	1,673	24.09	11.69	17.41	22.60	429,729	25,399	9,820	464,948
Side window	185	46	9	240	3.59	2.92	1.32	3.46	64,002	6,350	745	71,097
Windshield	490	113	24	627	8.82	11.94	4.03	9.02	157,358	25,935	2,272	185,564
Side door	421	96	100	617	8.60	8.67	15.37	8.79	153,402	18,840	8,669	180,912
Roof	28	9	3	40	0.35	2.36	0.17	0.56	6,311	5,131	97	11,539
Belt restraint	1,153	137	37	1,327	20.56	14.71	9.60	19.64	366,737	31,947	5,414	404,097
Airbag	1	0	0	1	0.02	0	0	0.02	376	0	0	376
Other interior	477	142	62	681	10.41	10.24	12.19	10.44	185,648	22,238	6,877	214,763
Exterior	17	10	18	45	0.23	0.51	3.05	0.33	4,032	1,100	1,723	6,855
Unknown	850	161	70	1,081	0	0	0	0	0	0	0	0
Total	6,372	1,262	625	8,259	100.00	100.00	100.00	100.00	1,783,942	217,215	56,407	2,057,564

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury.
Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2 and the vehicle was towed.

Table B-6: Adjusted* distribution of maximum AIS injury by contact point 1988-92 NASS: No airbag, unbelted drivers												
	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	184	109	74	367	2.80	4.54	5.30	3.19	47,904	14,016	6,478	68,398
Siderail/B pillar	28	22	27	77	0.45	1.42	1.59	0.65	7,688	4,394	1,944	14,026
Steer assembly	1,500	427	445	2,372	24.90	27.22	32.41	25.66	426,610	84,051	39,605	550,265
Instrument panel	1,830	303	268	2,401	26.28	12.39	21.01	23.98	450,213	38,253	25,676	514,141
Side window	144	51	15	210	2.60	2.52	0.74	2.48	44,571	7,782	906	53,259
Windshield	1,775	622	147	2,544	28.24	34.39	11.88	28.20	483,860	106,179	14,518	604,557
Side door	364	130	143	637	5.17	5.22	12.04	5.57	88,524	16,126	14,711	119,360
Roof	28	17	14	59	0.64	0.36	0.74	0.60	10,932	1,097	904	12,933
Belt restraint	13	1	1	15	0.44	0.01	0.04	0.35	7,503	28	51	7,582
Airbag	1	0	1	2	0.00	0	0.01	0.00	13	0	14	27
Other interior	440	219	133	792	8.17	10.04	10.88	8.59	139,885	31,012	13,298	184,195
Exterior	55	41	79	175	0.32	1.89	3.36	0.72	5,419	5,836	4,109	15,364
Unknown	1,023	234	177	1,434	0	0	0	0	0	0	0	0
Total	7,385	2,176	1,524	11,085	100.00	100.00	100.00	100.00	1,713,120	308,773	122,213	2,144,107
*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious injury coded for each injury source. Counts are of contacts with injury. Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2 and the vehicle was towed.												

Table B-7: Adjusted* distribution of maximum AIS Head/Face injury by contact point 1988-92 NASS: Airbag deployment, all drivers												
	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	5	1	3	9	1.30	0.83	21.10	1.70	411	43	184	637
Siderail/B pillar	4	1	2	7	0.94	1.78	15.40	1.39	296	91	134	522
Steer assembly	7	1	0	8	1.36	0.92	0	1.27	428	47	0	475
Instrument panel	1	0	0	1	0.18	0	0	0.16	58	0	0	58
Side window	2	7	0	9	3.49	10.17	0	4.32	1,100	521	0	1,622
Windshield	24	12	1	37	16.96	55.68	14.48	22.19	5,353	2,854	126	8,333
Side door	0	0	1	1	0	0	3.34	0.08	0	0	29	29
Roof	4	2	1	7	2.62	1.94	3.51	2.55	827	100	31	957
Belt restraint	3	0	0	3	8.13	0	0	6.83	2,566	0	0	2,566
Airbag	86	8	2	96	62.82	19.58	14.98	55.81	19,827	1,003	131	20,961
Other interior	4	0	0	4	1.77	0	0	1.48	557	0	0	557
Exterior	4	4	5	13	0.44	9.09	27.18	2.24	140	466	237	842
Unknown	15	9	3	27	0	0	0	0	0	0	0	0
Total	159	45	18	222	100.00	100.00	100.00	100.00	31,563	5,125	872	37,559
*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury.												

