INJURY PATTERNS ACCORDING TO CRASH CONFIGURATION

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ABSTRACT

Traffic accident investigation is one of the pilot studies addressed by the Committee on the Challenges of Modern Society, NATO, in a program to improve road safety throughout the world. Under the guidance and direction of the Netherlands, specially trained accident investigation teams from nine European and North American nations have produced approximately 520 indepth traffic accident reports of actual crashes. Intrinsic to these reports are the detailed descriptions of vehicle damage and occupant injury. Vehicle damage is quantified by application of the Vehicle Deformation Index (VDI). Injuries are recorded in a multivariate table which identifies type of injury, injury location on the body, severity of injury (Abbreviated Injury Scale—AIS), and component or element that caused the injury.

Statistical procedures will be presented to show the feasibility of using international traffic accident data collected according to a standard format.

Data from the 520 accident reports will be examined with respect to injury production and injury severity for various common vehicle damage patterns. Statistical charts, graphs, and tables will illustrate the findings. Significant phases in the data base will be presented.

A paper* presented later in these proceedings will describe the structure and characteristics of the NATO/CCMS accident investigation data file. With information derived from this file, we have attempted to explore the nature and severity of injuries with respect to collision configurations. The data and results presented herein have been interpreted within the constraint of a sample that typifies and describes only 520 accidents. Larger quantities of data obviously would produce greater statistical significance which is precisely the ultimate goal of the NATO/CCMS exercise.

Under these circumstances, therefore, we prefer to think of the results as suggestions rather than true indicators of trends, as they might be interpreted if sufficiently larger quantities of accidents were included in the data file.

*Barnwell, G.M., J.R. Cromack, A.F. Muller, and J.G. Kuiperbak. Some international data on traffic accident configurations and their associated injuries. Paper presented at International Conference on the Biokinetics of Impacts, Amsterdam, June 26-27, 1973.

The average number of vehicles involved in the sampled collisions was 1.91. Figure 1 shows the frequency of collisions as a function of the number of vehicles involved. It is evident that two-vehicle accidents were by far the most frequent, and that one- and two-vehicle accidents constituted the bulk of the sample.

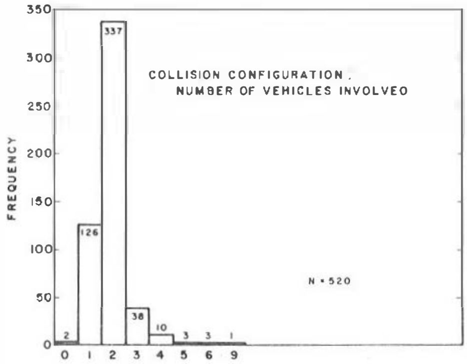

Figure 1

Figure 2 shows the distribution of collision configurations. Vehicle-to-object collisions, depicted as column VO, occurred in 105 cases. By our definition, the fixed object with which the vehicle collided may have been on or off the roadway. Rollover accidents, designated by Column R, totaled 47, while ran off roadway, Column RR constituted 86 of these accidents. Column VV, with 389 cases, denotes vehicle-to-vehicle collisions and is the predominant type of configuration. There were only two vehicle-to-pedestrian accidents, Column VP, in the sample, and 12 accidents in the Other, Column O, configuration. Thus, most of the accidents represent vehicle-to-vehicle configurations involving two vehicles. A further breakdown of the vehicle-to-vehicle configuration, given in Figure 3, reveals 136 head-on collisions, 169 side impacts, 14 sideswipes, and 70 rear impacts.

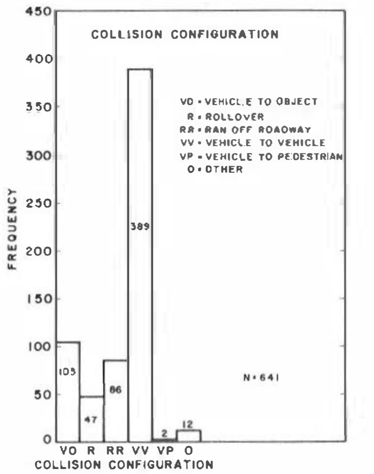

Figure 2

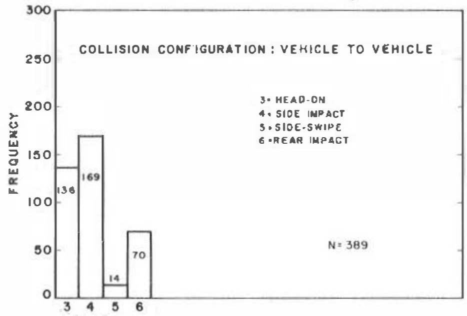

Figure 3

A survey of the Vehicle Deformation Index (VDI) reveals that a majority of the vehicles selected for inclusion in this sample demonstrated frontal damage, as shown in Figure 4, where the highest frequencies of impacts were in the 11, 12, and 1 o'clock positions.

