EPIDEMIOLOGICAL AND CLINICAL FEATURES OF SPINAL-CORD INJURED

PEDESTRIANS

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INTRODUCTION

Spinal-cord injuries sustained by residents of 18 selected counties of northern California, U.S.A. were exhaustively reviewed. Sixty-eight individuals were identified as having sustained spinal-cord injuries as pedestrians and details of their accidents and injuries are the subject of this report. The pedestrian is particularly vulnerable to serious or fatal injury when struck by a motor vehicle.

MATERIALS AND METHODS

Information for this report was abstracted from patient records by specially trained medical-record librarians. All records in all hospitals in the prespecified counties were reviewed, as were reports from coroners' offices, records of the State of California, Department of Health (Crippled Children's Service), Rehabilitation and Industrial Relations (Workman's Compensation). Information concerning the collisions was obtained from local police records and records of the California Highway Patrol. Details of case ascertainment, data abstraction and collection, and methods of quality control have been reported previously (Kraus, et al., 1975 see preceding paper).

Definitions

A spinal-cord injury was defined as an acute traumatic lesion of the spinal cord, cauda equina, or nerve roots resulting in motor or sensory deficit, or both. The injury must have occurred in 1970 or 1971 to a usual resident of 18 prespecified Northern California counties in those years. The population at risk of injury was defined as the usual residents of these Northern California counties.

The Abbreviated Injury Scale (AIS) was used to assign numerical values to each injury as defined by the International Classification of Diseases Adapted (ICDA). Each patient's hospital record and autopsy report was thoroughly reviewed to identify each ICDA codable injury. Following recommendations of Baker, et al., (1974) an Injury Severity Score (ISS) was also assigned each patient. Only one AIS score was assigned each body region (the highest scored injury for that region). The ISS score was obtained by adding the squared AIS score for the three highest scored body regions. The body regions were head, neck, chest, abdomen (including pelvis), and extremities. <u>Table I</u> summaries the AIS scores and their definitions.

TABLE 1.	ABBREVIATED	INJURY	SCALE	CODE	DESCRIPTIONS

CODE	DESCRIPTION	CODE	DESCRIPTION
0	No injury	5	CRITICAL (SURVIVAL
1	Minor		UNCERTAIN)
2	MODERATE	6	MAXIMUM (CURRENTL)
3	SEVERE (NOT LIFE-		UNTREATABLE)
	THREATENING)	9	Unknown
4	SERIOUS (LIFE-THREATENING,		

SURVIVAL PROBABLE)

RESULTS

The population at risk was slightly more than 5.8 million persons (29.1%) of the State's population according to the 1970 United States Census. From this population 619 patients with injuries to the spinal-cord were identified and met the criteria of being a usual resident of the 18 counties and injured in 1970 or 1971. Sixty-eight of those 619 individuals were injured as pedestrians (11% of the total injured). The spinal-cord injury incidence rate for pedestrians was 5.9 million population. Figure 1 gives age-sex specific incidence rates. After the first decade of life, incidence rates are about three times as high for males as for females. Peak incidence for males occurs after age 55 and for females less than 5 or more than 65 years of age.

FIGURE



This series of spinal-cord-injured pedestrains includes eight persons struck by a train. These cases are excluded from consideration in the epidemiologic analyses which follow. For purposes of analysis three general categories were formed of pedestrian actions preceding the collision: crossing the roadway at an intersection or designated marked crosswalk; crossing the roadway not at an intersection or designated crosswalk; and other activity in roadway such as walking on side of road, working on a vehicle in the roadway, getting in or out of a vehicle, etc. One-half of pedestrians with a spinal-cord injury were struck by a vehicle while crossing a roadway but not at an intersection or crosswalk. The driver of the striking vehicle failed to yield right-of-way for all 10 persons struck while crossing a roadway in an intersection or crosswalk. The relationship of age with category of pedestrian action could not be evaluated statistically because of the small numbers. Interestingly, however, as shown on <u>Table 2</u>, 10 of 16 injured pedestrians 14 years of age or less were struck while crossing a roadway at places other than an intersection or crosswalk, while only 2 of 12 pedestrians 65 years of age and older were struck crossing a roadway not at the intersection.

