ASPECTS OF EMERGENCY CARE

Some Features of Traffic Accidents

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British Medical Journal, 1969, 4, 799-801

Summary: Some aspects of urban and rural traffic accidents have been studied at the scene of some accidents in Birmingham and the county of Worcestershire. Accidents to pedestrians are essentially an urban problem, occur mainly at low speed, and most of the serious injury comes from the initial contact with the vehicle, rather than from secondary impacts with the road surface. The characteristics of motor-cycle accidents are more varied; in urban areas there are many side impacts, with consequent injury to the lower limbs, while rural collisions are predominantly front on, with a high incidence of head injury. Accidents to car occupants vary according to the environment.

Introduction

This paper describes some of the findings from a study of road accidents undertaken in and around Birmingham from 1965 to 1969. The research was interdisciplinary, the team consisting of a mechanical and civil engineer, a doctor, a traffic engineer, and a psychologist. The aspects of both the causes of the accident and the causes of the injuries were examined; this paper is concerned with some of the latter aspects, and their relations with vehicles and the environment. A more complete description of the work has been given by Kolbuszewski *et al.* (1969) and the detailed methodology by Mackay (1968).

The technique used was to examine a representative sample of road accidents selected from specified environments. Four hundred and twenty-five accidents occurring within the City of Birmingham were first examined, followed by 218 accidents in the county of Worcestershire. The latter group included both urban and truly rural accidents as well as those on the M5 motorway. The sizes of these groups were so arranged that when combined together they did so in the correct national urban/rural ratio. Hence the overall sample roughly corresponds to the situation for the country as a whole.

Specified on-call periods were arranged with the police, who agreed to inform me either by telephone or radio of the occurrence of an accident as soon as a 999 call was received. By this means the team could be at the scene usually within 20 minutes of impact, which is about the same time interval before the emergency services arrive. On-call periods were scheduled to give representative sampling by time of day and day of week, except that the period from midnight to 7.30 a.m. was not covered. Complete 24-hour coverage was beyond the team's resources; it proved better to obtain a larger sample than to devote many man-hours to a time of the day which produces relatively few accidents.

Once at the scene the team would talk to witnesses and those concerned, examine and photograph the vehicles, and collect all relevant environmental detail. Subsequently records of the injuries were obtained and often the injured were visited in hospital. Some three weeks after the collision the psychologist

visited the drivers in their homes. By this means a relatively small but representative number of road accidents have been examined in considerable depth. The immediate procedure at the scene combined with follow-up data from hospitals has proved to be a useful way of studying the origins of traffic injury, some of the results of which are discussed below.

The classification of injuries for analysis is difficult, since there are almost as many injury scales as there are groups engaged on the research. In the present work a five-point scale is used (Kolbuszewski *et al.*, 1969)—none, minor, moderate, severe, fatal. Patients are classified into one of these categories according to the clinical description of their injuries. Minor injuries are broadly those which receive outpatient treatment only—simple contusions and lacerations. Moderate injuries are simple fractures of the arms, mild concussion (conscious on arrival at hospital), lacerations over 2 in. (5 cm.) in length. Severe injuries are major fractures with displacement, depressed skull fractures, major visceral injuries. Fatal injuries are those causing death within 30 days of the accident. The sample of collisions included those in which only the vehicles were damaged as well as those in which injury occurred.

Results

Pedestrians

Figure 1 outlines the national situation for fatal and seriously injured road casualties in Great Britain for 1967. Pedestrian accidents are essentially an urban problem, with over 90% of them occurring in towns and villages. The present study included 103 pedestrians. Their age distribution was bimodal, 31% being under 10 years of age and a further third aged 60 and over. A third smaller group was also identifiable—the intoxicated middle-aged man. The estimated impact speeds for urban pedestrian and vehicle-occupant accidents is given in Fig. 2, compared with their accident severity. The mean speed in pedestrian accidents was less than 20 m.p.h. (32 k.p.h.). The dip in the pedestrian curve at the fatal category arose because two pedestrians were run over. This is infrequent, but when it does happen its consequences are very serious, regardless of vehicle speed. The normal trajectory for an adult,

FIG. 1.—Killed and seriously injured road casualties in Great Britain in 1967.

