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CHARACTERISTICS OF PATIENTS, TYPE OF ACCIDENT, AND MORTALITY IN A CONSECUTIVE SERIES OF HEAD INJURIES ADMITTED TO A NEUROSURGICAL UNIT

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There have been surprisingly few studies of representative samples of civilian head injuries, the great majority of which, unlike wartime injuries are closed injuries. Recent reports have come from the United States (Gurdjian and Thomas, 1965), Australia (Selecki, Hoy, and Ness, 1967), and Canada (Klonoff and Thompson, 1969). In this country, Barr and Ralston (1964) described 532 patients admitted over a five-year period to a general hospital with special facilities, the type of hospital to which, according to Lewin (1961), 90% of patients are admitted. Steadman and Graham (1970) surveyed 484 patients admitted to a provincial teaching hospital in one year. They remarked on the need for full clinical records of head injured patients and suggested these might be best provided by a specialized centre.

In this article the material consists of a consecutive series of adult admissions to a neurosurgical department which constitutes the Regional Centre for the treatment of head injuries and admits all types and degrees of injury. The characteristics of the patients, the types of accident, and the factors associated with mortality and residual brain damage are described.

METHOD AND MATERIAL

The data were derived from the case records of 474 adult patients (aged 15 years and over) admitted consecutively to the Neurosurgical Unit at the Newcastle General Hospital over a period of one year from April 1963 to March 1964. The criterion for admission was a period of unconsciousness following a head injury. The more severely injured were over-represented among those admitted from outside the immediate catchment area. All but 1% were closed injuries. Twenty-nine children were admitted during this period, but since most children are treated in the paediatric unit they have been excluded from the series. Eighty per cent of the patients were admitted directly to the unit and 20% were transferred from other hospitals in order to receive specialist care, usually within 48 hours.

RESULTS

THE PATIENTS

Comparisons were made with the population of Northumberland and Durham (General Register Office, 1954, 1963).

AGE AND SEX There were 386 males (81%) and 88 females (19%) distributed by age as shown in Table I. In both sexes there is a shift towards the younger age groups at the expense of the middle-aged; 43% of all patients were between 15 and 30 years of age compared with 26% of the general adult population.

MARITAL STATUS There was an excess of single and a deficit of ever-married among the patients com-

TABLE I

AGE DISTRIBUTION IN PER CENT OF PATIENTS AND OF GENERAL ADULT POPULATION, NORTHUMBERLAND AND NORTH DURHAM

	15–19	20–29	30–39	40–49	50–59	60–69	70–79	Over 80	All Ages
Males									
Population	9·6	16·9	19·5	18·3	17·3	11·3	5·7	1·6	
Patients	17·9	25·9	14·5	13·0	15·0	6·5	5·7	1·5	100·0 (386)*
Females									
Population	8·8	16·1	17·8	17·1	16·8	13·1	7·8	2·5	
Patients	20·5	18·2	11·4	8·0	13·6	13·6	10·2	4·5	100·0 (88)
Total									
Population	9·2	16·5	18·6	17·7	17·0	12·2	6·8	2·1	
Patients	18·4	24·5	13·9	12·0	14·8	7·8	6·5	2·1	100·0 (474)

*Figures in parentheses are numbers.

TABLE II
TYPE OF ACCIDENT BY SOCIAL CLASS, MALES

Class	Road	Domestic	Assault	Industrial	Sport	Other	Total	General Population
I and II	17 (9·4)	6 (11·3)	2 (3·8)	3 (4·5)	4 (33·3)	4 (18·2)	36 (9·3)	(12·3)
III	88 (48·6)	21 (39·6)	15 (28·8)	26 (39·4)	7 (58·3)	10 (45·5)	167 (43·3)	(52·3)
IV	45 (24·9)	9 (17·0)	10 (19·2)	28 (42·4)	1 (8·3)	5 (22·7)	98 (25·4)	(21·6)
V	31 (17·1)	17 (32·1)	25 (48·1)	9 (13·6)	0	3 (13·6)	85 (22·0)	(13·8)
Total	181	53	52	66	12	22	386	

Figures in parentheses are percentages

pared with the general adult population, but after correction for age this difference was found to be not significant. There was, however, a more than fourfold increase in the number of divorced persons, which would be expected to occur by chance only once in 2,500 times according to the Poisson distribution.

