THE SEVERITY AND CONSEQUENCES OF INJURIES IN URBAN TRAFFIC ACCIDENTS

by

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ABSTRACT

As part of an in-depth accident study, information was collected on the nature and severity of the injuries sustained by all road users involved in a representative sample of accidents to which an ambulance was called in metropolitan Adelaide during a twelve-month period. The treatment received, duration of hospital stay, period of restricted activity and the characteristics of any residual permanent disability were recorded. These factors are presented in relation to the severity of the injury and discussed with respect to causal mechanisms and possible preventive measures.

INTRODUCTION

A sample of accidents to which an ambulance was called in the Adelaide metropolitan area was investigated at the scene by the Road Accident Research Unit of the University of Adelaide. Each accident was attended by a team comprising an engineer, a psychologist and a medical officer. Their observations at the scene started an average of ten minutes after the ambulance was called and were supplemented by further investigations including examination of injured persons in hospital and follow-up interviews.

Three hundred and four accidents were investigated in the twelve months from 23 March, 1976. These accidents were an eight per cent sample of all road accidents as defined above. The sample was representative of this accident population by time of day and day of week (1).[1] The results have been published in a series of reports (see, for a general review, Reference 1) and in occasional papers. The study was sponsored by Transport Australia and the Australian Road Research Board.

The severity and the consequences of the injuries sustained by each type of road user are presented in this paper, which has been prepared under the sponsorship of the South Australian Department of Transport. The effect of seat belt wearing by car occupants is also presented.

INJURY SEVERITY

Three injury severity scales were used in the study: the Abbreviated Injury Scale (AIS) for single injuries (2), the Injury Severity Score (ISS) as an indication of the severity of injury to the three most severely injured body regions (3) and a somewhat subjective assessment of overall injury severity (1). The last of these three scales is not discussed here.

Note: [1] Numbers in parentheses denote references.

The severity and the number of injuries per person is shown in Table 1 for most of the persons involved in the accidents studied. Forty-five occupants of commercial vehicles are not included in this paper because the vehicles in this category ranged from small multi-purpose passenger vehicles to large transit buses. None of the occupants of these commercial vehicles sustained an injury rated AIS > 2 (5).

TABLE 1: SEVERITY AND NUMBER OF INJURIES PER PERSON

Most Severe Injury (AIS)	Number of Injuries per Person				Total
	0	1	2	3 or more	
Uninjured	384	-	-	-	384
1	-	122	86	77	285
2	-	11	28	91	130
3	-	1	11	48	60
4	-	-	-	9	9
5	-	-	-	1	1
6	-	-	-	8	8
Total	384	134	125	234	877

The severity of injury by type of road user is shown in Table 2 in terms of the highest AIS rating per road user. The relatively high percentage of uninjured car occupants derives mainly from the involvement of some of the cars in collisions with pedestrians and pedal cyclists, accidents in which the car occupant is rarely injured. However, even when injured car occupants only are considered they still have a lower percentage with injuries rated AIS > 1 than do any of the other three categories of road user.

TABLE 2: INJURY SEVERITY (AIS) BY TYPE OF ROAD USER

Injury Severity[1] (AIS)	Type of Road User				Total	
	Pedestrian	Pedal Cyclist	Motorcyclist	Car Occupant	No.	%
Uninjured	2.3%	4.3%	3.8%	51.9%	384	43.8%
1	20.5	26.1	36.3	33.0	285	32.5
2	36.4	34.8	32.5	11.0	130	14.8
3	27.3	30.4	22.5	3.2	60	6.8
4	4.5	4.3	-	0.8	9	1.0
5	2.3	-	-	-	1	0.0[3]
6	6.8	-	5.0	0.1	8	1.0
Total: %	100.0[2]	100.0[2]	100.0[2]	100.0	-	100.0[2]
No.	44	23	80	730	877	-

Note: [1] Most severe injury.
[2] Percentages do not total 100.0 because of rounding errors.
[3] Percentage is greater than zero but less than 0.05.

The mean values of ISS were: pedestrians, 10.1; pedal cyclists 9.5, motorcyclists, 5.6 and car occupants, 1.7.

CONSEQUENCES OF INJURY

The type of treatment, duration of hospital stay and restricted activity and the severity of any permanent disability were used as measures of the severity of the consequences of injury. Table 3 lists the type of treatment by the type of injured road user.

TABLE 5: TYPE OF TREATMENT BY TYPE OF INJURED ROAD USER

Type of Treatment	Type of Road User				Total	
	Pedestrian	Pedal Cyclist	Motorcyclist	Car Occupant	No.	%
None	-	-	-	1.7%	6	1.2%
First Aid at scene	7.0%	9.1%	6.5%	27.7	107	21.7
Casualty department	25.6	27.3	48.1	41.1	198	40.2
Hospitalised < 24 hours	2.3	4.5	5.2	11.1	45	9.1
Hospitalised ⩾ 24 hours	58.1	59.1	35.1	18.0	128	26.0
Fatal	7.0	-	5.2	0.3	8	1.6
Total: %	100.0	100.0	100.0[1]	100.0[1]	-	100.0[1]
No.	43	22	77	350[2]	492	-

Note: [1] Percentages do not total 100.0 because of rounding error.
[2] Type of treatment not known for one car occupant.

