PATTERNS OF INJURY AMONG DRIVERS HOSPITALIZED IN LEVEL-I TRAUMA CENTERS: HAVE FRONTAL AIRBAGS MADE A DIFFERENCE?

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ABSTRACT

This study describes the injuries of drivers discharged from Level-I Trauma Centers between 1995-1997. Differences in the drivers' injuries and outcomes by airbag deployment status and gender were evaluated using Chi^2 and T-tests. Data on 1,065 drivers (66 with airbags, 423 females) were obtained from the Massachusetts Registry of Motor Vehicle and Trauma Registries.

Once admitted to trauma centers, drivers with airbags did not differ from drivers without airbags regarding the number, type, clustering, severity or outcome of their injuries. The only exception was that female drivers sustained more fractures to the upper extremities and less injuries to blood vessels and certain traumatic complications ($p<0.05$).

The number of cars on the road with a frontal driver airbag system grew from 93,000 in 1987 to 44,000,000 in 1997 (NHTSA, personal communication). Hence, approximately 4 out of every 10 passenger cars and light trucks in the US fleet are currently equipped with pre-1998 airbag systems (since 1998 vehicles are equipped with "advanced" airbags). Of these pre-1998 vehicles, some 1,400,000 will be involved in a crash during their 10-15 years of "life", and 33% of

the crashes will be severe enough to cause fatal and non-fatal injuries to their occupants (NHSTA 1997). When these pre-1998 vehicles crash and their drivers need medical care, it will be most beneficial that health care providers know whether airbag deployment is associated with any changes in injuries, injury patterns, or injury severity.

These potential changes in injuries to hospitalized drivers are not completely addressed by existing studies addressing the overall effectiveness of pre-1998 airbag systems (Kahane 1996, NHTSA 1998, Barry et al 1999, Segui-Gomez In Press). Despite differences in their methodological approaches, all these studies demonstrate a fatality-reduction effect of airbags and a somewhat controversial effect on non-fatal injuries. It seems as if, from a statistical point of view, airbag deployment may be preventing some injuries at the expense of inducing others. Yet, none of these issues addresses whether drivers injured severely enough to require hospital admission, differ in their actual injuries and their severity.

In fact, the issue of airbag-induced injuries has been the subject of multiple engineering and medical case or case-series reports. The described injuries range from eye injuries (such as retinal tears, lens subluxation, contusion, hyphema, corneal injury, perforation, chemical keratitis), face injuries (such as facial abrasion, laceration, contusions, erythema or chemical burns), upper extremity injuries (such as distal radius & metacarpal fractures, hand burns, contusions, abrasions, or sprains, fingers & wrist fractures), rupture of the right atrium, aortic valve dysfunction, cervical spine injuries, abrasion to the breasts and bruises, ear barotrauma, abdominal injuries, to asthma attacks. (Scott et al 1993, Han 1993, Whitacre 1993, Rosenblatt et al 1991, Mishler 1991, Larkin 1991, Campbell 1993, Fukagawa et al 1993, Lesher et al 1993, Huelke et al 1992, Waltz 1995 Smally et al 1992, Huelke et al, 1992, Ingram et al 1991, Freedman et al 1995, Swans Biearman et al 1993, Huelke et al 1995, Lancaster et al 1993, Reiland-Smith et al, 1993, Traynelis & Gold 1993, Hoel 1993, Beckerman & Elberger 1991, Augenstein 1995, and Gross 1995). None of these reports address the concept of pattern of injuries and/or includes large samples. Only two additional studies begin to deal with this issue (Lau et al 1993, Blacksin 1993). Throughout this literature, one can find suggestions regarding the possibility that airbag deployment in a frontal or near-frontal crash may change the pattern of non-fatal injuries sustained by drivers and that these changes may vary according to their driver's gender.

