UPDATE ON THE PEDESTRIAN CRASH DATA STUDY

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ABSTRACT

In July 1994, a Pedestrian Crash Data Study (PCDS) was initiated within the United States to collect detailed crash reconstruction data on pedestrian crashes. Information on the first eighteen months of data collection was presented in a paper titled "Pedestrian Crash Data Study - An Interim Evaluation" at the ESV Conference held in June 1996. This paper will report on the continued progress and data collection efforts of the PCDS. It will report on the procedures implemented to sanitize the video recordings which are part of the data collection process for vehicle and scene documentation, and report on the continued successful implementation of the pedestrian contour gauge for the documentation of the pedestrian's contacts with the vehicle. Additional analyses of the pedestrian crash circumstances, including pre-crash, at crash, and injury consequences will also be discussed for 292 crashes.

BACKGROUND

In 1992, a need was identified for the National Highway Traffic Safety Administration (NHTSA) within the United States Department of Transportation to collect pedestrian crash data through the Crashworthiness Data System (CDS), a component of the National Automotive Sampling System (NASS), formerly known as the National Accident Sampling System. The detailed pedestrian crash data that NASS had collected prior to 1987, when the Crashworthiness Data System (CDS) was implemented, had become obsolete and current pedestrian crash data were needed to ensure that pedestrian crash analyses capabilities were consistent with real world crash events.

Data collection for the Pedestrian Crash Data Study (PCDS) began in July 1994, and as of March 1, 1998, over 500 pedestrian crashes have been or are under active investigation. However, due to the conversion of the NASS CDS to a fully electronic and automated data collection system in 1997 at the same PCDS sites, time and quality control constraints have prevented the construction of an analysis file containing all 500 crashes. Hence, this paper will report on the analyses of 292 crashes that are in the current analysis file.

The previously mentioned published paper can be referred to for further detail on the background of the Pedestrian Crash Data Study and prior pedestrian crash data collection efforts as part of the National Automotive Sampling System.

SIZE AND NATURE OF THE PROBLEM

During the last four years, pedestrian injuries have continued to decline, whereas, pedestrian fatalities remain about the same. In 1996, pedestrian-vehicle impacts resulted in 5,412 pedestrian fatalities and 82,000 pedestrians injured (see reference number 5). These figures are a slight decrease from 1995 when 5,584 pedestrians were killed and 86,000 were injured. Generally, since 1993, pedestrian fatalities have hovered about the 5,500 mark, whereas in terms of injuries, there has been a consistent and definite decrease from 94,000 injures in 1993 to 82,000 injuries in 1996. Passenger car, van, and light truck involvements account for nearly 86 percent of the pedestrian fatalities and for nearly 96 percent of the pedestrians injured. One pedestrian is killed by a motor vehicle every 97 minutes and injured every 6 minutes in the United States.

Data on pedestrian injuries from the 1982-1986 NASS data files, the last pedestrian data files available for analyses, show that approximately 40 percent of the pedestrian injuries resulted from contact with the vehicle, 32 percent resulted from contact with the ground and 26 percent of the injuries were from unknown contact sources. Data collected in the PCDS will be used to determine if newly designed vehicles are creating the same or different types of injury patterns since the mid-1980's. These data are needed to determine the types of injuries sustained and the contact mechanisms involved in pedestrian impacts with late model year vehicles.

SCOPE OF PEDESTRIAN CRASH DATA STUDY

The PCDS continues to be operational at the six sites that were selected because of the number of pedestrian crashes that occur at these locations. The sites selected to participate in the PCDS are: Chicago, Illinois; Buffalo, New York; Fort Lauderdale, Florida; Dallas, Texas; Seattle, Washington and, San Antonio, Texas.

A pedestrian is considered as any person who is on a trafficway or on a sidewalk or path contiguous with a trafficway, or on private property and who is in contact with the ground. Persons in or on a nonmotorist conveyance are not pedestrians and are excluded from this study.

For a crash to qualify for the Pedestrian Crash Data Study:

- The vehicle must be moving in a forward direction at the time of the impact.
- The vehicle must be a late-model-year passenger car, light truck or van. Late-model-year is defined as being manufactured in the last 5 years. It also includes non-late-model-year vehicles where the exterior design is the same as late-model-year-vehicles (e.g. Ford Taurus 1988 to 1994).
- The pedestrian may not be lying down or sitting.
- The striking portion of the vehicle's structure must be original equipment manufacturer (OEM) without previous damage and/or parts removed in the impact area.
- The pedestrian impacts are the vehicle's only impacts.
- The first point of contact between the vehicle and the pedestrian must be forward of the top of the A-pillar.

The Pedestrian Crash Data Study will collect data on 900 - 1000 crashes for clinical analysis. In 1994, 15 cases were initiated, 77 cases during 1995, 190 cases during 1996, 205 cases during 1997 and 13 cases for the first two months of 1998.

OPERATIONAL PROCEDURES

The data are collected through on-scene crash investigations (or within 24 hours) of pedestrian crashes involving late model year passenger cars, vans, and light trucks. If a vehicle or pedestrian can not be located and interviewed, or the vehicle damage measurements can not be obtained within 24 hours of the crash, the case is dropped from the study.

Police cooperation has been established at each site to conduct on-scene crash investigations or follow-ups within 24 hours. Notification of the crash is facilitated through a variety of media including the telephone and monitoring of police and emergency medical services radio frequencies.

If an investigation is conducted on-scene, the researcher notifies the police of their presence immediately upon arrival at the scene and proper investigation protocols are followed so as to ensure there is no interference or disruption to any police investigation. Once a determination is made that the case meets the selection criteria, the crash investigation commences.

DATA COLLECTION FORMS

Data are collected and automated on 144 different variables in the Pedestrian Crash Data Study. Environmental, human, and vehicle data are collected for all phases of the crash. As shown in Table 1, there are 24 variables in the pre-crash phase, 38 variables in the at-crash phase and 82 or more variables in the post crash phase.