Table B-8: Adjusted* distribution of maximum AIS Head/Face injury by contact point

1988-92 NASS: Airbag deployment, belted drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	2	0	1	3	1.01	0	2.36	0.94	236	0	7	243
Siderail/B pillar	3	1	2	6	1.11	4.12	34.38	1.71	260	85	95	440
Steer assembly	3	0	0	3	1.21	0	0	1.10	283	0	0	283
Instrument panel	0	0	0	0	0	0	0	0	0	0	0	0
Side window	0	3	0	3	0	12.99	0	1.04	0	269	0	269
Windshield	5	4	0	9	8.68	68.13	0	13.37	2,032	1,411	0	3,444
Side door	0	0	1	1	0	0	14.71	0.16	0	0	41	41
Roof	0	2	1	3	0	4.51	15.50	0.53	0	93	43	136
Belt restraint	3	0	0	3	11.02	0	0	10.01	2,580	0	0	2,580
Airbag	68	3	1	72	74.14	10.17	9.87	68.30	17,356	211	27	17,594
Other interior	4	0	0	4	2.39	0	0	2.17	560	0	0	560
Exterior	2	1	1	4	0.44	0.09	23.19	0.66	104	2	64	170
Unknown	8	1	1	10	0	0	0	0	0	0	0	0
Total	98	15	8	121	100.00	100.00	100.00	100.00	23,411	2,072	277	25,759

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury.

Table B-9: Adjusted* distribution of maximum AIS Head/Face injury by contact point
1988-92 NASS: Airbag deployment, unbelted drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	3	1	2	6	2.12	1.46	27.37	3.22	173	45	163	381
Siderail/B pillar	1	0	0	1	0.46	0	0	0.32	38	0	0	38
Steer assembly	4	1	0	5	1.77	1.63	0	1.64	144	50	0	194
Instrument panel	1	0	0	1	0.70	0	0	0.49	57	0	0	57
Side window	2	4	0	6	13.30	8.04	0	11.27	1,084	246	0	1,329
Windshield	19	8	1	28	40.25	46.26	21.85	40.88	3,281	1,412	130	4,824
Side door	0	0	0	0	0	0	0	0	0	0	0	0
Roof	4	0	0	4	9.99	0	0	6.90	814	0	0	814
Belt restraint	0	0	0	0	0	0	0	0	0	0	0	0
Airbag	18	5	1	24	30.97	26.71	9.59	28.79	2,524	815	57	3,397
Other interior	0	0	0	0	0	0	0	0	0	0	0	0
Exterior	2	3	4	9	0.44	15.91	41.19	6.50	36	486	245	767
Unknown	7	8	2	17	0	0	0	0	0	0	0	0
Total	61	30	10	101	100.00	100.00	100.00	100.00	8,152	3,053	595	11,800

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury.

Table B-10: Adjusted* distribution of maximum AIS Head/Face injury by contact point 1988-92 NASS: No airbag, all drivers												
	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	**1**	**2**	**3+**	**Total**	**1**	**2**	**3+**	**Total**	**1**	**2**	**3+**	**Total**
Front hdr/A pillar	309	152	95	556	7.47	9.80	18.66	8.17	93,913	25,770	8,119	127,802
Siderail/B pillar	49	43	27	119	0.97	3.00	3.51	1.38	12,157	7,887	1,525	21,569
Steer assembly	1,301	344	81	1,726	28.15	25.54	21.62	27.53	354,085	67,171	9,404	430,659
Instrument panel	157	65	21	243	5.21	3.26	3.40	4.83	65,529	8,575	1,480	75,585
Side window	269	90	22	381	6.76	4.79	3.51	6.34	85,089	12,595	1,525	99,208
Windshield	2,137	706	152	2,995	46.34	47.53	34.69	46.22	582,913	125,011	15,092	723,016
Side door	53	28	11	92	1.15	1.98	2.11	1.32	14,496	5,197	918	20,611
Roof	41	24	13	78	0.97	2.30	1.10	1.19	12,174	6,040	480	18,693
Belt restraint	9	0	0	9	0.13	0	0	0.10	1,628	0	0	1,628
Airbag	2	0	1	3	0.03	0	0.04	0.02	370	0	15	385
Other interior	89	14	4	107	2.43	0.54	0.46	2.06	30,605	1,408	202	32,215
Exterior	51	32	76	159	0.39	1.27	10.90	0.83	4,850	3,337	4,741	12,927
Unknown	553	186	101	840	0	0	0	0	0	0	0	0
Total	5,020	1,684	604	7,308	100.00	100.00	100.00	100.00	1,257,809	262,990	43,502	1,564,300
*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury. Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2, and the vehicle was towed.												