Identifying whether there are actual differences in injury patterns and characterizing them is crucial to expediting the delivery of efficient diagnostic and therapeutic procedures by health care providers who are in charge of managing severely injured individuals. In order to characterize these possible changes in the patterns of injury, we conducted a multi-year, prospective evaluation

of the nature and severity of injuries incurred by severely-injured drivers involved in front and front-angle crashes and admitted to Level-I Trauma Centers.

MATERIALS AND METHODS

Trauma Registry information of all drivers admitted to the six adult Level-I Trauma Centers in Massachusetts (Baystate Medical Center, Beth Israel Deaconess Medical Center, Boston Medical Center, Brigham & Women's Hospital, Massachusetts General Hospital, and University of Massachusetts Medical Center) from October 1, 1995, to December 31, 1997, was prospectively collected and deterministically matched with the crash records available at the Massachusetts Registry of Motor Vehicles.

On a quarterly basis, participating trauma centers submitted identification data regarding the motor vehicle occupants discharged from their centers during that period. The trauma center data submitted at this time included the patients' full name, gender, social security number, dates of birth, accident, hospital admission and discharge, and type of occupant (i.e., driver, passenger). These identification data were used to find the electronic- and hard-copy files of the accident reports at the Massachusetts Registry of Motor Vehicles. We searched for operator accident reports or (preferably) police accident reports. The data retrieved at this stage included the driver's license number, personal and police report numbers, vehicle's type of plate and plate number, Vehicle Identification Number (VIN), whether the patient or any other person involved in the crash was known to be dead as a consequence of the crash, car make, model, and year, safety devices (including airbag information), approximate cost of repair, direction of impact, and circumstances of the accident. Once the accident reports had been found, we requested from the admitting trauma center additional information regarding state of residence, transfer status, safety belt use, Glasgow Coma Scale upon arrival (and whether the patient had been intubated and/or chemically paralyzed), length of stay at the Intensive Care Unit, discharge disposition, and cause, nature and severity of the injuries. These latter variables are coded by the trauma registries using the International Classification of Diseases -9th revision-Clinical Modification (ICD-9-CM), the Abbreviated Injury Scale (AIS) scores (AAAM 1990), and the Injury Severity Score (ISS) (Baker and O'Neil 1976). Patients' record contained up to ten injury diagnoses and their AIS scores.

Data quality checks were performed to eliminate potential errors (e.g., duplicates due to transfers between the participating hospitals). When all the data had been compiled, we generated a number of additional elements, including: patient's age and length of

hospital stay, airbag presence (obtained after decoding of the VIN using VINDICATOR (HLDI 1993)), number of diagnoses per patient, and whether the reported diagnoses belonged to one of 16 ICD-9-CM standard chapter categories (DHHS 1980).

Driver inclusion criteria for the analysis entailed having been admitted alive to a participating trauma center, having a retrievable accident report, and being involved in a frontal or near-frontal crash (10-2 o'clock range).

For our analysis, we coded as a safety belt user at the time of the crash any patient for whom the trauma center indicated so. We coded as an airbag deployment case any driver for whom at least two of the three airbag data sources (i.e., VIN, trauma center, and registry of motor vehicle) indicated so.

A descriptive analysis was conducted to compare the nature, clustering, and severity of injuries experienced by two patient groups: those with an airbag and those without it. The analysis was then repeated after stratification by driver gender and airbag status. The descriptive analysis entailed the report of range, mean, and standard deviation for the continuous variables, and/or the frequency distribution for the categorical variables. The distributions of selected variables (e.g., severity scores, length of stay and discharge disposition) between drivers with and without airbags were compared using Chi^2 (for categorical variables) or T tests (for continuous variables), correcting for multiple comparisons. Statistical significance was defined at the $p \leq 0.05$ level. Data management and analysis were performed using Microsoft Access®, Excel® and SAS®.

RESULTS

A total of 3,183 drivers were discharged from Massachusetts Adult Level-I Trauma Centers during the study period. Of those, complete records after linkage with the Registry of Motor Vehicles were available for 1,377. Three-hundred and twelve of these were non-frontal crashes, thus a total of 1,065 drivers met our inclusion criteria for analysis. In this section, we will present the drivers' airbag status, their demographic and crash characteristics, the number, type and AIS severity of their injuries, whether their injuries clustered around patterns, and the drivers' overall severity and discharge disposition.