SOCIAL CLASS (Table II) The relationship of injury to social class varied with the type of accident, the Registrar General's class V being associated with assault and domestic accidents, class IV with industrial accidents, and classes I and II with the small number of injuries occurring during sport and recreation. Road accidents were not significantly related to social class.

PSYCHOLOGICAL STATUS AND ALCOHOLISM A previous history of epilepsy was found in 10 patients (2·1%), but in only three cases was the accident known to have been caused by a fit. None of these was a road accident. Seven patients were suffering from a psychosis, and these included the three cases of self-inflicted injury. Nineteen patients were known to be suffering from neurosis, psychopathic states or chronic alcoholism, but these conditions may have been under-recorded. Recent consumption of alcohol, however, was common; it was noted in 29% of males and in 10% of females.

TABLE III
TYPE OF ACCIDENT BY AGE AND SEX

	Sex	Age (years) 15–29	30–59	60+	Total
Road	M	85 (17·9)	70 (14·8)	26 (5·5)	181 (38·2)
	F	18 (3·8)	18 (3·8)	12 (2·5)	48 (10·1)
Domestic	M	8 (1·7)	32 (6·8)	13 (2·7)	53 (11·2)
	F	3 (0·6)	7 (1·5)	13 (2·7)	23 (4·9)
Assault	M	39 (8·2)	11 (2·3)	2 (0·4)	52 (11·0)
	F	8 (1·7)	2 (0·4)	0	10 (2·1)
Industrial	M	24 (5·1)	37 (7·8)	5 (1·1)	66 (13·9)
	F	1 (0·2)	0	0	1 (0·2)
Sport	M	9 (1·9)	1 (0·2)	2 (0·4)	12 (2·5)
	F	2 (0·4)	1 (0·2)	0	3 (0·6)
Other	M	4 (0·8)	13 (2·7)	5 (1·1)	22 (4·6)
	F	2 (0·4)	1 (0·2)	0	3 (0·6)
Total	M	169 (35·6)	164 (34·6)	53 (11·2)	386 (81·4)
	F	34 (7·2)	29 (6·1)	25 (5·3)	88 (18·6)
	M and F	203 (42·8)	193 (40·7)	78 (16·4)	474 (100·0)
Incidence per 100,000 population at risk	M	75·9	35·4	33·9	45·9
	F	15·0	6·2	11·8	9·7

THE ACCIDENTS

The accidents were classified under five headings: road, domestic, assault, industrial, and sporting; in 5% of cases the accident could not be classified. The distribution of patients by age, sex, and type of accident is shown in Table III.

ROAD ACCIDENTS As expected, these accounted for by far the largest number (229) of head injuries, nearly half the total, with males predominating by nearly 3 to 1. Of these patients 33% were pedestrians,

TABLE IV
ROAD ACCIDENTS, ALCOHOL, AND MORTALITY

	No. of Patients	No. who had taken Alcohol	No. of Deaths
Pedestrian	76 (33·2)*	20	26
Car	61 (26·6)	10	3
Scooter and motorcycle	52 (22·7)	6	3
Push bicycle	20 (8·7)	3	0
Other	20 (8·7)	2	1
Total	229 (99·9)	41	33

*Percentages in parentheses

27% occupants of cars, 23% riders of scooters or motor cycles, 9% cyclists, and 9% other road users (Table IV). Altogether cars were involved in 119 of the accidents, that is, in over half of all road accidents (about a quarter of all accidents). Compared with 14% of all other injured road users, 26% of pedestrians had probably been under the influence of alcohol at the time of the accident.

Road accidents were responsible for the more serious injuries as judged by death, depth of unconsciousness, visceral and bony injury, shock, and duration of stay in hospital. There were 33 deaths (14%), pedestrians accounting for three-quarters of these.

DOMESTIC ACCIDENTS These accounted for 76 cases or 16% of all admissions. Of these accidents

40 were due to falls from a height (usually down stairs) and 17 to falls on a level surface. Five patients had struck their heads on objects without falling and five were found lying unconscious. Fainting (5), an epileptic fit (3), and ingestion of barbiturates (1) were also reported. Forty-six per cent of the patients (mostly males) had taken alcohol. Compared with the other types of accident, domestic accidents were relatively common among women.

INDUSTRIAL ACCIDENTS These were the cause of 67 (14%) of the injuries and all except one of the patients were males. Half of the injuries were due to falls at work, often from quite small heights (a range of 5 to 25 ft; 1·5 to 7·6m), a quarter to falling objects (stones and pieces of machinery), and a fifth to mining accidents.