Additionally, there are six variables that are derived on the analysis files as they are created, such

Table 1.
The Distribution of PCDS Forms by their Relationship to the Crash Events

Number of PCDS Variables by Event Type			
	Pre-Crash	At-Crash	Post-Crash
Environmental	11	11	0
Human	11	16	47*
Vehicle	2	11	35

* add 13 variables per injury

as the Maximum AIS (MAIS), Day of Week, and Injury Severity Score (ISS). A complete listing of the automated variables by the five primary data collection forms is included in the appendix to this paper.

The Accident Form collects data on the general characteristics of the event such as the time of day, the vehicle class, and the general area of damage for the vehicle involved.

The Pedestrian Assessment Form documents data on the characteristics of the pedestrian (age, sex, height, weight), their avoidance actions, orientation at impact, alcohol and drug presence, and the consequences of their injuries such as their treatment, hospital stay, and injury severity. Height measurements include ground to knee, hip, shoulder and overall height.

The Pedestrian Injury Form contains thirteen variables for **each** injury that is documented from official or unofficial records. Each injury is coded according to AIS90 injury descriptors with modifications for NASS CDS. In addition to the injury description, additional data collected for each injury include: the contact source of the injury; the striking profile; the type of damage; and the damage depth. Injuries are documented sequentially on the form by order of occurrence as determined during the reconstruction of the crash.

The General Vehicle Form contains vehicle make and model data, official record data for the driver, such as alcohol and drug information, pre-crash data as to vehicle movement, environmental data, and reconstruction data for determining impact speed.

The Vehicle Exterior Form contains pedestrian contact data for both front and side pedestrian contacts, front and side pedestrian vertical and wrap measurements, detailed hood measurements, material identifications, and vehicle dimensions. Non-automated data include: the scene diagram; the crash case summary form; and, interview forms for the pedestrian and driver.

UPDATE ON NEW DATA COLLECTION TECHNIQUES

The two new techniques implemented for this study in 1994 included the use of video cameras to quickly document the on-scene crash data and the development of a contour gauge to quickly and accurately measure pedestrian contacts on the vehicles.

During the last two years of data collection, not only has the Hi8 video camera proven to be an expedient and effective method to capture important data, but the technology has been developed to quickly and cost effectively sanitize these videos for future distribution without loss of the quality of information documented on them.

When the study was initiated, the Hi8 video camera was compared to 35mm single lens reflex cameras. The study showed that the video camera was capable of quickly capturing physical evidence during an on-scene investigation. In addition, the field researcher provided an audio description of the video image. Evidence generated in a pedestrian crash is often very minor and barely visible. The Hi8 video camera is ideal for documenting this type of evidence because it is capable of viewing detailed physical evidence on the pavement left from the pedestrian at the point of impact, or even a tiny thread of fabric left on the vehicle. The slide photography, traditionally done in NASS CDS, is not as efficient in capturing on-scene evidence as the video camera. The video camera is capable of filming thirty frames per second which enables data quality reviewers to freeze frames of captured evidence and to make accurate assessments of the data collected.

With Hi8 video selected as the medium, a structured guideline for video taping each case has also been developed. The accident scenes are video taped to show actual paths of the vehicle and the pedestrian along with audio descriptions which associate the evidence with a scaled reference in the environment. The vehicle is also documented in a video format where each contact made by the pedestrian is viewed with various angles, closeups, and finally referenced with the contour gauge.

Before data is made available for analysis, each case must be sanitized. Sanitization is the procedure used to remove all personal identifiers contained in a case. Identifiers found on vehicles include the license plate, VIN, registration and inspection tags, along with any company names or phone numbers that might be found on commercial vehicles. Since on-scene investigations are conducted, the faces of all officials (e.g., police and EMT) as well as the pedestrian must be concealed. Street signs that identify the location of the crash must also be masked. In addition, audio must be sanitized whenever names or other identifiers can be heard.

Nonlinear editing technology is used in the video sanitization process. Each Hi8 video tape is digitized through a high quality video capture board to maintain video quality. Once digitized, the entire image can be viewed, frame by frame. The video technician identifies and marks each segment of the tape that needs sanitization. A custom mask is fitted over all objects requiring sanitization. Special care is taken to ensure that the mask covers only the object being sanitized. An audio message is inserted on the video tape reporting whenever important physical information is covered in the sanitization process. This becomes necessary whenever a license plate or other identifying object is contacted by the pedestrian.

A moving mask must be created whenever the object to be sanitized moves. Moving masks are also required whenever the camera pans across a stationary object. To accomplish this, a mask must be moved into proper position frame by frame. The result is a moving mask that continuously conceals the object in question.

After all video segments have been sanitized, a disclaimer is inserted at the beginning of each video. The disclaimer states "The audio portion of this video tape is the express opinion of the field researcher as perceived at the time of taping. Since all pertinent data are not available to the researcher at the time of taping, conclusions made might not represent the final determinations made during the quality control process." Also inserted is the case number along with video running time. At the end of the video an "End of Tape" title page is inserted.

The next step is to record the entire sanitized video onto a new Hi8 tape. In addition, the sanitized video is recorded onto a Beta tape for long term storage and possible future creation of MPEG video, written to CD-ROM or DVD. The final step is to label each Hi8 tape with the year and PCDS case number.

The contour gauge was created to provide a frame of reference on the vehicle for verifying the accuracy of the measurements and to provide an efficient and uniform method to document the pedestrian contact evidence. In addition, it provides an opportunity to reapply the exact locations of contacts on similar vehicles for simulation of impacts.

The contour gauge consists of two scaled ribbons which create an isometric coordinate system which wraps to the shape of each vehicle. The first scaled ribbon begins on the ground, below the center of the front bumper, and wraps over the vehicle along the longitudinal center which creates the "X" axis. This "X" axis wrap scale also assists in referencing the wrap orientation of the pedestrian with the ground. The "Y" axis is then placed laterally across the hood, or windshield with some vans, and referenced with the front axle of the subject vehicle. Scaled contact markers are then placed on the vehicle to identify the evidence and measured within the coordinate system created by the contour gauge. More than one marker may be used to identify the evidence when long streaks or large swiping areas and dents occur.

