CLINICAL CAUSES OF DEATH IN DIFFERENT CATEGORIES OF ROAD USER

ABSTRACT

The clinical causes of death in 289 victims of road accidents are discussed in this paper. The leading cause of death amongst the vehicle occupants in the sample was injury to the chest and amongst pedestrians and pedal-cyclists injury to the head; amongst the small number of motor-cyclists (or scooter-riders) seen, injury to the head or to the chest were equally common.

Asphyxia was the primary cause of death in 9 percent of the fatalities. In only two out of the 289 deaths was it thought that a fatal outcome might have been averted by early and comparatively simple resuscitative measures.

Amongst vehicle occupants in the sample the principle sources of fatal injury to the chest were the steering wheel and column assembly and the facia panel in frontal impacts, the A and B posts and the doors in side impacts; and for the head, the roof and header rail, in frontal impacts.

1. INTRODUCTION

The object of this paper is to examine the clinical causes of death amongst the various categories of road user, viz: vehicle occupants, pedestrians, pedal cyclists and motor-cyclists (or scooter riders); and, in addition, to consider briefly the sources of fatal injury amongst vehicle occupants and methods of reducing the incidence of such injuries. The data used in the paper have been obtained as a result of attendance by the authors at 289 post-mortems undertaken at a number of hospitals in the vicinity of the Transport and Road Research Laboratory in Berkshire, England, on road traffic accident victims, all of whom died within 30 days of the accident. For 99 of the vehicle occupant deaths the vehicles involved in the accidents were also investigated.

2. CATEGORIES OF CAUSE OF DEATH

We have divided the clinical causes of death into the following categories: death due to a single cause i.e. fatal injury to one region of the body; death due to fatal injury to two regions of the body; and death due to multiple fatal injuries involving more than two regions of the body. We have also distinguished those cases in which asphyxia appeared to have been the primary cause of death and those few cases in which a post-injury complication was the cause of death. The results are given in Table 1, in which the numbers of the different clinical causes of death are shown for the four different categories of road user investigated.

3. DISCUSSION OF DATA

It will be seen in Table 1 that the leading single cause of death amongst vehicle occupants was injury to the chest. It is to be noted also that amongst vehicle occupants whose death was due to fatal injury to two or more regions of the body, injury to the chest was still the most common fatal injury sustained. The predominance of chest injury as a cause of death

amongst vehicle occupants in this sample is to be compared with the Registrar General's statistics for England and Wales (1971), which show that in vehicle occupant fatalities about equal numbers of deaths were due to injury to the head and injury to the chest, abdomen and pelvis grouped together.

In contrast, for pedestrians, injury to the head was the leading cause of death in our sample when a single cause of death could be determined and this pattern was even more pronounced amongst pedal-cyclists. Where death was due to fatal injury to two or more regions of the body injury to the head was still the most common fatal injury sustained amongst pedestrians, and amongst cyclists fatal injury to the head and to the chest were equally common causes of death. These results which show that fatal injury to the head predominated as a cause of death amongst pedestrians and cyclists are in line with those quoted in the Registrar General's statistics for these categories. Table 1 shows that for the small number of motor-cyclists or scooter rider deaths investigated in our sample the numbers of deaths due to chest injury and to head injury were equal.

In comparing our results with those of the Registrar General it should be mentioned, although the pattern of fatal injury for each category of road user is probably not affected, that the Registrar General's statistics include those road user deaths (about 3 percent of the total) which occur more than 30 days after an accident.

It will also be seen from the table that deaths primarily due to asphyxia accounted for about 9 percent of the 289 deaths. This incidence of asphyxia as a cause of death is to be compared with Lauppi's figure of 14.3 percent as a primary cause of death amongst 300 road accident fatalities dying within 48 hours, quoted by Gögler (1962). It is mainly amongst this group of fatalities that early resuscitative measures may be of value in saving life. However, detailed examination of these cases and of all other potentially recoverable cases, including those with intra-abdominal or chest cage injuries, showed that only 2 cases out of the 289 would probably have been saved by comparatively simple measures to improve the airway; although a further 4 might possibly have been saved by early intensive care, i.e. massive blood transfusion or intubation with or without positive pressure respiration initiated within 15-30 minutes of the accident.