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pedestrian when struck by a car is for him to rotate on to the bonnet and into the windscreen, and, if the car speed is high, to go on over the roof.

FIG. 2.—Estimated mean relative impact speeds versus accident severity for urban road accidents.

Pedestrians are injured both by the primary impacts with the vehicle and secondary impacts with the road surface. Table I shows that, although the road surface produced most of the injuries, the primary vehicle impacts caused most of the severe and fatal ones.

TABLE I.—Severity and Source of Pedestrian Injuries When Known (94 Patients)

Source	Minor and Moderate Injuries	Severe and Fatal Injuries	Total
Vehicle	64	46	110
Road	117	31	148
Total	181	77	258

On average each pedestrian received 2.7 injuries. The relative frequency and anatomical distribution of injury is given in Fig. 3. Minor injuries have been excluded from this analysis. The large number of lower-limb and pelvis injuries is of note, as is the fact that the head was injured in over 70% of serious pedestrian accidents.

The primary impacts leading to injury have been related to their source on the vehicle in Table II.

TABLE II.—Car Exterior Components Causing Pedestrian Injury

Component	% of Vehicle Contact Injuries
Bumpers	29.2
Wings	13.5
Headlights	9.4
Bonnet	8.3
Wheels	7.3
Windscreen	6.3
Windscreen frame	5.2
Grill	4.2
Wing mirrors	3.1
Doors (including handles)	2.1
Insignia	1.0
Unclassified	10.4
	100.0

These results suggest that because the vehicle is the major source of serious injury, and because pedestrian collision speeds are normally low, owing to the urban environment, changes in exterior car design may well be beneficial. In particular, bumpers, which give rise to a tremendous number of lower-limb fractures, could well be repositioned and their shape improved.

One-third of pedestrian casualties are under 10 years of age and therefore are less than about 4 ft. 6 in. tall. Some 52% of injured pedestrians were struck by the front of cars, 35% by the nearside and nearside front corner, and 13% by the offside front corner and side. Children were struck by the sides of cars more frequently than adults and on the whole were less severely injured.

Nine pedestrians died in the study. Five of these died within five minutes, before the arrival of any emergency vehicle, while the remaining four survived for several days. It was felt that in none of these cases would early medical care at the scene of the accident have affected survival (Mackay, 1969).

Motor-cyclists

Accidents involving motor-cycle riders and passengers are most common in urban environments, though an appreciable number do occur in rural areas as well (Fig. 1). Like pedestrians, motor-cyclists are injured in both phases of any collision, but the primary impact when the opposing vehicle strikes them causes most of the serious trauma. The crash configurations of motor-cycle accidents vary according to the environment. In urban accidents motor-cycles are most frequently struck on the side, giving rise to a great deal of damage to the legs. In rural accidents, however, head-on collisions are more frequent, as are collisions in which a motor-cycle runs into the rear of a more slowly moving vehicle. In these types of crash head injuries feature more prominently. Fig. 3 shows the benefits of using a helmet by motor-cycle riders, compared with other road users. Like pedestrians, the legs of motor-cyclists are very frequently injured, but unlike pedestrians they suffer very few injuries to the pelvis.

FIG. 3.—Frequency of major injury to body areas for road users receiving major injury (%).

Car Occupants

Table III shows the relative frequency with which various parts of the car exterior are struck in collisions in the urban, rural, and motorway environments which were studied.

TABLE III.—Relative Frequency of Impacts on Cars

	Urban (%)	Rural (%)	Motorway (%)	Total (%)
Front	32.9	28.4	21.0	31.4
Front corners ..	22.9	22.5	15.8	22.6
Right side	17.9	15.7	20.2	17.5
Left side	11.1	10.1	5.3	10.7
Rear	9.4	11.3	5.3	9.8
Rollover	5.8	12.0	32.4	8.0

These data show that, though frontal impacts are very frequent, others are of major importance. In front corner impacts the occupants are projected diagonally inside the car so that they strike the door pillars or the central part of the facia. Side impacts make up over a quarter of the total. In these

circumstances the occupants receive impacts from the door and its frame and risk ejection in many collisions. Roll-over accidents are a special feature of the rural environment.