The contour gauge has proven to be a reliable source for data documentation and has been developed for use in computer reconstructions or actual simulations and examinations of pedestrian interactions with vehicles.

DATA ANALYSIS

Data from 292 pedestrian crashes were analyzed for this update on the PCDS. All cases were single vehicle and single pedestrian events with an equal number of drivers and pedestrians involved.

Pedestrian Characteristics

Males and females were evenly distributed with a count of 186 (50%) each. Two of the females who were involved were reported to be pregnant (in their first trimester) at the time of the crash. However, both women received only minor injuries (AIS 1). In terms of age, there were no pedestrians under the age of three. Fifty-three (18%) of the pedestrians were between the ages of 3 and 12, while 29 (10%) were between the ages of 13 and 19. The vast majority, 183 pedestrians or 63%, were between the ages of 19 and 65, with an additional 26 (9%) over the age of sixty-five. There was one pedestrian whose age was unknown. Figure 1 shows the distribution of the pedestrians by their age groupings.

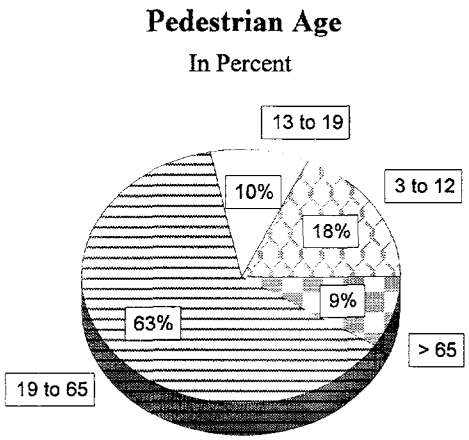

Figure 1. Percentage of involved pedestrians by age.

In regards to overall height, fifty-five (19%) pedestrians were 152 centimeters (5 feet) or shorter with the most predominant group 106 (36%) of pedestrians being between 153 and 168 cm (between 5' and 5' 6"). Eighty-one (28%) were between 169 and 183 cm (5'7" to 6 feet) and sixteen pedestrians (5%) were over 183 cm (six feet) tall. The height of the pedestrian appears to have some correlation to the Maximum AIS (MAIS) as seen in the Figure 2 below.

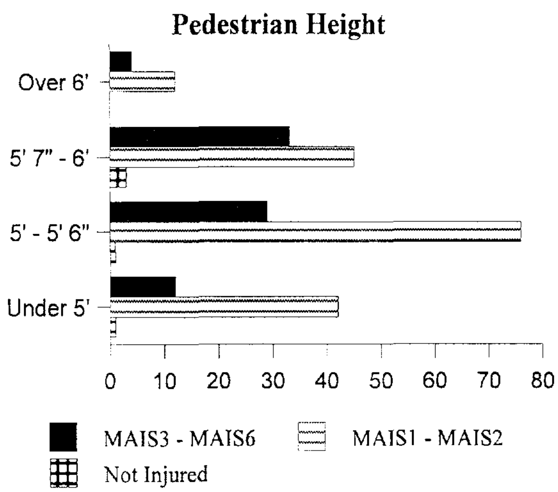

Figure 2. Distribution of MAIS by pedestrian height.

It appears from the population in the data base, that those individuals between 5'7" and 6' were more likely to receive a serious injury (MAIS3 - MAIS6) than any other population in the height distributions. This could be attributed to the likelihood of head contact on the vehicle's windshield or some other structure and could be worthy of further evaluation as more crashes are investigated and added to the data base.

Vehicle Characteristics

Figure 3 shows the distribution of the

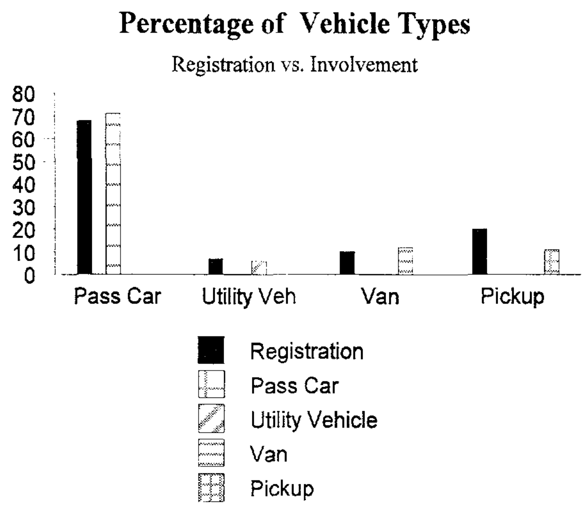

Figure 3. Percentage of vehicle types by registration and involvement.

vehicle types by overall registrations in the United States and their involvement in the PCDS.

Of the involved vehicles, 206 (71%) were passenger cars and 86 (29%) were other light vehicles, collectively referred to as light trucks (pickups), vans, and utility vehicles. This is nearly identical to the composition of vehicle registrations in the United States. However, within the "other" group, the mix of vehicles found in this study differs from registration data. The 18 utility vehicles in the study make up six percent of the data, closely matching the seven percent of registered vehicles. Overall, vans make up ten percent of registered vehicles, but 36 vehicles (12 percent) in the study were vans. Since the June 1996 Interim Evaluation, the population of registered minivans has increased

2 percentage points to 6% while full-size vans remained at 4%. In the present study, 9 percent of the vehicles were minivans, and 3 percent were full size vans. The remaining 32 vehicles (11 percent) were pickup trucks, which are 20 percent of registered vehicles. The present study differs from the registered vehicle fleet mainly by an over representation of minivans, and an under representation of pickup trucks.

Figure 4 shows the distribution of pedestrian injuries by vehicle type by crash involvement, involvement of vehicle type for all injuries and involvement of the vehicle types for serious injuries AIS3 - AIS6. There were a total of 2,180 injuries documented for the 292 pedestrians. Of these, 1,445 (66%) were from passenger cars, 323 (15%) were from pickup trucks, 164 (8%) were from utility vehicles and 248 (11%) were from vans.