DETERMINING AIRBAG STATUS

Of 236 drivers (22% of all drivers) for whom at least one of the three data sources (namely VIN, trauma center or accident report) indicated the presence and/or deployment of an airbag, only 9 had the three data sources in agreement. Two of the data sources agreed for additional 58 drivers (Table 1). Thus, 67 drivers (9+58),

or 6% of the total, met our classification criteria to be classified as "airbag" drivers.

Table 1. Airbag Information (N= 236 Drivers)

Agreement Among Sources of Airbag Information	N (%)
Three sources agreed (subtotal):	9 (4.0)
Trauma Center + Registry of Motor Vehicles + VIN	9
Two sources agreed (subtotal):	58 (24.0)
Trauma Center + Registry of Motor Vehicles	27
Trauma Center + VIN	25
Registry of Motor Vehicles + VIN	6
One source only (subtotal):	169 (72.0)
Trauma Center	72
Registry of Motor Vehicles	26
VIN	71

DRIVERS' DEMOGRAPHICS AND CRASH CHARACTERISTICS - The ages of the 1,065 drivers ranged from 16 to 94 (mean 42, standard deviation 19). Sixty percent of them were male. All but 14 of the drivers were Massachusetts' residents. Safety belts were worn by 40% of the drivers. Less than 4% of the drivers were ejected from the vehicle after the crash. Half of the crashes (50%) occurred when the vehicle hit another vehicle in traffic; among the remaining crashes, running off the roadway was the most common form of crash (33%). Two-hundred and thirty-three of the vehicles were totaled after the crash.

The 66 airbag drivers ages ranged from 17 to 78 (mean 44, standard deviation 18), 38 were male, and only 1 was not a Massachusetts' resident. Sixteen drivers wore safety belts, and none were ejected from the vehicle. Almost half of these drivers (42%) crashed when they hit another vehicle in traffic, whereas 48% run off the roadway. Seventeen vehicles were totaled after the crash.

The only statistically significance between drivers with and without airbags regarding demographic and crash characteristics was safety belt use: female drivers with airbags were less likely to have their safety belt on at the time of crash than drivers without airbags ($p=0.06$).

INJURIES – Two-hundred and thirty drivers (22%) sustained a single injury. Among the 833 multiple-injured drivers, 19%, 18%, 13%, 7%, 6%, 4%, 3%, 2%, and 6% presented two through ten injuries, respectively. Thus, a total of 3,465 diagnoses were available. There were no statistical

differences in the number of reported injuries by airbag status or gender and airbag status.

Overall, open wounds to the head, neck and trunk were the most common injuries (15%), followed by fractures to the neck and trunk (13%), intracranial injuries (12%), and internal injuries to the chest, abdomen and pelvis (10%). Analysis of these injuries by airbag status confirmed statistical significant differences in the overall distribution of these injuries (p=0.03). Specifically, drivers with airbag involvement were more likely to sustain fractures to the upper extremities (e.g., fracture of clavicle or upper end open fracture of radius or ulna) and less likely to sustain certain traumatic complications (e.g., traumatic shock) and injuries to blood vessels (e.g., injuries to the aorta) ($p<0.05$). Drivers with airbags also presented higher frequencies of fractures to the lower extremity, open wounds to the upper and lower extremity and fractures to the neck and trunk. However, these differences did not reach statistical significance (Table 2).