Figure 5 shows the distribution of degree of damage, with the VDI damage severity scale from 1 to 9, in order of increasing severity. The mean damage severity rating was 3.32, with the most frequent ratings being 2 or 3. However, in 104 cases, the severity rating was 5 or higher.

Since frontal damage was reported most frequently, and the direction of force was aligned most often with the longitudinal axis of the vehicle, we felt that these combinations of variables might be most fruitful in a study of the nature and severity of injuries.

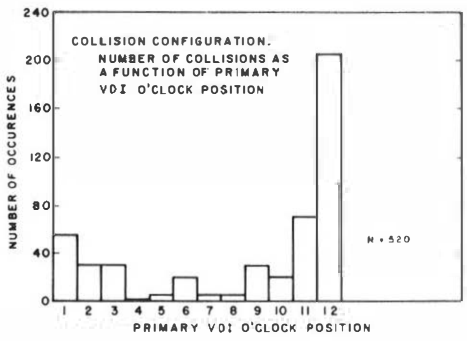

Figure 4

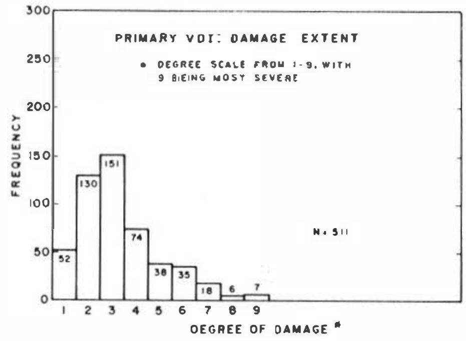

Figure 5

Figures 6 through 9 illustrate some of the ways in which statistical information in the files may be used to identify injury-producing objects in the vehicle interior. Each of these figures is based on injuries to drivers only in frontal collisions. Figure 6 presents the frequency of facial injuries in relation to the interior area of the vehicle contacted. The high-frequency contact areas are easily identified as the steering assembly (code 9), the sunvisors and fittings and/or top molding (code 10), and the windshield (code 12). Figure 7 shows the frequency of scalp injuries as a function of area contacted. Again, the sunvisor region (code 10) and the windshield (code 12) are high-frequency contact regions; and, in addition, the A-pillar (code 14) is involved in a few cases. Figure 8 shows the frequency of brain injuries and closely corresponds to Figure 7. Figure 9 shows the frequency of chest injuries; and, the single outstanding injury-producer is, of course, the steering assembly (code 9).

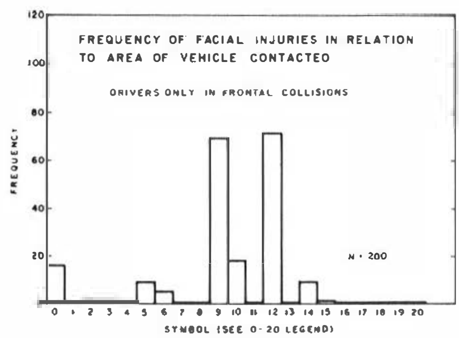

Figure 6

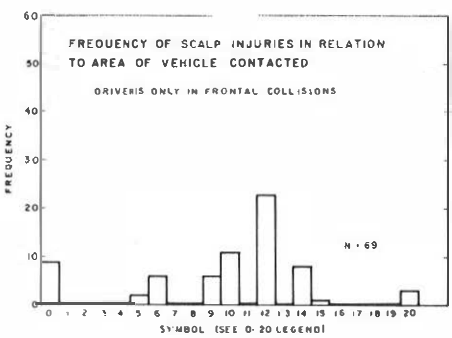

Figure 7

0-20 Legend—Applies Only to Figures 6 Through 13

0 – Unknown
1 – A/C or Ventilation Outlets
2 – Glove Compartment Area
3 – Hardware Items (Ashtray, Knobs, etc.)
4 – Heater or A/C Ducts
5 – Instrument Panel
6 – Mirrors
7 – Parking Brake
8 – Radio
9 – Steering Assembly
10 – Sunvisors and Fittings and/or Top Molding (Header)
11 – Transmission Selector Lever
12 – Windshield
13 – Armrests
14 – A-Pillar
15 – B-Pillar
16 – C-Pillar
17 – D-Pillar
18 – Courtesy Lights
19 – Hardware (Side)
20 – Surface Side Interiors