Table B-11: Adjusted* distribution of maximum AIS Head/Face injury by contact point 1988-92 NASS: No airbag, belted drivers												
	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	146	55	29	230	11.50	15.00	13.93	12.11	53,484	13,342	1,803	68,629
Siderail/B pillar	26	24	6	56	1.16	5.65	2.35	1.89	5,398	5,029	304	10,732
Steer assembly	634	159	37	830	38.02	33.58	36.35	37.29	176,778	29,872	4,707	211,358
Instrument panel	38	16	5	59	1.14	2.76	3.23	1.45	5,322	2,452	419	8,192
Side window	156	42	9	207	11.07	6.62	6.38	10.26	51,468	5,889	827	58,184
Windshield	434	105	23	562	29.02	28.59	19.42	28.74	134,937	25,433	2,515	162,885
Side door	23	3	3	29	1.97	0.89	3.94	1.85	9,180	795	510	10,485
Roof	22	7	2	31	1.13	5.35	0.42	1.78	5,256	4,763	54	10,073
Belt restraint	8	0	0	8	0.34	0	0	0.28	1,584	0	0	1,584
Airbag	1	0	0	1	0.08	0	0	0.06	365	0	0	365
Other interior	56	5	3	64	4.27	0.85	1.62	3.67	19,852	755	209	20,817
Exterior	10	7	15	32	0.28	0.72	12.37	0.62	1,297	639	1,601	3,536
Unknown	223	78	27	328	0	0	0	0	0	0	0	0
Total	1,777	501	159	2,437	100.00	100.00	100.00	100.00	464,921	88,969	12,949	566,839
*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury. Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2, and the vehicle was towed.												

Table B-12: Adjusted* distribution of maximum AIS Head/Face injury by contact point
1988-92 NASS: No airbag, unbelted drivers

	(unweighted)				(column percentages)				(weighted, adjusted)			
	AIS				AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total	1	2	3+	Total
Front hdr/A pillar	163	97	66	326	5.17	7.29	20.31	6.01	41,027	12,678	6,204	59,909
Siderail/B pillar	23	19	21	63	0.86	1.72	4.05	1.10	6,788	2,985	1,238	11,011
Steer assembly	667	185	44	896	22.55	21.65	16.28	22.20	178,769	37,683	4,974	221,427
Instrument panel	119	49	16	184	7.52	3.50	3.37	6.69	59,605	6,099	1,030	66,734
Side window	113	48	13	174	4.32	3.90	2.52	4.19	34,259	6,794	771	41,823
Windshield	1,703	601	129	2,433	56.18	56.70	40.78	55.80	445,410	98,669	12,459	556,538
Side door	30	25	8	63	0.69	2.50	1.30	1.02	5,438	4,349	397	10,185
Roof	19	17	11	47	0.88	0.82	1.37	0.88	6,941	1,424	417	8,782
Belt restraint	1	0	0	1	0.01	0	0	0.01	76	0	0	76
Airbag	1	0	1	2	0.00	0	0.05	0.00	12	0	14	27
Other interior	33	9	1	43	1.39	0.38	0.03	1.17	11,026	667	10	11,703
Exterior	41	25	61	127	0.45	1.54	9.94	0.93	3,537	2,672	3,038	9,247
Unknown	330	108	74	512	0	0	0	0	0	0	0	0
Total	3,243	1,183	445	4,871	100.00	100.00	100.00	100.00	792,888	174,021	30,552	997,461

*Cases with unknown injury sources in the raw data are distributed proportionally among known cases for the weighted frequencies and column percentages. Table shows the most serious head/face injury coded for each injury source. Counts are of contacts with injury.
Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2, and the vehicle was towed.