Age	Crossing at Intersection	Crossing Not at Intersection	OTHER ACTIVITY IN ROADWAY	ALL ACTIVITIES
<u><</u> 14	2	10	4	16
15-24	1	4	3	8
25-44		7	5	12
45-64	1	7	4	12
ô5+	6	2	4	12
All Ages	10	30	20	60

TABLE 2, NUMBER OF SPINAL-CORD INJURED PEDESTRIANS BY AGE AND PEDESTRIAN ACTION

Thirty-six of 54 injured pedestrians were struck between 6:00 p.m. and midnight (22 persons) or midnight and 6:00 a.m. (9 persons). For six, the time of injury was not recorded on the police report. Thirty-six of 60 pedestrians were struck on Fridays (10), Saturdays (15), or Sundays (11). Pedestrians were least likely to be struck by a motor vehicle on Mondays or Tuesdays (4 cases each day). There was no association between category of pedestrian action and day of occurrence of the injury.

Blood alcohol levels were reported for 31 of 50 fatally injured pedestrians. The level was 0.10% by weight* or higher for 17 (54.8%) of those 31 injured pedestrians. The range in blood alcohol levels was 0.10 to 0.33% by weight. Fifteen of these 17 cases were 25 years old or older, and all 17 were fatally injured between 6:00 p.m. and 6:00 a.m. Category of pedestrian action preceding a fatal pedestrian injury was not related to blood alcohol level.

The sizes (wheelbases) of the striking vehicles were grouped into three classes: wheelbase up to 112 inches; wheelbase 112 or more inches (intermediate and full-size automobiles, pick-up trucks, and vans); and large vehicles such as trucks, buses, etc. Wheelbase was derived from the description in the police report. For example, according to the Journal of Automotive Industries, the wheelbase of a 1968 Ford Fairlane is 116 inches. Fifty-two of the 60 injured pedestrians were struck by an automobile. Two cases involved a tractor-trailer and for 6 others the description of the striking vehicle was not recorded (unknown for hit-and-run incidents) in the police report.

*Alcohol level of legal intoxication.

Thirty-eight of 52 pedestrians struck by an automobile or pick-up truck were dead at the scene or dead-on-arrival (D.O.A.) at the hospital (usually within 15 minutes of injury). There were eight in-hospital deaths and six survivors: these were combined in comparing length of survival with size of vehicle. <u>Table 3</u> shows no association between length of survival and size of striking vehicle.

	LENGTH OF		
Size of Striking	Less than	15 Minutes	Total
Vehicle	15 Minutes	or Longer	
<pre>< 112 inch wheelbase 2 112 inch wheelbase</pre>	11	1 ^a	12
	27	13 ^b	40
ALL SIZES	38	14	52

TABLE 3.	NUMBER OF	SPINAL-CORD	INJURED	PEDESTRIANS	BY	LENGTH	٥F
	SURVIVA	AL AND SIZE (OF STRIKI	IIIG VEHICLE			

% (1) + n.s.

^aIN-HOSPITAL DEATH. ^bINCLUDES 7 IN-HOSPITAL DEATHS.

Only 10 of 68 injured pedestrians survived. Figure 2 shows the location and number of the AIS-scored injuries of the survivors. Figure 3 shows the number and location of the potentially fatal injuries (AIS \geq 4) sustained by the survivors. There was no ISS score greater than 50 for any of the survivors; however, 45% of the patients who died also had ISS scores of less than 50.



<u>Figure 4</u> shows the number and location of the AIS-scored injuries for the 58 fatal cases, and <u>Figure 5</u> indicates the number and location of the fatal injuries (AIS 6) sustained by the pedestrians. One patient survived who had an AIS score of 6 in the cervical spine.



Figure 6 locates all the AIS-coded injuries for all 68 pedestrians in the series. Considering the total number of ICDA-coded injuries sustained by the pedestrian, the average number of injuries was 3.1 for survivors and 7.8 for the fatalities. These numbers are considerably higher than the number of AIS injuries, since the AIS system scores only the most severe injury in each region and ignores the remaining injuries. The pedestrian commonly had several injuries in each region.