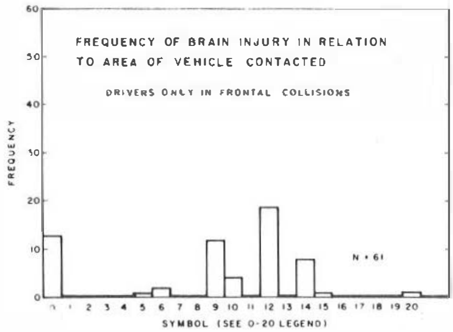

Figure 8

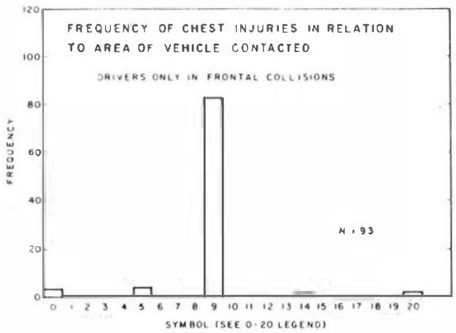

Figure 9

Figures 10 through 13 summarize the injury frequency data for all occupants in all collision configurations. Again, in Figure 10, the high-frequency contact regions for facial injuries are easily identified: the instrument panel (code 5), mirrors (code 6), steering assembly (code 9), sunvisor area (code 10), windshield (code 12), A-pillar (code 14), and surface of side interiors (code 20).

The frequency of scalp and brain injuries in Figures 11 and 12 correspond to the same contact areas as the facial injuries except the injury hazard from the instrument panel (code 5) and steering assembly (code 9) is less pronounced, that is, the frequency of occurrance of injury from these components is lower. Figure 13 shows the frequency of chest injuries for all occupants and all collision configurations. In addition to the steering column (code 9), the instrument panel (code 5) and the surfaces of side interiors (code 20) also are relatively important contact regions.