Table B-13: Injury rate per hundred drivers by contact point 1988-92 NASS: Airbag deployment accidents								
	All injuries				Head/Face injuries			
	AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total
all drivers n= 479								
Front hdr/A pillar	0.362	0.041	0.161	0.564	0.328	0.034	0.147	0.508
Siderail/B pillar	0.244	0.075	0.116	0.435	0.236	0.073	0.107	0.416
Steer assembly	7.222	1.435	0.248	8.905	0.341	0.038	0	0.379
Instrument panel	17.202	1.234	0.466	18.902	0.047	0	0	0.047
Side window	1.480	0.429	0	1.909	0.878	0.416	0	1.294
Windshield	6.745	2.568	0.858	10.171	4.269	2.276	0.101	6.646
Side door	6.881	0.844	0.802	8.527	0	0	0.023	0.023
Roof	0.714	0.082	0.020	0.815	0.659	0.079	0.024	0.763
Belt restraint	13.427	0.278	0.640	14.346	2.047	0	0	2.047
Airbag	39.764	1.808	0.123	41.695	15.814	0.800	0.104	16.718
Other interior	8.182	2.295	0.325	10.801	0.444	0	0	0.444
Exterior	0.655	0.381	0.258	1.294	0.111	0.371	0.189	0.672
Total	102.878	11.471	4.015	118.365	25.174	4.087	0.696	29.957
belted drivers n=304								
Front hdr/A pillar	0.299	0	0.018	0.317	0.259	0	0.007	0.266
Siderail/B pillar	0.292	0.096	0.171	0.560	0.284	0.093	0.104	0.482
Steer assembly	9.007	0.558	0.086	9.651	0.310	0	0	0.310
Instrument panel	15.991	1.057	0.146	17.194	0	0	0	0
Side window	0	0.303	0	0.303	0	0.294	0	0.294
Windshield	5.294	1.588	0	6.882	2.224	1.544	0	3.768
Side door	6.594	0.559	0.946	8.099	0	0	0.045	0.045
Roof	0.045	0.105	0.027	0.177	0	0.102	0.047	0.149
Belt restraint	18.462	0.358	0.826	19.646	2.823	0	0	2.823
Airbag	37.360	1.270	0.075	38.705	18.992	0.230	0.030	19.252
Other interior	8.955	2.089	0.037	11.081	0.613	0	0	0.613
Exterior	0.161	0	0.042	0.203	0.114	0.002	0.070	0.186
Total	102.460	7.982	2.376	112.818	25.617	2.267	0.303	28.187
unbelted drivers n=175								
Front hdr/A pillar	0.531	0.164	0.495	1.189	0.509	0.131	0.479	1.120
Siderail/B pillar	0.115	0	0	0.115	0.111	0	0	0.111
Steer assembly	2.462	3.970	0.744	7.175	0.425	0.146	0	0.571
Instrument panel	20.434	1.631	1.334	23.399	0.169	0	0	0.169
Side window	5.428	0.765	0	6.193	3.189	0.722	0	3.911
Windshield	10.617	5.283	3.133	19.032	9.653	4.156	0.383	14.192
Side door	7.645	1.623	0.491	9.760	0	0	0	0
Roof	2.497	0	0	2.497	2.396	0	0	2.396
Belt restraint	0	0	0.095	0.095	0	0	0	0
Airbag	46.180	3.248	0.181	49.609	7.427	2.399	0.168	9.994
Other interior	6.120	2.653	1.108	9.881	0	0	0	0
Exterior	1.974	1.513	0.844	4.331	0.105	1.429	0.722	2.256
Total	104.002	20.851	8.425	133.277	23.984	8.983	1.752	34.719