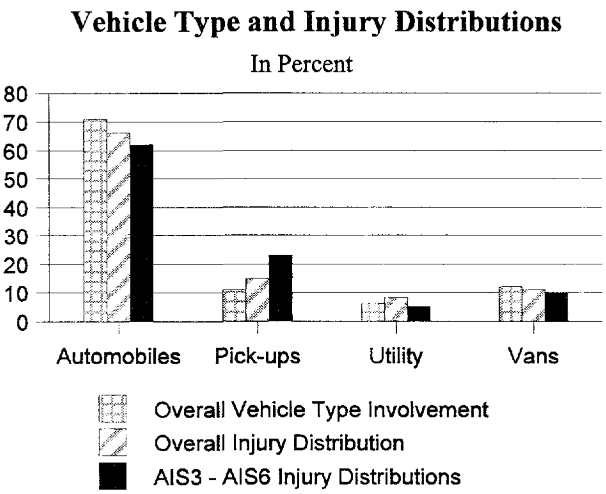

Figure 4. Percentage of vehicle types distributed by involvement and injury distributions.

When the serious injuries (AIS3 - AIS6) were examined the involvement by vehicle type changed significantly. There were 396 injuries coded at the AIS3 - AIS6 injury severity levels. Passenger cars accounted for 244 (62%), utility vehicles for 22 (5%), and vans for 39 injuries or 9%. However, pickup trucks accounted for 91 or 23% of the serious injuries which is far greater then their overall distribution of 11% in the crash population and their involvement in general injury causation.

Pre-Crash

Prior to the crash, the physical motions of the pedestrians indicated that 163 or 56% were walking, 11 or (4%) were not moving and the motions of 8 (2%) are not known. A significant number, 110 or 38%, of the pedestrians were running or jogging but it is not known if this is related to any type of intended physical exercise or activity.

In relation to the pedestrian's motion prior to any avoidance actions, 252 or 86% of the pedestrians were attempting to cross the roadway. This supports the fact that 227 (78%) of the pedestrians had their chest orientation either to the left or the right of the striking vehicle prior to the impact.

The vehicle driver's pre-crash attention to the driving task was reported as paying full attention for 224 (77%) crashes and distraction by other occupants or outside events accounted for 23 (8%) of the crash events. The driver's attention was described as other or unknown for the remaining crashes.

Prior to the critical event, 176 (60%) of the drivers indicated that the vehicle was moving straight. When a vehicle was involved in a turning maneuver, a pedestrian was more likely to be struck in a left turn 63 (22%) rather than a right turn 22 or 8%.

The critical crash event was reported as pedestrian in the roadway for 198 (68%) pedestrians. This would indicate that some of the vehicles had made their intended turns and then impacted the pedestrian. When examining the data, the number for the right turns 22 (8%) remains the same in relation to the pre-event movement and the critical crash event. However, the data for left turns, indicates that the vehicle made its turn and impacted the pedestrian after turning 51 (18%) and was moving forward.

Drivers made no avoidance maneuvers in 116 (40%) of the crashes. One hundred seventy-six (60%) of the drivers had the opportunity to attempt an avoidance maneuver. When a maneuver was undertaken, the drivers for 39 (13%) of the cases braked and also made a steering maneuver with about two thirds of them going to the left and one third to the right. The most likely avoidance maneuver consisted of braking only in 121 (43%) of the crashes. In these cases when only braking occurred, 74 had not brake lockup and 47 crashes did. When looking at MAIS levels for the vehicles that did and did not have lockup, there appears to be higher MAIS severity scores for the vehicles where brake lockup occurred. This appears in Figure 5 below. Data was also examined using impact speeds of less than and greater than 20MPH to see if this significance still

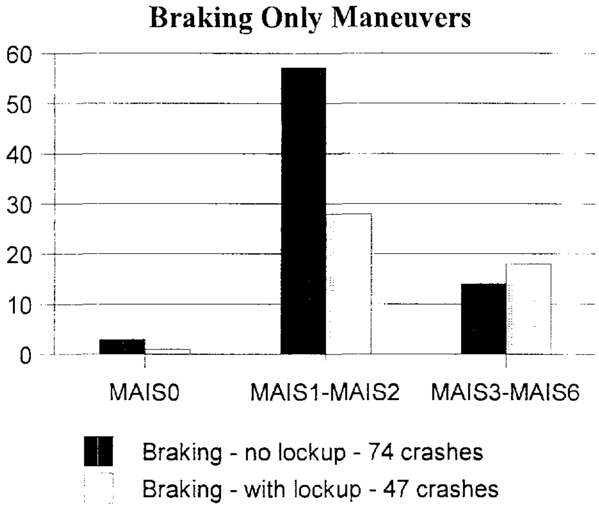

Figure 5. Distribution of vehicles that had braking only maneuvers.

existed. It appeared that even when impact speeds were taken into account there was an over representation of more serious crashes with brake lockups. As more crash data is collected, this will necessitate further examination in the future.

At Crash

One hundred seventy-one (59%) crashes were at or related to an intersection or driveway and the remaining were not. The weather was reported as being clear for 233 (80%) crashes, rain for 55 (19%) and snowing 4 (1%) of the crashes. However, wet roads accounted for 71 or 24% of the crashes. Sixty-two percent or 182 of the crashes occurred during daylight. The remaining were dark but lighted 73 or 25%, dark 14 or 5%, dusk and dawn 23 or 7%.

The variables describing the pedestrian's orientation at impact enables the examination of the pedestrian's body, as it interacts with the vehicle at impact. At various impact speeds the orientation of the pedestrian has contributed to the level of injury. The pedestrian is wrapped or carried by the vehicle in 120 (41%) of the cases. The pedestrian is knocked to the ground in 74 (25%) crashes, thrown in 40 (14%), shunted or pushed aside in 35 (12%), passed over in 7 (2%) and all other impact types account for the 16 (6%) remaining cases as noted in Figure 6.