Table 2. Distribution of Injury Categories by Airbag Status and Gender (N = 3,465 injuries)

	Female		Male	
Injury Categories (ICD-9-CM codes)	Airbag N=110	No Airbag N=1,284	Airbag N=111	No Airbag N=1,960
Fractured skull (800-804)	5.8	6.4	8.3	8.6
Fractured neck and trunk (805-809)	16.7	11.8	12.4	12.7
Fractured upper extremity (810-819)*	12.5	6.8	9.1	5.4
Fractured lower extremity (820-829)	17.5	12.3	10.7	8.2
Dislocation (830-839)	3.3	2.3	0.8	1.8
Sprains and strains (840-848)	0.0	1.6	0.8	1.0
Intracranial injury (850-854)	8.3	11.7	18.2	11.6
Internal injury to chest, abdomen, pelvis (860-869)	8.3	10.0	9.1	10.7
Open wound head, neck, trunk (870 879)	7.5	13.5	14.1	16.4
Open wound upper extremity (880-887)	3.3	1.5	3.3	3.3
Open wound lower extremity (890-897)	1.7	2.8	0.0	2.6
Injury to blood vessel (900-904)*	0.0	0.4	0.0	0.3
Superficial injury (910-919)	5.0	7.2	5.0	7.0
Contusions with intact skin (920-924)	9.2	10.8	7.4	8.9
Injury to nerves and spine (950-957)	0.8	0.1	0.8	0.8
Certain traumatic complications (958-959)*	0.0	0.6	0.0	0.7
All categories (800-999)*, ** for Females	100.0	100.0	100.0	100.0

Notes: * $p \leq 0.05$ for airbag vs. non-airbag, regardless of gender; ** $p = 0.06$

We then evaluated the frequency distribution of these injury categories by gender and airbag status (Table 2). Female drivers with airbag involvement presented more fractures and open wounds to the upper extremities, fractures to the lower extremities, neck and trunk, dislocations and injuries to nerves and spine than female drivers with no airbag deployment. Neither of these differences achieved statistical significance *per se*, although collectively they almost achieved statistical significance (p=0.06). No differences in frequency distribution were observed between male drivers with or without airbags.

Severity of Injuries – Most of the injuries were AIS 1 (45%) or AIS 2 (36%) (Table 3). The AIS distribution was significantly different between drivers with and without airbag involvement (p=0.009), particularly due to the lower frequency of AIS 1 (p=0.002) among drivers with airbag involvement.

Table 3. AIS Distribution (%) by Airbag Status (N=3,448 Injuries*)

AIS Categories	Airbag (N=223)	No Airbag (N=3225)
Minor (AIS 1)**	36.8	45.6
Moderate (AIS 2)	40.8	36.0
Serious (AIS 3)	17.5	12.3
Severe (AIS 4)	1.8	4.1
Critical (AIS 5)	0.9	0.9
Maximum (AIS 6)	0.0	0.3
Unknown (AIS 9)	2.2	0.8
Total**	100.0	100.0

Notes: * 17 injuries had missing AIS; ** p≤0.05

Among female drivers, 44% of the injuries were AIS 1, followed by AIS 2 (38%), AIS 3 (13%), AIS 4 (4%), AIS 5 (0.6%), AIS 6 (0.1%) and AIS 9 (0.4%). There were no significant differences in this distribution by airbag status (data not shown). The injuries reported for male drivers followed a very similar distribution: AIS 1 (46%), AIS 2 (35%), AIS 3 (12%), AIS4 (4%), AIS 5 (1%), AIS 6 (0.29%), and AIS 9 (1.3%). The distribution of these male drivers AIS scores by airbag status was significantly different (p<0.01), mostly due to the fact that male drivers with airbag involvement had significantly fewer AIS 1 (p<0.05) at the expense of having more severe injuries (38% vs. 35%, 18%

vs. 12%, and 4% vs. 1% AIS 2, 3, and 5 with airbags and without airbags, respectively).

DRIVERS' PATTERNS OF INJURIES – The 822 drivers who sustained multiple injuries sustained multiple injuries within ICD-9-CM categories (418 drivers) as well as across injury categories (remaining 404 drivers). To explore the patterns of injuries and their frequencies we limited our analysis to the 7 most frequently reported ICD-9-CM categories. The 2,944 injuries (85% of the total 3,465 injuries reported) clustered in 215 different patterns. These patterns reflect multiple combinations of single and multiple injuries across the selected 7 ICD-9-CM categories. Most of these patterns (208 of 215) occurred in less than 2% of the patients each. Although the overall distribution of 215 patterns was significantly different between drivers with and without airbags (p=0.008, data not shown), the change in the distributions of each of the 7 most common patterns did not reach statistical significance (Table 4).