There were 35 individuals with cervical-cord injuries, 21 with thoracic-cord injuries, and 7 with lumbar-spine injuries. Three patients had injuries at two levels of the spinal cord. Figures 7, 8, and 9 show the number and location of the AIS-scored injuries according to the region of the spinal cord. The number of injuries was highest in the cervical spine.

The time from injury to death was determined for 23 patients who died from injuries not inherently fatal (no injury had an AIS of 6). Three of these individuals died in less than five minutes, and seven died hours or days after being struck. Thirteen people died between five minutes and one hour after injury, a period during which appropriate emergency medical care might affect the outcome. <u>Figure 10</u> shows the anatomic region for the injuries with an AIS of 4 or 5 for individuals without inherently fatal injuries or those who died between five minutes and one hour after injury.



Figure 8. The number of AIS scored injuries by anatomic location for 21 pedestrians with thoracic spinal cord injuries. ure 9. The number of AIS scared injuries by anatamic lacation for 7 pedestrians with lumbar spinal cord injury.



Figure 10. Anatomic location of potentially fatal pedestrian injuries(AIS code 4-5, excluding 6) on 13 patients dying between 5min and 1hr.

SUMMARY-DISCUSSION

Although Baker, et al., (1964) and Bull (1975) found correlations between age and length of survival, our series did not show any relationship between ISS score and survival for such a small number of individuals was also difficult to ascertain. Baker suggests an ISS score of 50 as pivotal above which survival becomes doubtful. In our series all survivors had ISS scores below 50, but 45% of those patients who succumbed also had ISS scores below 50 and many of those were young. Our assessment of the AIS for use with spinal-cord-injured patients suggests that some modifications are needed. Injuries to the spinal cord below C4 should be classified as 3 or 4 depending on the severity of damage, rather than the 5 now recommended. Clinical experience with patients with spinal-cord injuries indicates that those below C4 are usually not fatal. A pedestrian who sustains a spinal-cord-injury is certainly not exempt from other injuries. Surviving patients averaged 3.1 injuries, and there was an average of 7.8 injuries to those who died. The distribution of injuries was surprisingly even, with head, neck, trunk, and extremities all receiving about an equal share. Fatal injuries occurred predominantly in the neck, which probably reflects our selection only of individuals with a spinal-cord injury. Severance of the spinal-cord at the base of the skull was the most frequent fatal injury in the cervical area, whereas patients with thoracic spinal-cord injuries quite frequently had ruptures of the heart and aorta. The crushed chest and lungs also accounted for some deaths.

Considering what might be done to reduce the number of pedestrians dying from collisions with a motor vehicle, efforts should be made to separate pedestrians from vehicular traffic or at least make them more visible, especially at night. Alcohol also played a significant role in pedestrian fatalities. Over half of the fatally injured pedestrians were intoxicated at the time of injury. Impaired mental acuity from excessive ingestion of alcohol doubtlessly caused some of the pedestrians to fail to recognize the approach of the motor vehicle, thus contributing to the collision. Isolation from vehicular traffic is the only practical method of protecting intoxicated individuals. Fifty-four per cent of the pedestrians with spinal-cord injury died immediately or soon thereafter (< 5 minutes), and thus would be unsalvageable. The size of the vehicle striking the pedestrian did not seem important, even the smallest vehicle was capable of inflicting fatal injuries. Once injured, the pedestrian needs rapid and expert medical care to prevent further injury and death. Of the 23 who died of potentially nonfatal injuries, only three died so soon after the accident that emergency medical care was impractical. Thirteen patients (56%) died within the first hour, which is in the critical time in which resuscitative measures might reduce mortality. The institution of high-quality emergency medical services should play a significant role in reducing fatal vehicular pedestrian collisions. Interestingly, chest and abdominal injuries were the major cause of death in these potentially salvageable patients. Head and neck injuries constituted only 23 per cent of these injuries. Considering the method of patient selection, it is surprising that head and neck injuries were not more common, however. In any case most injuries in this area were considered lethal, so these patients are not potentially salvageable.

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