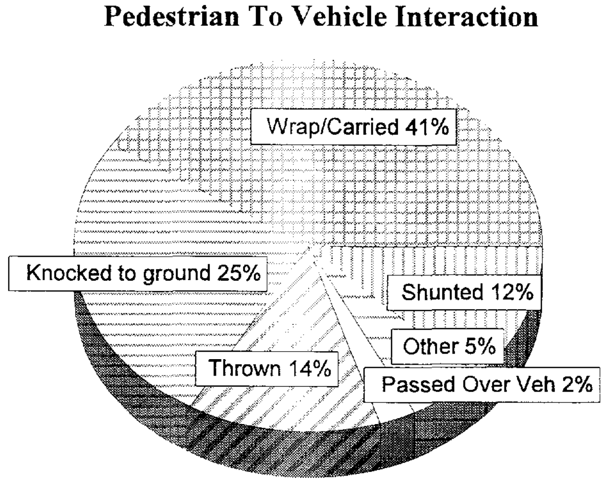

Figure 6. Percentage of crashes distributed by pedestrian to vehicle interaction.

The pedestrian's arm orientations at impact were almost evenly divided: 97 (33%) pedestrians impacted were holding something in their hands or arms, 89 (30%) were not holding anything, 74 (26%) had their arms extended, and the remaining 32 (11%) had their arms in an unknown or other manner The carrying of an object may contribute to or prevent an injury depending on the crash dynamics.

One pedestrian extending her arm while holding an umbrella received a fractured forearm when the leading hood edge of a sport utility vehicle struck her arm. If her arm had not been in this position it would not have been struck. A positive example of carrying an object was noted in a case with a child wearing a backpack. At impact she wrapped over the front hood of a vehicle with her back against the striking surface. Because her backpack absorbed most of the impact force, she received no significant injuries.

Figure 7 shows the distribution of impact speeds in the PCDS grouped in 15 KMPH (9 MPH) ranges . The impact speed is coded as a measure of severity in 271 of the 292 cases (93%). As previously mentioned the majority of the PCDS cases occur in urban areas with a high density of motor vehicle and

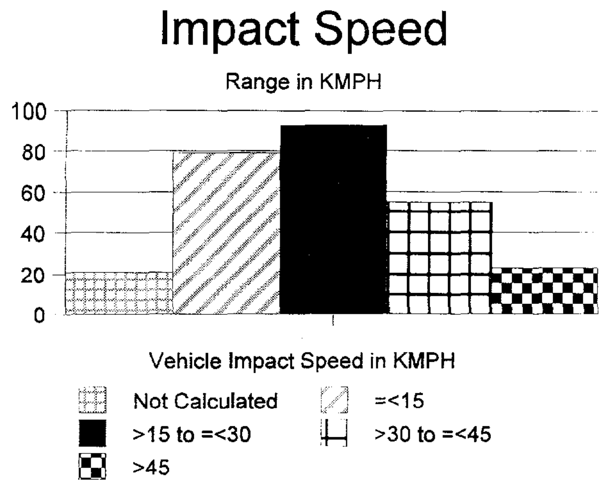

Figure 7. Number of crashes broken down by impact speed.

pedestrian traffic. As a result, the majority of the impact speeds include in the PCDS are in the 15 KMPH (9 MPH) to 45 KMPH (27 MPH) range.

The exterior of the vehicle that strikes the pedestrian is throughly documented, including 37 automated variables and detailed sketches of pedestrian contacts. The documentation is based on the plane of initial contact. The front plane contains data on 64 (86%) cases, while the side plane accounts for the remaining 10 (14%) cases.

Outcome vs. Injury

Of the 292 pedestrians involved in crashes, all but six pedestrians or 98% received some type of injury and 266 pedestrians or 91% received treatment at a medical facility. Only seven of the injured people did not receive any type of treatment for their injuries. Exactly half of those involved, 147 or 50% were treated at a trauma center and 104 or 36% were transported to a hospital for treatment. Although 102 pedestrians were hospitalized for their injuries, the number of days hospitalized is only known for 81 individuals. The average hospital stay for those 81 pedestrians who were hospitalized was 11 days.

Injury data were collected from both official and unofficial data sources (autopsy reports, hospital discharge summaries and emergency room reports, interview data, etc.) and coded to NASS injury coding protocols which are based upon AIS90. The AIS90 developed by the Association for the Advancement of Automotive Medicine is a systematic way to describe injuries by using a specific coded format. One major modification that NASS made to AIS90 was the inclusion of a single digit to account for the location or aspect of the injury on the body region (e.g. left leg, right arm, forehead, etc.) injured.

The overall distribution for Maximum AIS (MAIS), which is the highest single AIS code for a pedestrian with multiple injury levels, is shown in Figure 8 . The highest AIS severity sustained by any pedestrian in any crash was an AIS 6. Two hundred sixty-eight or 92% of the pedestrians involved in the crashes received more than one injury.

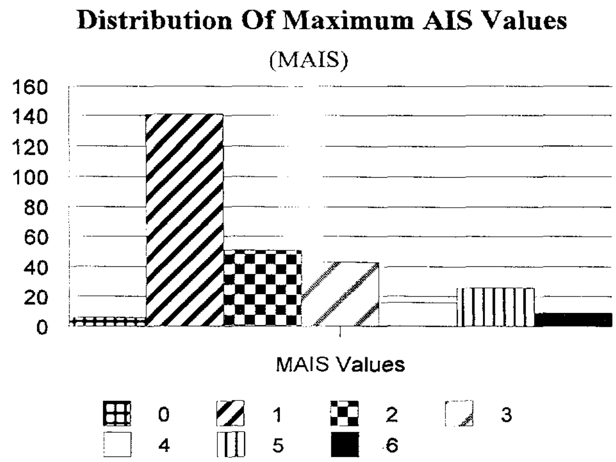

Figure 8. Number of crashes broken down by maximum AIS.

A total of 2,180 injuries were sustained by the 286 pedestrians that were injured. Lower extremity injuries accounted for 740 or 34% of the injuries followed by the upper extremities having 424 or 19% of the total injuries. The head and face were the next most frequent body regions injured having 370 (17%) and 359 (17%), respectively, of the injuries. The total injury distributions for all body regions are shown in Figure 9.