The mean duration of hospitalisation and of restricted activity (including any period in hospital) is shown for each type of injured road user in Table 6. 'Restricted activity' is defined here as not being able to work or attend school, or being unable to continue with "usual" activities because of being injured in the accident.

TABLE 6: DURATION OF HOSPITALISATION AND RESTRICTED ACTIVITY BY TYPE OF INJURED ROAD USER

Mean Duration (days)	Type of Road User			
	Pedestrian	Pedal Cyclist	Motorcyclist	Car Occupant
Hospitalisation	16.1	15.4	8.2	2.5
Restricted Activity	46.9	47.7	38.1	12.7

Finally, in this section, the severity of any permanent disability resulting from the injuries sustained in the accident is listed in Table 7. "Severe" indicates total permanent disability; "moderate", a disability that has a significant effect on the person's abilities but not to the extent that he is unable to care for himself. "Minor", refers to a permanent disability that may have some effect on the person's choice of employment or recreation.

TABLE 7: SEVERITY OF PERMANENT DISABILITY BY TYPE OF INJURED ROAD USER

Severity of Permanent Disability	Type of Road User				Total	
	Pedestrian	Pedal Cyclist	Motorcyclist	Car Occupant	No.	%
No Disability	56.4%	63.6%	65.7%	91.9%	388	83.6%
Minor	28.2	31.8	22.9	6.9	57	12.3
Moderate	5.1	4.5	5.7	0.9	10	2.2
Severe	2.6	-	-	-	1	0.2
Fatal	7.7	-	5.7	0.3	8	1.7
Unknown	(4)[1]	(-)	(7)	(18)	(29)	(-)
Total: %	100.0	100.0[2]	100.0	100.0[2]	-	100.0
No.	39	22	70	333	464	-

Note: [1] Numbers in parentheses are not included in the percentages or the column totals.
[2] Percentages do not total 100 because of rounding errors.

As can be calculated from the data shown in Table 1, only 2.1 per cent of the non-fatally injured road users had an AIS > 3. Therefore the following results, which relate only to persons whose most severe injury was rated AIS ≤ 3, include almost 98 per cent of those whose injuries were not fatal.

THE ASSOCIATION BETWEEN THE SEVERITY AND THE CONSEQUENCES OF INJURY

The mean value of AIS for the most severe injury per person is shown in Table 8 for each category of treatment of these injuries. The mean ISS is also listed in this Table.

TABLE 8: INJURY SEVERITY BY TYPE OF TREATMENT OF INJURED ROAD USER (AIS ≤ 3)

Mean Injury Severity	Type of Treatment				
	None	First-Aid at Scene	Hospital		
			Casualty Dept.	Admitted	
				< 1 day	≥ 1 day
AIS[1]	1.2	1.1	1.2	1.8	2.4
ISS	1.5	1.5	2.1	4.7	9.5

Note: [1] AIS for the most severe injury per person

The association between injury severity and both the duration of any stay in hospital and of any period of restricted activity is indicated by Tables 9 and 10, which show the mean durations in days for the listed values of AIS and ISS respectively.

There were no cases rated AIS ≤ 3 that resulted in total permanent disability but there were eight in which the disability was rated as being of moderate severity and 52 of minor severity. The association with the highest AIS per injured person and ISS is shown in Table 11.

TABLE 9: INJURY SEVERITY (HIGHEST AIS) BY DURATION OF HOSPITALISATION AND OF RESTRICTED ACTIVITY (AIS ⩽ 3)

Mean Duration (days)	Injury Severity (Highest AIS per person)		
	1	2	3
Hospitalisation	0.3	4.1	23.5
Restricted Activity	4.6	26.1	77.7

TABLE 10: INJURY SEVERITY (ISS) BY DURATION OF HOSPITALISATION AND OF RESTRICTED ACTIVITY (AIS ⩽ 3)

Mean Duration (days)	1	2	3-5	6-9	10-15	16-27
Hospitalisation	0.3	0.3	2.9	11.5	15.0	33.1
Restricted Activity	3.6	7.5	20.2	50.3	69.6	81.9

TABLE 11: INJURY SEVERITY BY SEVERITY OF PERMANENT DISABILITY (AIS ⩽ 3)

Mean Injury Severity	Severity of Permanent Disability			
	Nil	Minor	Moderate	Severe
AIS[1]	1.35	2.40	2.88	-
ISS	2.86	9.85	12.25	-

Note: [1] AIS for the most severe injury per person.

SEAT BELT WEARING AND THE SEVERITY AND CONSEQUENCES OF INJURY

The wearing of seat belts is required by law in South Australia, as is the fitting of a seat belt to all seating positions in a car. Retrospective fitting of belts to older cars is not required and so a seat belt was not available for 26 per cent of the car occupants in the accidents studied. Belt usage could not be confirmed for just over a third of occupants who had a belt available but 70 per cent of the remaining two thirds were known to have been wearing the belt at the time of the crash. Overall, including those with no belt available, 45 per cent of the car occupants were wearing a seat belt.,

Table 12 lists measures of the severity and consequences of injury for those car occupants for whom belt usage was known.