Table 4. Most Frequent Patterns of Injuries and Their Distribution (%) by Airbag Status. All Drivers (N= 1,065) and Female Drivers (N = 423)

	All Drivers		Female Drivers	
Injury categories	Airbag (N=67)	No Airbag (N=998)	Airbag (N=28)	No Airbag (N=395)
Injury/injuries to the chest, abdomen or pelvis:				
Single injury	6.0	9.1	7.1	8.1
Multiple injuries	7.5	4.11	10.7	2.8
Single intracranial	7.5	8.1	3.6	6.8
Single intracranial and injury/injuries to the chest, abdomen, or pelvis:				
Single injury	4.5	6.1	3.6	8.1
Multiple injuries	0.0	4.6	0.0	4.3
Single fracture to lower extremity	4.5	4.6	7.1	6.6
Single fracture to neck and trunk	4.5	4.3	<2	<2

Among female drivers, the injuries clustered in 126 patterns. All but 8 of these patterns were present in less than 2% of the drivers each. Although these distributions varied by airbag status (Table 4 female drivers columns, overall p=0.03), none

of the specific changes in particular patterns did achieve statistical significance individually.

The injuries reported among male drivers clustered in 163 injury patterns. No differences in the distributions of these patterns were observed by airbag status (data not shown).

DRIVER'S SEVERITY AND DISCHARGE DISPOSITION –There were no statistically significant differences by airbag or gender and airbag status regarding: (a) GCS at the time of admission (average GCS was 14.4), (b) ISS (average ISS was 10.4), (c) length of stay at the trauma centers (average 6.3 days), or (d) length of stay at the Intensive Care Units, if admitted (average 3.9 days) (data not shown).

Seven drivers (0.6%) died while at the Trauma Centers. Airbags were involved in only one of these deaths, that of a female driver. Although drivers with airbags had a higher fatality frequency (2%) than drivers without airbags (0.6%), this difference did not reach statistical significance.

CONCLUSIONS & DISCUSSION

Our findings suggest that airbag deployment has not dramatically altered the frequency or distribution of injuries among drivers admitted to Level-I Trauma Centers. The most frequent injuries occur equally to drivers with and without airbags. The only exception to this statement would be the fractures to the upper extremity (and to a lesser extend, open wounds to the upper extremity), which are the only injury categories with a statistically significant increase among airbag-involved drivers. This increase seems to be driven by the increase in such injuries among female drivers. Increases in upper extremity injuries in drivers with airbag deployment have already been documented (NHSTA 1996, Martin et al 2000).

Regarding the severity of the injuries and the drivers, no differences were found between drivers with and without airbags -- except that male drivers with airbags seem to have more severe injuries than male drivers without airbags.

Drivers in motor vehicle crashes tend to suffer multiple injuries and of multiple types. Trying to catalog those multiple injuries to identify patterns proved very difficult given the small frequency of most combinations.

Besides the comparisons regarding the frequency and distributions of injuries and injury patterns, several other interesting facts were identified through this research. Some of these have to do with data linkage in injury research, both across similar institutions (e.g., trauma centers) and across "complementary" institutions (e.g.,

trauma center and registry of motor vehicles). Besides making sure that the coding criteria for identical variables were alike (and if not, then making them alike), particular attention was placed in ensuring that the operational definitions and inclusion criteria were compatible (e.g., did admission to the trauma registry include death on arrival?). Also, and despite the increasing availability of computerized files to transfer data, not all data available in records gets computerized. For example, direction of impact is not electronically recorded in the accident files, which means that we still needed to access individual paper copies of the accident records. Lastly, increasing the sources of information also increased the possibility of some sources disagreeing in the responses to particular variables. For example, the characterization of drivers regarding airbag status became much more complex. Discrepancies between medical data, accident data and VIN have already been documented (Cercarelli et al 1996, Rosman and Knuiman 1994, Grant et al 1998, Segui-Gomez and Lescohier 1995a).