Sixty-two patients (13%) were admitted after an *assault* or a *self-inflicted injury*. Assaults most often took place during a drunken brawl (28) and fights in which alcohol was not detected accounted for 10 cases. Domestic quarrels accounted for 13, premeditated attacks for 5, self-inflicted injuries for 3 cases, and in 3 the exact circumstances were not recorded.

Assault was associated with male sex, youth, and low social class. Fifty-six per cent of the patients had been drinking; 15 had been under psychiatric care for neurosis, psychopathic disorder, alcoholism or epilepsy. The injuries were comparatively mild.

Injuries occurring during sport or recreation amounted to 15 cases, 3% of the total. The patients were mostly adolescents or young adults. Falls, usually as a result of climbing or riding mishaps, were the commonest cause. Three patients were hurt during games of football or hockey, two in swimming baths, and one while boxing.

THE OUTCOME

Fifty-one patients (10·8%) died in the unit, 9·6% of the males and 15·9% of the females. The percentage was higher among transferred patients (20%) than among direct admissions (8%). Seventy-two per cent of deaths occurred within one week of admission and 47% within 24 hours; 12·9% survived with unequivocal signs of residual brain damage still present on discharge from the unit (hemipareses, spasticity, tremor, gnostic disorders, objective memory deterioration or gross personality change). The remaining patients survived with a postconcussional syndrome or made complete recoveries and will be described in detail elsewhere (Kay, Kerr, and Lassman, 1971).

Table V shows the outcome after each type of accident in terms of death and residual brain damage. Domestic and road accidents had the highest mortality and between them accounted for all but six of the deaths; there were no fatalities following injuries due to assault or sport. As Table IV shows, pedestrians with a mortality of 34% were at much greater risk than other road users of whom only 4·5% died. Road accidents contributed the largest number of patients with residual brain damage, but accidents in the home were followed by the smallest proportion of recoveries, i.e., survival without brain damage. Table V also shows the mean age and the mean level of consciousness on admission (see below) in each accident group, from which it appears that the outcome was related to both of these characteristics.

AGE AND LEVEL OF CONSCIOUSNESS

The relationship between outcome and age is set out in Table VI. Mortality, which lies between 3 and 9% in the younger age groups, increases progressively from the age group 50–59 upwards, while the proportion of brain-damaged survivors remains relatively constant at all ages. The mean scores for level of consciousness are also shown; there is a small but significant correlation with age ($r = 0{\cdot}15$, $N = 474$, $P < 0{\cdot}01$).

The level of consciousness on admission was chosen as the criterion of the severity of the head injury, (i.e., of the initial brain trauma) because the other possible measures, the duration of unconsciousness and of post-traumatic amnesia, cannot be estimated in patients who die without regaining consciousness. Level of consciousness was divided into grades, scored 1 to 5: 'fully conscious', 'responds to simple questions', 'responds to sharp requests',

TABLE V

TYPE OF ACCIDENT, MORTALITY, AND RESIDUAL BRAIN DAMAGE

	Industrial	Road	Domestic	Assault	Sport	Other	Total
Died	2 (3·0)	33 (14·4)	12 (15·8)	0	0	4 (16·0)	51
Brain damaged	13 (19·4)	28 (12·2)	14 (18·4)	2 (3·2)	2 (13·3)	2 (8·0)	61
Recovered	52 (77·6)	168 (73·4)	50 (65·8)	60 (96·8)	13 (86·7)	19 (76·0)	362
Total	67	229	76	62	15	25	474
Mean age (yr)	37±1·8	39±1·3	57±2·3	26±1·5	28±4·6	43±2·6	39±0·9
Level of consciousness on admission*	1·61±0·13	2·29±0·10	2·27±0·17	1·28±0·07	1·53±0·27	2·00±0·26	2·03±0·06

*See text

TABLE VI
OUTCOME AND AGE

	15–19	20–29	30–39	40–49	50–59	60–69	70–79	Over 80	All Ages
Died	3 (3·4)	4 (3·4)	6 (9·1)	2 (3·5)	11 (15·7)	8 (21·6)	12 (38·7)	5 (50·0)	51 (10·8)
Brain damaged	11 (12·7)	8 (6·9)	12 (18·2)	6 (10·5)	11 (15·7)	7 (18·9)	4 (12·9)	2 (20·0)	61 (12·9)
Recovered	73 (83·9)	104 (89·7)	48 (70·7)	49 (86·0)	48 (68·6)	22 (59·5)	15 (48·4)	3 (30·0)	362 (76·3)
Total	87	116	66	57	70	37	31	10	474
Level of consciousness on admission*	1·93±0·15	1·72±0·11	2·24±0·17	1·75±0·17	2·29±0·18	2·32±0·24	2·39±0·31	2·70±0·60	2·03±0·06