Tables 2 to 5 give a breakdown of the types of fatal injury occurring in different regions of the body for all categories of road user irrespective of whether death was due to injury to one or more regions of the body. In Table 2 it will be seen that where fatal injury to the head was sustained, whether as a single cause of death or as one of a number of causes of death, the leading pathology of the injury was fracture of the skull with intra-cranial haemorrhage, most commonly of an intra-cerebral variety. It will also be seen that a substantial number of fatal head injuries consisted of intra-cranial haemorrhage without skull fracture, in all of which there was clinical evidence to suggest that the head had impacted upon some interior structure of the vehicle. It would seem therefore that some fatal head injuries must be due to loads applied to the skull which are below fracture tolerance levels.

Table 3 shows that amongst the fatal neck injuries in the sample, the majority of such injuries, as would be expected, were fracture-dislocations of the upper cervical spine either at the atlanto-occipital joint or below this level, with damage to the cord, but that a few fatal injuries involved deep soft tissue structures, viz laceration of a carotid artery or a crushed larynx.

TABLE I

Number of deaths amongst 289 road users, by cause of death and by category of road user

Cause of death / Category of road user	Fatal injury to one region of the body					Asphyxia as the Primary Cause of death					Post - injury complications				Fatal Injury to two regions of the body	Fatal injuries to more than two regions of the body	All Causes
	Head Injury	Neck Injury	Chest Injury	Abdominal Injury	Lower Limb Injury	Blood in Bronchial tree	Vomit in Bronchial tree	Blood and Vomit in Bronchial tree	Chest trapped	All types of Asphyxia	Fat Embolism	Pulmonary Embolism	Air Embolism	Other			
Vehicle Occupants (172)	27	6	49	11	–	11	5	1	1	18	1	3	–	7	31	19	172
Pedestrians (72)	24	5	8	–	–	4	1	–	–	5	2	4	–	4	12	8	72
Pedal Cyclists (25)	12	2	1	–	–	1	–	–	–	1	–	–	–	1	7	1	25
Riders of Motor Cycles or Scooters (20)	4	1	4	1	1	1	1	–	–	2	–	–	1	1	3	2	20
All categories of road user (289)	67	14	62	12	1	17	7	1	1	26	3	7	1	13	53	30	289

TABLE 2

Numbers of fatal head injuries, by type of injury sustained, amongst 289 fatally injured road users of all categories

Fracture of skull with no macroscopic evidence of intracranial damage	Fracture of vault and/or base of skull with intracranial haemorrhage			Intracranial haemorrhage with no fracture of skull			All types
	Subdural or subarachnoid haemorrhage	Intra-cerebral haemorrhage	Extra cerebral and Intra-cerebral haemorrhage	Subdural or subarachnoid haemorrhage	Intra-cerebral haemorrhage	Extra cerebral and Intra-cerebral haemorrhage	
3	21	45	31	13	10	15	138

NOTE: In many cases injury to the head was not the only cause of death.

TABLE 3

Numbers of fatal neck injuries, by type of injury sustained, amongst 289 fatally injured road users of all categories

Fracture dislocation of upper cervical spine with damage to the cord	Deep soft tissue injuries
24	2

NOTE: In many cases injury to the neck was not the only cause of death.

The different kinds of fatal chest injuries occurring in the sample are shown in Table 4. It will be seen that rupture of the thoracic aorta (usually at the level of the obliterated ductus arteriosus) or of the heart or of both of these organs, with or without fracture of the rib cage, was the leading cause of fatal injury. There were a few cases in which a stove-in-chest without intra-thoracic injury appeared to have been one of the causes responsible for death amongst those dying of double or multiple causes; and in a small number of cases fatal injury to the chest consisted of a fractured rib cage with a lesion to the respiratory system, for example extensive bi-lateral lacerations of the lungs, or a ruptured main bronchus, or with complications such as a torn pulmonary artery or a massive haemothorax, usually combined with other fatal injuries elsewhere.

Two thirds of the 48 cases sustaining rupture of the aorta also sustained multiple fractures of the ribs, but in the remaining third of the cases there appeared to have been no damage to the rib cage. No attempt will be made in this paper to discuss the mechanism of rupture of the aorta; but it is worthy of notice that in a minority of the cases investigated, crushing of the chest by a load sufficient to cause fracture of the rib cage was not a causative factor; although, in this connection it is also to be noted that the average age of those with rib fracture was 43 years and amongst those with no rib fracture it was 26 years. Further investigation into the etiology of rupture of the thoracic aorta should be possible as more cases accumulate in our sample. The importance of damage to the aorta as a cause of death is not only shown by the results obtained in this paper, and particularly for vehicle occupants, but is also mentioned by Ruffell-Smith (1968) who concluded that the leading intrathoracic cause of death for all road users dying within 12 hours of the accident was rupture of the aorta.