Speed at impact is a variable which also changes considerably with the environment. Fig. 4 compares estimated impact speeds in urban and rural car accidents in this study with similar research in Adelaide, Australia (Robertson *et al.*, 1966), and the United States (Garrett, 1961). The urban environments of Adelaide and Birmingham have almost the same impact speed distributions, with 80% of collisions occurring at less than 30 m.p.h. (48 k.p.h.) and 40% at less than 20 m.p.h. (32 k.p.h.). By contrast, 23% of the rural accidents in Worcestershire took place at 40 m.p.h. (64 k.p.h.) or more, as did 60% of the rural American ones.

FIG. 4.—A comparison of impact speeds in England, Australia, and the U.S.A.

The known sources of injury to drivers and nearside front-seat passengers are compared for urban and rural collisions in Fig. 5. These data emphasize the importance of front corner and side impacts in causing injury, particularly in urban environments. The door, side structure, and roof are all major sources of injury. In rural accidents ejection as a mechanism of injury becomes important, as does collision with the instrument panel and the scuttle area. This latter is the region around the legs and includes the front bulkhead, and, for drivers, the pedals. The higher collision speeds of rural accidents, where considerable frontal collapse occurs, accounts for the increased incidence of these sources in that environment.

FIG. 5.—The relative frequency of known sources of major injury to front seat occupants compared for urban and rural environments.

Passengers are ejected and seriously injured more frequently than drivers, who are protected to some extent by the steering wheel. Injuries from the instrument panel and windscreen are less frequent in drivers than in passengers; instead, the steering

assembly is concerned in many injuries to the driver's chest and face. Work by Gissane and Bull (1964) has shown that the front-seat passenger is injured more frequently than the driver, however, so that relatively speaking the presence of the steering assembly is beneficial. The newer energy-absorbing steering columns now fitted to some cars appear to be reducing the incidence of severe chest injury caused by the rearward movement of the older rigid designs in frontal collisions. A possible consequence of the collapsible column, however, is that injuries from the windscreen may increase, because the newer design increases the chance of the head coming into contact with the windscreen.

Urban and rural differences are emphasized in Fig. 3, which compares the frequency of injury (excluding the minor category) for front seat car occupants. The high incidence of head and face injury to passengers, particularly in rural environments, stands out, while drivers—especially rural drivers—have more injuries to the legs.

In this study there were 23 riders or vehicle occupants who died. Of these, 11 died within 15 minutes, four survived longer than 15 minutes but died within four hours, and the remaining eight died after periods from between four hours and 18 days. These figures are in general agreement with a study of Australian fatalities by Robertson and Tonge (1968). For those who died immediately or within five minutes, a ruptured aorta was the most common cause of death, though brain damage was responsible for some. The longer surviving cases had a greater variety of injuries which led to death; brain and spinal trauma were common, as were secondary complications such as bronchopneumonia or embolism. For the riders and vehicle occupants who died, some 43% might have had a greater chance of survival if some medical treatment had been available at the scene of the accident within 10 minutes. In this respect vehicle occupants and riders differ from pedestrians. The latter usually either die immediately or survive for days rather than minutes. Since accidents to pedestrians are an urban problem, whereas those to other road users are divided between urban and rural areas, it would appear that the greatest benefits from improved medical care schemes at the scene of the accident would be obtained in rural environments.

Aspects of this research have been financed by the Science and Medical Research Councils, to whom the author is indebted greatly, I should also like to thank Professor Kolbuszewski for his support of the work, and the other members of the Accident Research Unit past and present, particularly Dr. C. P. de Fonseca, who were concerned with the collection of much of the data.

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