*See text

TABLE VII
LEVEL OF CONSCIOUSNESS ON ADMISSION AND OUTCOME

	Fully Conscious	Responds to Simple Questions	Responds to Sharp Requests	Reacts to Pain	Comatose	Total
Died	3 (1·1)	1 (1·4)	5 (10·6)	10 (21·3)	32 (69·6)	51 (10·8)
Brain damaged	16 (6·0)	6 (8·7)	13 (27·7)	15 (31·9)	11 (23·9)	61 (12·9)
Recovered	246 (92·8)	62 (89·8)	29 (61·7)	22 (46·8)	3 (6·5)	362 (76·3)
Total	265	69	47	47	46	474

Figures in parentheses are percentages

'responds to painful stimuli', and 'comatose'. Among survivors its correlation with post-traumatic amnesia was 0·80.

Table VII shows that as the level of consciousness decreased the chances of dying increased progressively, from 1·1% in patients who were fully conscious to 69·6% in those who were comatose. The percentage of brain-damaged patients also increased though in a less striking fashion. There were highly significant differences in mean 'scores' between patients who died (4·26 S.D. 1·23), brain-damaged survivors (2·98 S.D. 1·47), and the remainder (1·55 S.D. 0·94).

To obtain a prediction of mortality with a combination of features, discriminant function analyses were carried out with death as the dependent variable

TABLE VIII
CORRELATIONS AND MULTIPLE CORRELATIONS WITH DEATH

	All Ages (N=474)		Under 50 (N=326)		50 and Over (N=148)	
	r	β	r	β	r	β
Age groups*	0·31	0·21	0·04	0·03	0·27	0·20
Level of consciousness	0·55	0·43	0·49	0·45	0·62	0·47
Surgical shock	0·39	0·21	0·26	0·13	0·46	0·23
Associated injuries	0·27	0·02	0·12	—	0·35	0·09
Intracranial haemorrhage	0·32	0·05	0·23	0·02	0·35	0·08
Predicted variance	0·40		0·26		0·51	
Multiple correlations	0·63		0·51		0·71	
F ratios	45·2		15·8		20·8	
P	<0·001		<0·001		<0·001	

*Under 50: 15–19, 20–29, 30–39, 40–49
Over 50: 50–59, 60–69, 70–79, 80+
β = Standardized partial regression coefficients

(Table VIII). Of the five features finally used, three accounted for 96% of the predicted variance—level of consciousness, presence or absence of surgical shock, and age. The addition of other variables, such as previous head injury or skull fracture, did not improve the prediction.

Discriminant functions were also calculated separately for patients below and above the age of 50 (Table VIII). It was found that age predicted death only in the latter (r = 0·27). To determine whether the correlation of age with death is significant independently of the severity of injury in the older group, level of consciousness, shock, associated injuries, and intracranial haemorrhage were converted into a single composite variable derived from their combined weighted scores (Guilford, 1956). With this variable held constant, the partial correlation of age with death was then recalculated and found to be highly significant (partial r = 0·25).

A different set of features predicted the likelihood of residual brain damage among survivors. Shock and age were not important, while intracranial haemorrhage and skull fracture both improved the prediction given by level of consciousness on admission.

DISCUSSION

DEMOGRAPHIC ASPECTS

As in other published series (Selecki *et al.*, 1967; Klonoff and Thompson, 1969; Steadman and Graham, 1970), males predominated over females, the sex ratio being 4:1. Male predominance is partly due to social factors that expose them to greater

hazard as, for example, in industry, but may also be a consequence of biological or psychological factors that result in more aggressive, destructive, and risk-taking behaviour, such as brawling, drug-taking, and suicide. A factor that increased the male: female ratio was undoubtedly the sex difference in the consumption of alcohol, particularly in domestic accidents (falling down stairs when drunk) and assaults (drunken brawls between youths). Nevertheless, the relative liability of the sexes to injury is difficult to assess, because, as Backett (1965) has pointed out, the true populations at risk are generally not known.