Table 5 shows that the leading cause of fatal injury to the abdomen was rupture of the liver, often combined with rupture of the spleen. Rupture of the spleen alone was never found to be a sole cause of death; but in combination with other injuries, often to other regions of the body, it was thought to have contributed substantially to death on a number of occasions. Rupture of the abdominal aorta occurred in two cases, and fatal injuries to other viscera, for example, to the duodenum or to the pancreas were occasionally seen. Fatal injury to the abdomen alone is not a frequent cause of death (see Table 1) but it is frequently seen when there are two or more causes of death, usually in combination with rupture of the aorta or of the heart.

TABLE 4

Numbers of fatal chest injuries, by type of injury sustained amongst 289 fatally injured road users of all categories

Rupture of Heart		Rupture of Aorta		Rupture of Heart and of Aorta		Stove in Chest	Fracture of rib cage with other intrathoracic injuries	All types
With fracture of rib cage	Without fracture of rib cage	With fracture of rib cage	Without fracture of rib cage	With fracture of rib cage	Without fracture of rib cage			
16	1	32	16	3	1	18	11	98

NOTE: In many cases injury to the chest was not the only cause of death.

TABLE 5

Numbers of fatal abdominal injuries, by type of injury sustained, amongst 289 fatally injured road users of all categories

Rupture of Liver	Rupture of Liver and Spleen	Rupture of Spleen	Rupture of Abdominal Aorta	Other	All Types
35	12	11	2	4	64

NOTE: In many cases injury to the abdomen was not the only cause of death.

We would like, finally, to discuss briefly some suggestions for the prevention of fatal injury in vehicle occupants. Table 6 shows the sources of fatal injury to different regions of the body amongst 99 fatally injured occupants in which the vehicles were also investigated. It is clear, in the context of vehicle occupant fatalities, that the most important safety design task is either to improve the energy absorbing characteristics of the steering wheel and column assembly and of the facia panel or to limit occupant contact with these structures by means of adequate occupant restraint or to use a combination of both approaches; and that for side impact collisions, for optimum protection, attention must be paid to intrusion and to the energy absorbing requirements of the A and B posts and the doors. Table 6 also shows that one half of the fatal injuries to the abdomen were caused by the same parts of the vehicle which caused injury to the chest; so that the case for improving the safety design features of these structures of the vehicle is further enhanced, as is the case for adequate occupant restraint - and particularly because some of the fatal injuries noted in the table were caused by ejection.

It will be seen in Table 6 that fatal head injury is mainly related to quite different interior structures of the vehicle, viz to the roof, header rail and windscreen frame; and it is to these structures therefore that the greatest consideration must be given in connection with the placing of padding in order to protect the head from fatal injury.

Seat belts are cited in Table 6 as a cause of fatal injury to the chest in one case and to the abdomen in one case. It is generally agreed that lap and diagonal seat belts reduce the risk of serious injury (and probably also of fatal injury) by a factor of about 50 percent (RRL Leaflet. 1968). In these two fatalities the belt was incorrectly worn in one and in the other there was an unbelted rear seat occupant sitting behind the fatally injured belted occupant. These two fatalities would almost certainly have occurred if belts had not been worn. Valuable though seat belts are, restraint systems could probably be further improved.

TABLE 6

Numbers of fatal injuries amongst 99 vehicle occupant fatalities by region of the body and by source of injury

Source of Injury / Region of body	Steering Wheel and Column Assembly or Facia	Roof Header rail or Windscreen frame	A Post or B Post or Door (intrusion)	Ejection	Seat Belt	Other	All sources of injury
Head	3	21	2	2	–	3	31
Neck	–	1	1	1	–	1	4
Chest	28	2	14	6	1	–	51
Abdomen	13	–	9	3	1	–	26
All regions	44	24	26	12	2	4	112

NOTE: The number of injuries is greater than the number or occupants because many occupants sustained more than one fatal injury.
Those injuries for which a source could not be determined are not included in the Table.

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