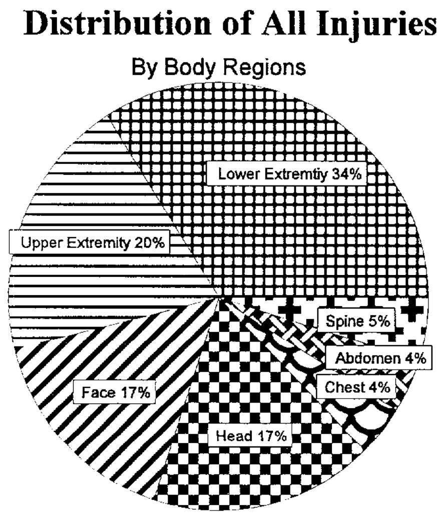

Figure 9. Percentage of all injuries distributed by body region.

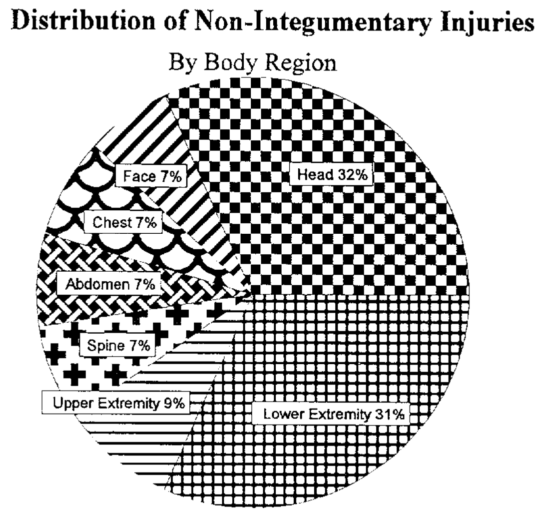

Figure 10. Percentage of all non-integumentary injuries by body region.

It is noted that overall injury distributions among body regions change when soft tissue or integumentary injuries are excluded from the total injury distributions. Distributions for the 767 non-integumentary injuries among body regions is shown in Figure 10. Lower extremity injuries remain the most frequent body region injured with 241 (31%) injuries. Of that number, 72% of the injuries were fractures to the lower extremity skeletal system. However, the head then represents 244 (31%) of the injuries, with the remaining injuries almost evenly divided among the remaining body regions. In regard to non-integumentary head injuries, it is noted that 29 injuries were skull fractures, 157 were injuries to the brain and 57 injuries involved loss of consciousness.

The 2,180 injuries that occurred actually represented 272 different types of injuries. Soft tissue injuries (AIS 1) accounted for 1,413 or 65% of the injuries and accounted for 43 of the different injury types by body region. Deleting these injuries due to their minor severity and outcome, the following is a listing of the five most frequent injuries that occurred along with the injury's count:

Injury	Count
Open Fx Tibial Shaft	34
Cerebrum - Subarachnoid Hemorrhage	33
Open Fx Lateral Malleous-Fibula	27
Fx Head/Neck/Shaft Fibula	22
Fx Femur Shaft	17

The wrap distance from the ground to where a head contact are shown in Figure 11. The ground to head contact is collected for both front and side planes. Previous studies have shown the head contact to be a significant source of injury. However, in the 236 front plane contacts, 110 (47%) had no head contact.

The data also show that 39% (93 of 236) of the cases have recorded a head wrap contact measurement to the vehicle long enough that the face or head contacted the hood or windshield. Sometimes these head contacts could result in no injuries, but this also clearly shows that, 39% of the time, the head or face did make contact with the vehicle. As noted in Table 2, the windshield accounted for 320 injuries, 26% of which were AIS 3-5. The hood surface was noted as the injury source in 206 injuries, with only 17% of hood surface injuries in the AIS 3-5 range.

Injuries are documented on the injury forms according to the sequence in which the body region contacted the vehicle or other injury component (e.g. ground) and there is no limit to the actual number of injuries that are coded for an individual. Lower extremity contacts accounted for 192 or 67% of the first injuries received for the 286 pedestrians that were injured. Other first contacts by body region included 38 (13%) contacts by the upper extremity, 20 (7%) contacts by the head and 20 (7%) contacts by the face. As the number of injury producing contacts increase, there is a reduction in the number of lower and upper

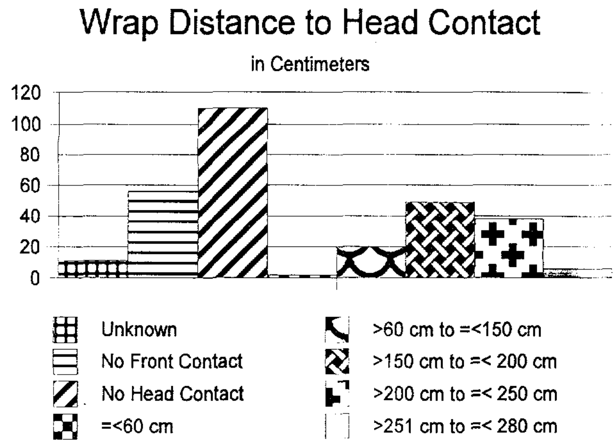

Figure 11. Number of crashes broken down by wrap distance to head contact.

extremity contacts and an increase in the number of contacts to the head and face. These data documents that head and facial injuries follow extremity injuries during the crash sequence.

Table 2.
Distribution of Contact Sources by AIS Levels

Contact Source by AIS Level			
Contact	AIS 1-2	AIS 3-5	Total
Front Bumper	236	75	311
Hood Edge	116	47	163
Reubfirced Hood	45	23	68
Front Grille	34	10	44
Front Header	12	9	21
Wheels	53	9	62
Side Mirrors	45	0	45
Other front	65	2	67
Wiper Blade	38	0	38
A1 Pillar	47	35	82
Hood Surface	170	36	206
Cowl Area	13	18	31
Front Fender Side	62	4	66
Windshield Glazing	237	83	320
Ground	490	33	523
Other	121	12	133
Total	1784	396	2180

The known injury mechanism sources were coded for 99% of the 2,180 injuries. Forty-two different contacts were coded as causing injuries with the most common injury contributors shown in Table 2. The ground was the most frequent injury contact with 490 contacts. However, 93% of the injuries from this contact were at minor AIS levels. Serious injuries (AIS 3-6) were more likely to be caused by contact with the front bumper, hood edge, cowl area or A pillar and it appears that if contact was made to one of these areas, there was a greater likelihood that a serious or life threatening injury would occur. This data is reflected in Figure 12 below.