This study is not exempt of limitations. Firstly, despite our timely search for police reports at the registry of motor vehicles, we were unable to find the crash records of some 1,500 additional drivers admitted to the participating trauma centers. In a pilot study conducted in early 1995 (Segui-Gomez and Lescohier 1995b), we identified state of residence, change of last name (due to change in marital status), and misspellings or either the name and/or social security information as the major reasons for the lack of matching between the trauma registry and the registry of motor vehicles data. In the pilot test, we tested whether the unlinked drivers were significantly different regarding demographic, crash and injury variables and we could not prove statistically significant differences in any parameter. Hence, we have no evidence to disregard the drivers analyzed in this study as not representative of the population of drivers admitted to a Massachusetts Level-I Trauma Center after a crash.

Despite these limitations, this is, to our knowledge, the first report of such a large series of drivers hospitalized in Level-I Trauma Centers for which both detailed medical and crash data were linked. All previous reports of the patterns of injuries associated with airbag deployment relied on either much smaller samples, or only one data source or another. Contrary to what those engineering or medical literature case reports may suggest, our study of a large number of drivers admitted to Level-I Trauma Centers after a crash, could not identify differences in the number, type, clustering and severity of the injuries sustained by airbag status or gender and airbag status. The only two aspects that differed between airbag and non-airbag drivers were that: (a) female drivers with airbags had a higher frequency of upper extremity fractures and a lower frequency of

injuries to blood vessels and traumatic complications than female drivers without airbags, and (b) male drivers with airbags had a higher frequency of more severe injuries (as measured by the AIS) than men drivers without airbags.

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(*Presenter:* Maria Segui-Gomez)

Uwe Meissner: I don't understand the exercise of this paper. You go out and pre select severely injured drivers from two different sets – airbag deployed, not deployed. How then can you make a comparison without considering the severity of the crash?

M. Segui-Gomez: In response to the first point, I said at the beginning that this was part of a much larger and comprehensive study in which we had to deal with many other aspects. We felt that even though this is a very restricted application because we're only talking about comparing patients who are severe enough to be admitted to hospital, it was worth putting all these case reports in perspective and identifying where indeed the medical practitioners had to change any of their current practices because of this new array of injuries and that was the point of the exercise. Your point is very well taken but as you very well know, there is no way to find crash severity information unless you go to indepth investigation which was not feasible in this study. And because we were doing complementary work that dealt with that issue, we felt it was not relevant to have it in here. However, this is all conditional on the fact that regardless of which crash you were in, you were injured severely enough to be in hospital and we take it from there.

U. Meissner: But if I get to a trauma center as a victim, then I already pass a pre selection that I'm severely injured. I really don't expect a difference in outcome whether I have been in an airbag deployed car or not.

M. Segui-Gomez: It does because if you have been listening to all the reports on liver injuries or aortic injuries or upper extremity fractures, it makes a difference whether the physician who will be taking care of you decides first to rule out some of these injuries or decides to continue with his routine diagnostic procedures. So it does matter whether the clinician taking care of you is aware that there are any differences that he or she should be taking care of. I would care that if there are differences, the physician who's taking care of me knows about them.

U. Meissner: I agree on that. However, how does a clinician know that an airbag has been deployed or not?

M. Segui-Gomez: Well, the EMS personnel records this information. It's being collected in the trauma registries. The same way they are asking whether you were belted, they are asking whether the airbag deployed. The point of this exercise was to say maybe that's one question that they need to ask. Maybe when you are rolled through the door, they need to ask whether you had an airbag or not.