DISCUSSION

Almost all of the injuries sustained in this representative sample of road accidents in a metropolitan area were rated AIS ⩽ 3 (Table 1). Even so, 47 per cent of those persons injured had three or more separate injuries.

There were eight persons who died in or soon after the accident. One car occupant was fatally injured when his car was struck by a train at a level crossing. Four motorcyclists were killed, all in single vehicle collisions

TABLE 12: SEVERITY AND CONSEQUENCES OF INJURY TO CAR OCCUPANTS BY SEAT BELT USAGE[1]

Severity and Consequences of Injury	Seat Belt Usage[2]	
	Yes	No
Mean AIS	0.82	0.89
Mean ISS	2.21	2.77
Mean Duration (days):		
Hospitalisation	1.44	1.62
Restricted Activity	16.68	21.72

Note: [1] AIS $\leq$ 3 and occupants aged 16 to 55 years in all accidents to which an ambulance was called (including pedestrian, pedal cycle and motorcycle collisions with cars)

[2] Cases in which belt usage was uncertain or unknown are omitted.

with roadside objects. The three pedestrians who were killed included two who were struck by a car at a speed of about 60 km/h (the legal limit) and one infant in a baby carriage who was crushed under the rear wheels of a bus. An 18 month old girl who was struck by a motorcycle and is listed above as the one case of total permanent disability in fact died about two years after the accident.

There were no motorcyclists, apart from the fatal cases, with an injury rated AIS > 3. This may be partly a consequence of the virtually universal use of crash helmets, as required by law. (In two of the fatal cases the force of the impact greatly exceeded the level of protection that could reasonably be expected to be afforded by a crash helmet, in another the strap of the helmet was not fastened and the helmet came off before the impact and in the final case the rider's neck was broken when he rode into a post and wire fence.)

The association between the two measures of injury severity and the mean duration of hospitalisation and of restricted activity is shown in Table 13 for each category of injured road user, drawing on data from Tables 2 and 6 and from an adjustment of the ISS ratings listed above for all persons involved, deleting those who were not injured. It can be seen that the relationship between the four types of road user is similar for the mean values of the highest AIS per person and the mean duration of restricted activity. The mean values of ISS, however, bear a closer relationship to the mean duration of hospitalisation.

The implications of these findings are that the length of time spent in hospital is more nearly linearly related to the severity and number of injuries a person sustained than to the severity of the most severe single injury, whereas the period of restricted activity is not markedly influenced by the number of injuries but does relate closely to the severity of the most severe injury. These relationships are maintained in the data presented in Tables 9 and 10 for all road users having a maximum AIS of 1, 2 or 3.

TABLE 13: INJURY SEVERITY AND CONSEQUENCES BY TYPE OF INJURED ROAD USER

Injury Severity or Consequences	Type of Road User			
	Pedestrian	Pedal Cycle	Motorcycle	Car Occupant
"AIS"	1.6	1.5	1.3	1.0[1] (1.4)
"ISS"	2.9	2.8	1.6	1.0 (3.6)
"Hospitalisation"	6.4	6.2	3.3	1.0 (2.5)
"Restricted Activity"	3.7	3.8	3.0	1.0 (12.7)

Note: [1] Values shown are based on mean values (in 'days' for rows 3 and 4) adjusted to an arbitrary value of 1.0 for car occupants. The actual values for car occupants are shown in parentheses.

One seventh, or 14.7 per cent, of the persons who were injured in these accidents but who survived were permanently disabled to some degree (Table 7). The incidence of residual disability was much greater among pedal cyclists (36.3 per cent) and pedestrians (35.9 per cent of those who were injured).

The type of treatment received, as described in Table 8, was closely related to both the mean AIS of the most severe injury and the ISS, based on the three most severely injured body regions. There was a similarly close relationship between these two measures of injury severity and the severity of any permanent disability (Table 11).

The data presented in this paper do not include any reference to the type of injury or to the body regions injured. It is probable, however, that many of the differences observed between types of road users derive from differences in patterns of injury. For example, motorcyclists were much less likely to have been admitted to hospital than were pedestrians and pedal cyclists (Table 5). This largely accounts for the shorter mean duration of hospitalisation (averaged over all who were injured) (Table 6). But there is a much smaller difference between motorcyclists and these other two types of road user when comparing the mean duration of restricted activity (Table 6) and the percentage who were permanently disabled (Table 7). This may be because more than half (55.5 per cent) of the severe injuries sustained by motorcyclists were to the lower extremities whereas the corresponding percentage for pedestrians was 30.0 (4) and for pedal cyclists 35.3 (5).

Table 12 shows the extent to which seat belt wearing reduces the mean severity of injury and the mean duration of both hospitalisation and restricted activity. The last two measures may well form a more readily understood basis for arguing a case for compulsory belt wearing than the severity of injury. A reduction of about 30 per cent in the time off work due to injury if even half of the car occupants in accidents are wearing seat belts is of obvious consequence in economic terms.

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