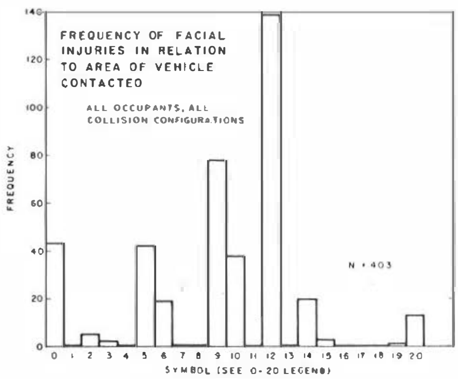

Figure 10

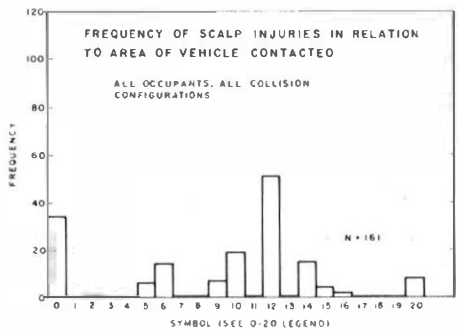

Figure 11

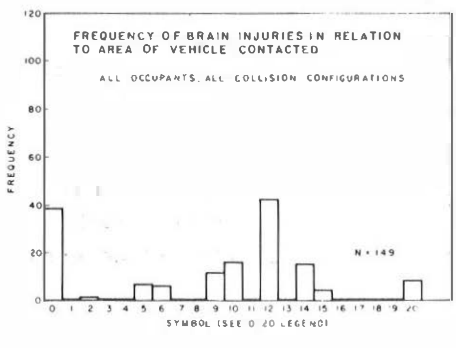

Figure 12

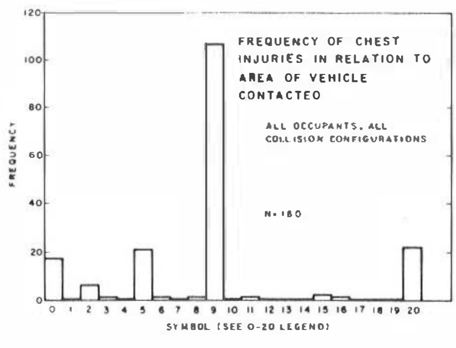

Figure 13

We have made some preliminary comparisons of injury severity and VDI damage rating for several collision configurations, in cases when seat belts were worn and in cases when they were not worn. For 254 cases involving frontal collisions and drivers not wearing seat belts, a mean injury severity of 2.21 with a standard deviation of 1.97 corresponded to a mean VDI damage rating of 3.36 with a standard deviation of 1.88. The correlation between injury severity and VDI rating was 0.40. For 54 cases involving frontal collisions and drivers wearing seat belts, the mean injury severity was 1.82 with a standard deviation of 1.39, while the mean VDI damage rating was 3.35 with a standard deviation of 1.65. The correlation between injury severity was 0.33. Thus, there is a low correlation between injury severity and VDI damage rating. Further, the injury severity of drivers wearing seat belts was lower than that for drivers not wearing seat belts, while the average VDI damage extent was the same in both cases.

Some further comparisons of injury severity with VDI damage extent are made in Tables 1 and 2. Table 1 compares injury severity and VDI damage extent for drivers wearing seat belts and drivers not wearing seat belts for various impact directions. The correlation coefficients between injury severity and VDI damage ratings are in the last column, but those based on small sample sizes should be ignored. Probably the best comparison is with respect to the 12 o'clock impact direction, since the sample sizes are larger. Examination of these values again confirms the value of seat belts in frontal collisions. The larger value of injury severity (2.67) for drivers wearing seat belts in the 9 and 3 direction is probably due to the small sample size, which apparently included some severe injuries, since the standard deviation (3.61) is much larger than any of the others.

Table 2 presents some further data on injury severity and VDI damage extent for the front seat outboard passenger, both with and without seat belts. These sample sizes are also relatively small. Unfortunately, the only reasonable sample sizes are again with respect to the 12 o'clock direction. Occupants wearing seat belts received lower injuries than occupants not wearing them for approximately equal mean VDI damage ratings.

TABLE 1. INJURY SEVERITY VS. DAMAGE EXTENT FOR DRIVERS ONLY

	O'Clock Direction of Impact	Restraint Worn?	N	Mean	S.D.	VDI & Inj. Correlation
Inj. Sev.	12	No		2.1447	1.8101	
VDI Extent			159	3.2704	1.9542	0.4058
Inj. Sev.	12	Yes		1.6757	1.3955	
VDI Extent			37	3.1892	1.9838	0.1432
Inj. Sev.	6	No		1.3750	2.1871	
VDI Extent			16	3.0625	1.8062	−0.1920
Inj. Sev.	6	Yes		1.0000	0.0000	
VDI Extent			7	3.5714	2.0702	0.0000
Inj. Sev.	9+3	No		2.0208	1.9295	
VDI Extent			48	3.2708	1.3643	0.4100
Inj. Sev.	9+3	Yes		2.6667		
VDI Extent			9	3.4444		0.9341

TABLE 2. INJURY SEVERITY VS. VDI DAMAGE EXTENT FOR FRONT SEAT OUTBOARD PASSENGER

	O'Clock Direction of Impact	Restraint Worn?	N	Mean	S.D.	VDI & Inj. Correlation
Inj. Sev.	12	No		2.3165	1.5734	
VDI Extent			79	3.2658	1.9461	0.4327
Inj. Sev.	12	Yes		1.4500	1.4318	
VDI Extent			20	3.3000	1.8382	0.1260
Inj. Sev.	6	No		0.5000	0.5774	
VDI Extent			4	5.7500	0.9574	0.9045
Inj. Sev.	6	Yes		1.3333	0.8165	
VDI Extent			6	4.0000	1.8974	0.0000
Inj. Sev.	3+9	No		1.8750	2.0497	
VDI Extent			24	3.4583	1.4738	0.0198
Inj. Sev.	3+9	Yes		2.7500	4.1932	
VDI Extent			4	3.7500	2.2174	0.9590

The data presented herein should illustrate the scope of our ongoing research and indicate the advantages of such an international cooperative effort to collect standardized traffic crash data. We believe the feasibility of such a system has been demonstrated, and continued data collection and sharing of this type should prove beneficial to all participating countries.