Jeff Runge: While I appreciate the take home message that clinicians don't necessarily need to pay attention to different patterns of injury, or that they're not likely to occur once a patient is admitted to a trauma center, it's sort of an odd logic because all of those things have been considered in order to get the patient into the trauma center in the first

place. So, yes, physicians in the Emergency Department need to understand that patterns of injury may differ, whether there's an unrestrained patient, a seat belt only, an airbag only, or airbag plus seat belt. So those considerations have already been made by the time the population is selected. So while I appreciate the fact that the trauma surgeon now can turn his attention to the xrays and the bleeding, let's not kid ourselves into thinking that those patterns do differ when it really matters and that's in the Emergency Department. We send home 20 people for every person who is admitted to a trauma center, and without the knowledge of their restraints and their pattern of injury, that simply would not be the case.

M. Segui-Gomez: I agree partially with what you are saying. The point of the paper was not to dismiss the severe injuries that are being reported and are visible and are likely to occur. The point was to say don't forget the ones that you used to be worried about because they are still there. And the second thing is that you are right in that there might have been a number of considerations in admitting these patients to the hospital to begin with, but the fact of the matter is that once you have admitted them, they are no different from each other. So how did they arrive to that point is the question. If they were any different and if their injuries were any different and if those differences were the ones leading to hospital admission, that would be here. They were not. The reasons by which these patients were admitted were the same reasons, the same type of injuries.

J. Runge: I understand, and I maintain that once they're already admitted, they've already passed through the sieve sufficiently that those issues are not of much importance anyway. And you've confirmed this.

Jeya Padmanaban: I understand that you cannot identify crash severity, but you do make the statement that the injuries sustained by drivers in cars with airbags are much more severe than injuries sustained by drivers in cars without airbags. Did you try to normalize those two groups?

M. Segui-Gomez: I didn't say that the injuries were more severe. I only said that there was a slightly larger proportion of AIS 1 injuries in one case or the other.

J. Padmanaban: Okay, a larger proportion …

M. Segui-Gomez: But that's relevant in many ways.

J. Padmanaban: So when you're comparing these two sets, did you try to make the set of groups that you are comparing pretty much the same, or looked at make and model, or model years, or anything else to compare them?

M. Segui-Gomez: We could not do crash severity, that I've said. Model years had to be 1986 through 1997 and I failed to say that in the slides. And as I said, this was part of a much larger piece of work in which we were using NASS data and using crash severity and so on in terms of real world data. But in this particular case, this was a very simple descriptive comparison of the proportions of injuries.

J. Padmanaban: The other question is the fact that Massachusetts is one of the few states without a mandatory use law. Do you think that has any effect? The belt use is pretty low.

M. Segui-Gomez: If I remember correctly, the average reported safety belt use in these particular groups was a little higher than 50% which was pretty much what was the average in the state at the time. Your point would be whether additional analysis by segregating these patients by safety belt use was warranted and that was the initial hope that we would be able to separate these patients, but at the end of '97, we were barely able to compare airbags so we had to stop there because of the sample size. I can only add one more thing which is that the baseline level of injury would be higher or lower depending upon whether safety belt use was higher or lower, but there is no real evidence that the interaction between airbag and safety belt would have a significant impact on the number or distribution of those injuries. That remains to be proven at that level.

Ken Digges: I've been doing analysis of the data at the Lehman Injury Research Center on cases of frontal crashes with airbags and belts and without, and one of the things that we see from about 150 cases with airbags and about the same number with belts is a tendency of the belt cases to have head injury more frequently than the airbag cases do. And in the absence of a head injury with the belt and airbag cases, there is a much more frequent tendency for the remaining injuries to be occult injuries and ones which are much more difficult to diagnose. Consequently, we are urging caution in examining airbag injuries of belted occupants when there's no head injury to look for some of those other injuries because we are seeing them much more frequently in airbag belted cases than we are in belted cases alone because the head injury goes along with the belted case.

M. Segui-Gomez: And I can only say that we did not do a further breakdown by safety belt and … What you are suggesting is directly related to the safety belt, but I agree with your statement that in the case of occult injuries, there is further diagnostic work to be done in these patients.