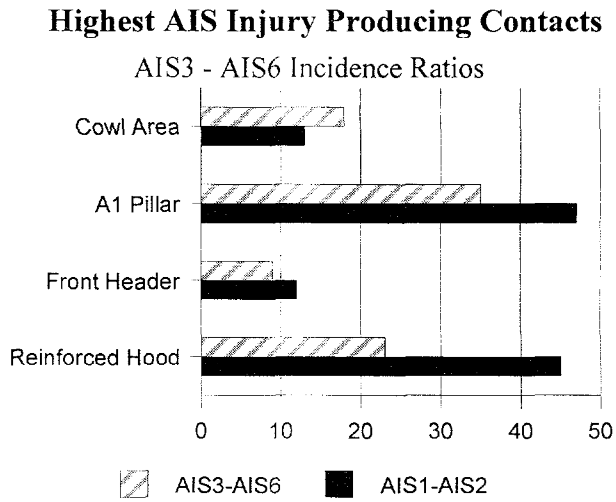

Figure 12. Relationship of the major AIS3-AIS6 injury producing contacts to AIS1-AIS2 injury levels.

The maximum AIS's (MAIS) were also tabulated against impact speeds. In Figure 13, it is clear that impact speed does affect the severity of the outcome. Approximately 89 of the 94 (95%) MAIS 3-6 injuries occur at impact speed greater than 15 KMPH. The vast majority of MAIS 1 injuries occurred at the two lowest groupings of impact speeds (below 31KMPH). MAIS2 injuries were retained as a separate MAIS injury group since many upper and lower extremity, and facial fractures are at the AIS2 level and could appear prior to the occurrence of more severe internal injury. It is clearly seen that MAIS2 injuries appear more frequently at this impact speed level. At impact speeds above 30KMPH the number of MAIS3-6 injuries rise substantially which is a clear indicator of speed having significant impact on MAIS severity and outcome.

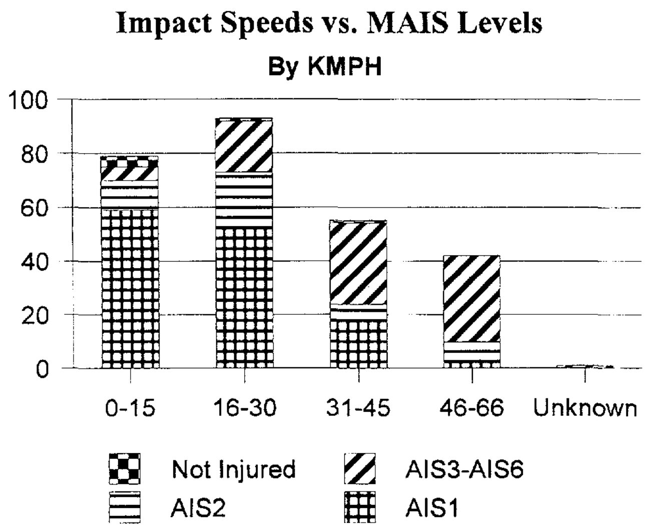

Figure 13. The distribution of impact speeds by MAIS levels.

CONCLUSIONS

The Pedestrian Crash Data Study (PCDS) is at the midway point in data collection since 500 crashes have been selected for investigation. This paper reports on some of the data collected for 292 of those crashes. The new data collection techniques that were implemented for the PCDS (video cameras and the contour gauge) have proven to be very effective means to collect scene and vehicle damage data and to accurately document contacts on the vehicle for reconstruction purposes and to ensure quality control. The success of the video sanitization efforts have ensured that the video tapes can be quickly and accurately sanitized without any loss to the quality of the tape or the information presented on the tape.

The analysis of the data thus far has shown several interesting points that will merit further exploration as more crashes are added to the data analysis file and as other crashes are initiated for investigation. These include additional analysis of pedestrian height in relation to the type of striking vehicle. In regard to vehicle type, the data showed that pickup trucks were over represented in causing serious injury (AIS3-AIS6) in relation to their overall distribution (11%) in the study.

As additional data are collected, further examination of brake lockup will be required to determine if lockup plays any role in causing more serious injury in relation to pedestrian crashes. The additional 400-600 new crashes for analysis should provide meaningful data to support or negate this issue.

The vehicle mechanisms producing serious injuries will also need further study. Additional injury contact data on the cowl area, A1 pillar, front header and reinforced hoods will be needed to determine if these areas are continuing to provide a disproportionate number of AIS3-AIS6 injuries in relation to their overall involvement in pedestrian crashes.

DATA AVAILABILITY

To obtain copies of the Pedestrian Crash Data Study file or individual cases contact:

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4 National Accident Sampling System, Crashworthiness Data System, AIS-90 Injury Coding Manual, U. S. Department of Transportation, National Highway Traffic Safety Administration, 1993.

5 Traffic Safety Facts 1996, A Compilation of Motor Vehicle Crash Data from the Fatal Accidnet Reporting System and the General Estimates System, U. S. Department of Transportation, NHTSA, 1997.