Table B-14: Injury rate per hundred drivers by contact point 1988-92 NASS: No airbag deployment								
	All injuries				Head/Face injuries			
	AIS				AIS			
Injury source	1	2	3+	Total	1	2	3+	Total
all drivers n=12,302								
Front hdr/A pillar	2.607	0.633	0.193	3.434	2.212	0.607	0.191	3.010
Siderail/B pillar	0.359	0.237	0.055	0.650	0.286	0.186	0.036	0.508
Steer assembly	18.210	3.433	1.373	23.016	8.338	1.582	0.221	10.142
Instrument panel	20.729	1.499	0.837	23.065	1.543	0.202	0.035	1.780
Side window	2.554	0.333	0.039	2.925	2.004	0.297	0.036	2.336
Windshield	15.160	3.107	0.396	18.663	13.727	2.944	0.355	17.027
Side door	5.687	0.824	0.550	7.061	0.341	0.122	0.022	0.485
Roof	0.407	0.147	0.024	0.578	0.287	0.142	0.011	0.440
Belt restraint	8.751	0.756	0.128	9.635	0.038	0	0	0.038
Airbag	0.009	0	0.000	0.009	0.009	0	0.000	0.009
Other interior	7.659	1.254	0.475	9.388	0.721	0.033	0.005	0.759
Exterior	0.223	0.163	0.137	0.523	0.114	0.079	0.112	0.304
Total	82.354	12.387	4.206	98.947	29.621	6.193	1.024	36.838
belted drivers n=6,211								
Front hdr/A pillar	2.396	0.490	0.067	2.953	2.037	0.508	0.069	2.614
Siderail/B pillar	0.287	0.216	0.014	0.517	0.206	0.192	0.012	0.409
Steer assembly	13.177	2.352	0.711	16.239	6.734	1.138	0.179	8.051
Instrument panel	16.369	0.967	0.374	17.710	0.203	0.093	0.016	0.312
Side window	2.438	0.242	0.028	2.708	1.960	0.224	0.031	2.216
Windshield	5.994	0.988	0.087	7.068	5.140	0.969	0.096	6.204
Side door	5.843	0.718	0.330	6.891	0.350	0.030	0.019	0.399
Roof	0.240	0.195	0.004	0.440	0.200	0.181	0.002	0.384
Belt restraint	13.969	1.217	0.206	15.392	0.060	0	0	0.060
Airbag	0.014	0	0	0.014	0.014	0	0	0.014
Other interior	7.072	0.847	0.262	8.181	0.756	0.029	0.008	0.793
Exterior	0.154	0.042	0.066	0.261	0.049	0.024	0.061	0.135
Total	67.952	8.274	2.149	78.375	17.709	3.389	0.493	21.591
unbelted drivers n=6,091								
Front hdr/A pillar	2.955	0.865	0.400	4.219	2.531	0.782	0.383	3.696
Siderail/B pillar	0.474	0.271	0.120	0.865	0.419	0.184	0.076	0.679
Steer assembly	26.316	5.185	2.443	33.944	11.028	2.325	0.307	13.659
Instrument panel	27.772	2.360	1.584	31.716	3.677	0.376	0.064	4.117
Side window	2.749	0.480	0.056	3.285	2.113	0.419	0.048	2.580
Windshield	29.848	6.550	0.896	37.293	27.476	6.087	0.769	34.331
Side door	5.461	0.995	0.907	7.363	0.335	0.268	0.025	0.628
Roof	0.674	0.068	0.056	0.798	0.428	0.088	0.026	0.542
Belt restraint	0.463	0.002	0.003	0.468	0.005	0	0	0.005
Airbag	0.001	0	0.001	0.002	0.001	0	0.001	0.002
Other interior	8.629	1.913	0.820	11.362	0.680	0.041	0.001	0.722
Exterior	0.334	0.360	0.253	0.948	0.218	0.165	0.187	0.570
Total	105.676	19.047	7.539	132.263	48.910	10.735	1.885	61.530
Vehicles are passenger cars in which there was no air bag deployment, direction of force is 10 to 2, the vehicle was towed, and delta-v, if known, is 10 or greater.								

Appendix C

Note on comparing current results with previous work for this project

The results and tables that are part of this report are not comparable with the preliminary work done for this project. Comparisons between the injury rates and population frequencies and distributions reported here and the rates, frequencies, and proportions reported earlier are not valid. Several changes have been implemented in the data files, list of contact points, and weighting and adjustment procedures. These changes will be discussed here.