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APPENDIX 1
PEDESTRIAN CRASH DATA STUDY VARIABLE LIST

PEDESTRIAN ACCIDENT FORM

AC01 Primary Sampling Unit
AC02 Case Number - Stratum
AC03 Number of General Vehicle Forms Submitted
AC04 Date of Accident
AC05 Time of Accident
AC06 SS15 Administrative Use
AC07 SS16 Pedestrian Crash Data Study
AC08 SS17 Impact Fires
AC09 SS18
AC10 SS19
AC11 Number of Recorded Events in this Accident
AC12 Accident Event Sequence No.
AC13 Vehicle Number
AC14 Class of Vehicle
AC15 General Area of Damage
AC16 Vehicle Number or Object Contacted
AC17 Class of Vehicle
AC18 General Area of Damage

DERIVED VARIABLES

Day of Week
Year
Stratification
Month

PEDESTRIAN ASSESSMENT FORM

PED01 Primary Sampling Unit
PED02 Case Number - Stratum
PED03 Pedestrian Number
PED04 Pedestrian's Age
PED05 Pedestrian's Sex
PED06 Pedestrian's Overall Height
PED07 Pedestrian's Height - Ground to knee
PED08 Pedestrian's Height - Ground to Hip
PED09 Pedestrian's Height - Ground to Shoulder
PED10 Pedestrian's Weight
PED11 Pedestrian Attitude
PED12 Pedestrian Motion
PED13 Pedestrian's Action Relative to Vehicle
PED14 Pedestrian's Body (Chest)Orientation Prior Impact
PED15 Pedestrian's First Avoidance Actions
PED16 Pedestrian's Head Orientation at Initial Impact
PED17 Pedestrian Body (Chest)Orientation Initial Impact
PED18 Pedestrian's Arm Orientation at Initial Impact
PED19 Pedestrian's leg Orientation at Initial Impact
PED20 Vehicle/Pedestrian's Interaction
PED21 Police Reported Alcohol Presence
PED22 Alcohol Test Result for Pedestrian
PED23 Police Reported Other Drug Presence for Pedestrian
PED24 Other Drug Specimen Test Result for Pedestrian
PED25 Injury Severity (Police Rating)
PED26 Treatment - Mortality
PED27 Type of Medical Facility
PED28 Hospital Stay
PED29 Working Days Lost
PED30 Glasgow Coma Scale (GCS) Score
PED31 Was the Pedestrian Given Blood?
PED32 Arterial Blood Gases (ABG)-HCO3
PED33 Time to Death
PED34 1st Medically Reported Cause of Death
PED35 2nd Medically Reported Cause of Death
PED36 3rd Medically Reported Cause of Death
PED37 Number of Recorded Injuries for This Pedestrian

DERIVED VARIABLES

Maximum AIS
Injury Severity Score

PEDESTRIAN INJURY FORM

PI01 Primary Sampling Unit Number
PI02 Case Number - Stratification
PI03 Pedestrian Number
PI04 BLANK
PI05 Source of Injury Data
PI06 Body Region
PI07 Type of Anatomic Structure
PI08 Specific Anatomic Structure
PI09 Level of Injury
PI10 AIS Severity
PI11 Aspect
PI12 Injury Source
PI13 Injury Source Confidence Level
PI14 Direct/Indirect Injury
PI15 Striking Profile

PI16 Type of Damage
PI17 Damage Depth

PEDESTRIAN GENERAL VEHICLE

VEH01 Primary Sampling Unit Number
VEH02 Case Number - Stratum
VEH03 Vehicle Number
VEH04 Vehicle Model Year
VEH05 Vehicle Make
VEH06 Vehicle Model
VEH07 Body Type
VEH08 Vehicle Identification Number
VEH09 Police Reported Travel Speed
VEH10 Speed Limit
VEH11 Police Reported Alcohol Presence for Driver
VEH12 Alcohol Test Result for Driver
VEH13 Police Reported Other Drug Presence for Driver
VEH14 Other Drug Specimen Test Result for Driver
VEH15 Vehicle Curb Weight
VEH16 Vehicle Cargo Weight
VEH17 Vehicle Special Use(This Trip)
VEH18 Impact Speed
VEH19 Accuracy Range of Impact Speed Estimate
VEH20 Data Source of Impact Speed
VEH21 Driver's Attention to Driving
VEH22 Pre-Event Vehicle Movement
VEH23 Critical Precrash Event
VEH24 Attempted Avoidance Maneuver
VEH25 Precrash Stability After Avoidance Maneuver
VEH26 Precrash Direction Consequences of Avoidance Maneuver
VEH27 Relation to Junction
VEH28 Trafficway Flow
VEH29 Number of Travel Lanes
VEH30 Roadway Alignment
VEH31 Roadway Profile
VEH32 Roadway Surface Type
VEH33 Roadway Surface Condition
VEH34 Traffic Control Device
VEH35 Traffic Control Device Functioning
VEH36 Light Conditions
VEH37 Atmospheric Conditions

PEDESTRIAN EXTERIOR VEHICLE FORM

PEV01 Primary Sampling Unit
PEV02 Case Number - Stratum
PEV03 Vehicle Number
PEV04 Original Wheelbase
PEV05 Original Average Track Width
PEV06 Hood Material
PEV07 Hood Original
PEV08 Hood Length
PEV09 Hood Width Forward Opening
PEV10 Hood Width Midway
PEV11 Hood Width Rear Opening
PEV12 Hood/Fender Vertical/Lateral Crush From Pedestrian
PEV13 Windshield Contact Damage From Pedestrian Contact
PEV14 Front Bumper Cover Material
PEV15 Front Bumper Reinforcement Material
PEV16 Front Bumper - Bottom Height
PEV17 Front Bumper - Top Height
PEV18 Forward Hood Opening
PEV19 Front Bumper Lead
PEV20 Ground to Forward Hood Opening
PEV21 Ground to Front/Top Transition Point
PEV22 Ground to Rear Hood Opening
PEV23 Ground to Base of Windshield
PEV24 Ground to Top of Windshield
PEV25 Ground to Head Contact
PEV26 Ground Clearance
PEV27 Side Bumper-Bottom Height
PEV28 Side Bumper-Top Height
PEV29 Centerline of Wheel
PEV30 Top of Tire
PEV31 Top of Wheel Well Opening
PEV32 Bottom of A-Pillar at Windshield
PEV33 Top of A-Pillar at Windshield
PEV34 Top of Side View Mirror
PEV35 Centerline to A-Pillar at Bottom of Windshield
PEV36 Centerline to A-Pillar at Top of Windshield
PEV37 Centerline to Maximum Side View Mirror Protrusion
PEV38 Ground to Side/Top Transition
PEV39 Ground to Hood Edge
PEV40 Ground to Centerline of Hood
PEV41 Ground to Head Contact