1. The most obvious change is in the sheer number of cases available for analysis with the addition of another year of NASS. Preliminary work was based on the combined 1988-1991 NASS CDS file. For the current work, the 1992 NASS CDS file has been added. One simple result of this change is to increase the number of cases. For the non-airbag-deployed cases, the addition of another year is not of great significance to the distributions. The earlier file included about 15,000 cases, so another year would not, by itself, have the potential to substantially change the distributions. However, adding another year of data for the airbag-deployed cases did substantially increase the sample size. The number of airbag-deployed cases increased from 267 to 489, almost doubling the available sample size. This large increase in the number of raw cases has the potential for significant changes in the distributions of contact points and severities. The estimates should also be more reliable since they are based on more data.

   There was also a change in the vehicles selected for the non-airbag, control group. Previous work included all light vehicles in the control group, including pickups and other light trucks. This resulted in a distribution of vehicles that was not comparable to the airbag-deployed group. To make the distribution of vehicle type more similar to the airbag-deployed group, only light passenger vehicles are included. This removed a substantial number of vehicles from the non-airbag group. In the file prepared for the previous work, there were 15,349 vehicles represented. Taking only light passenger vehicles, along with the other limitations described above, resulted in a file of 12,606 vehicles. The mix of non-airbag vehicles in the current analysis is substantially different from that of the preliminary work.

   Two other minor changes influenced the composition of the non-airbag group. The first has to do with restraint use. In the last iteration, automatic belts as well as lap-only and shoulder-only were included in the "no restraint" category. For the current work, "no restraints" or "no belt" means no belts of any sort, whether manual or automatic. The second modification is the exclusion of all non-airbag cases with a known delta-V of less than 10. The combined effect of both of these exclusions is to eliminate about 18% of non-airbag cases that would otherwise be included.

2. Different weights are used to produce population estimates. The NASS CDS files for 1988 and 1989 only have one weight variable, the "national inflation factor." The files for 1990 and 1991 include two weight variables, "national inflation factor" and "ratio inflation factor." In the earlier runs, the "national inflation factor" was used to weight the cases. The 1992 NASS CDS file includes only the "ratio inflation factor." A number of discussions with NHTSA determined that NHTSA has standardized on the "ratio inflation factor" as the proper weight to produce population estimates. For years that do not include the "ratio inflation factor," the "national inflation factor" is the appropriate weight. Accordingly, for the work reported here the "national inflation factor" was used for 1988-89 NASS cases, and the "ratio inflation factor" was used to weight 1990-92 NASS.

3. Reviews of the previous work suggested identifying the most important three non-rail injury-producing contact points, rather than combining them into an "other non-rail" category. This is a valuable suggestion, but the result is to increase the number of injury-producing contacts captured in the tables. The original NASS CDS file codes almost 80 categories for "source of injury." These categories are combined appropriately to form more manageable and meaningful general categories. In producing the tables, the most severe injury of all those assigned to one of the combined categories is counted. Since the "other non-rail" category has been split into four categories ("windshield," "steering assembly," "instrument panel," and "other non-rail") a case that previously had only one contact tabulated for non-rail injury sources can now have up to four contacts. The result is a greater number of total contacts shown in the tables. Comparisons of rates and frequencies from the current methodology are valid and internally consistent, but are obviously not valid for the earlier work done with a different methodology and classification scheme.

4. One of the NASS injury source codes includes contacts with a side window and one of a number of other nearby surfaces in the passenger compartment. Among the other surfaces were the A-pillar, B-pillar, and roof side rail. The Office of Planning and Policy reviewed a sample of cases with this code to see how many included contact with the different interior rail surfaces at issue. They then redistributed injury-contacts with the multiple code to A-pillar, B-pillar, and other rail surfaces according to the proportions in their sample of cases. This redistribution of injury-contacts with the multiple-source code was followed in the previous effort. The result, however, of implementing the redistribution is to create contacts where none had existed before. For example, there were some cases with no A-pillar contacts coded. But since there were some contacts coded with the multiple-source code, a number of those contacts were recoded as A-pillar contacts. Moreover, the cases reviewed by P&P did not address the effect of airbag deployment. Upon reviewing this work, the committee decided not to implement the P&P redistribution. Since this adjustment was not made with the current work, the results are not comparable to the previous effort.