As is the case for accidents in general, there is a tendency for head injury to be relatively commoner in the young and the elderly than in the middle-aged; the type of accident, however, changes with age. Though road accidents caused half the casualties at all ages, patients under 30 were mainly travelling in cars, or on motor cycles or scooters, while those over 50 were mainly pedestrians. Excluding road accidents, young males were most likely to have been injured at work or assaulted, while middle-aged males were as prone to domestic as to industrial accidents. In elderly females domestic accidents, mainly due to falling, were as common as road accidents.

The fourfold increase over expectation of divorced persons is in keeping with the view that psychological factors play a role in the causation of accidents, since divorcees are known to be over-represented among the mentally disturbed and among suicides. A history of epilepsy (2·1%) was also rather more frequent than would be expected from the 0·5% prevalence of epilepsy in the general population (Brewis, Poskanzer, Rolland, and Miller, 1966), but in only three cases was an actual fit known to have been the cause of the accident.

Alcohol Consumption

The proportion of patients who had taken alcohol was very high, i.e., 31% of all those under the age of 60, 29% of all males, and 26% of pedestrians. The last figure agrees well with a report on traffic accidents in Oslo which showed that every fourth pedestrian casualty in the age group 15–64 was under the influence of alcohol (Blikra and Ringkjob, 1968). Alcohol also contributed to 46% of domestic accidents. According to the Metropolitan Life Insurance Company Statistical Bulletin (1967), alcohol is a factor in 17% of accidental deaths in the home.

The high frequency of alcohol consumption in this series may be a reflection of local culture, offences due to drunkenness in the north-east being among the highest in the United Kingdom (Home Office, 1962). Another possibility is that some of these patients may have been admitted as a precaution when there was a doubt about the presence of a head injury. However, mortality among the alcohol users was only slightly less (8·3%) than among the remainder (11·6%), and among the road casualties there was no difference. Admission policy alone can therefore hardly account for the high proportion of patients who had recently taken alcohol.

If it were assumed that alcohol was the decisive factor in *every* accident in which the patient had been drinking, about half the domestic accidents and assaults and one-fifth of the road accidents would not have occurred if no alcohol had been consumed. As the condition of the uninjured parties, for example some of the drivers of cars involved in the accidents, is not known, these estimates may not greatly exaggerate the role of alcohol consumption in causing accidents. Routine blood alcohol estimations in a series of patients with head injuries would seem to be worth undertaking.

Outcome

Mortality was very significantly correlated with the level of consciousness on admission to the unit ($r = 0·55$). Among survivors, this index was correlated with residual brain damage ($r = 0·45$), with duration of loss of consciousness ($r = 0·73$), and with duration of post-traumatic amnesia ($r = 0·80$). As it can be defined in simple clinical terms and is applicable to all patients who are brought to hospital alive, it seems to be a useful measure of the severity of the initial brain trauma. Ideally, for prognostic use, it should be assessed at a standard interval after the accident, but in this series it proved an important predictor in both direct admission and transferred patients.

One of the most striking observations about the outcome after head injury is the increased mortality in older patients (Gurdjian and Thomas, 1965; London, 1967). In this series mortality showed a progressive rise from the 50–59 age group upwards. Under this age, nearly all the predicted variance was contributed by two features—the severity of the initial head injury (measured by level of consciousness) and the overall severity of the injuries (measured by the presence or absence of shock). Age, sex, skull fracture, and intracranial haemorrhage added little to the prediction. The post-mortem findings showed that most of the younger patients had died as a result of severe brain damage together with, in some cases, severe multiple injuries. Only two patients were not comatose on admission. Only

three patients did not receive head surgery. Thus the prospects of reducing mortality in younger patients from the fairly low figure of 4·6% are not promising. The main task for the future will be to prevent such injuries occurring.

Above the age of 50 there were 36 deaths, a rate of 24%, and the question arises whether this relatively high mortality might be reduced nearer to the rate for the young. There appear to be three possible causes, singly or combined, for the higher mortality:

(1) Elderly patients might be liable to the relatively more serious types of accident, e.g., pedestrian road accidents. However, although this was to some extent true of the older patients as a whole, *among the deaths* both the head and the associated injuries tended to be less severe than in the younger patients. For example, only one-half of the fatal cases among the over 50s were comatose on admission compared with 13 of 15 fatal cases under this age, a difference that is significant ($P < 0.05$). Thus elderly patients tended to die from trauma of a degree that younger patients survived.

(2) The second possibility is that death was more frequent in older patients owing to age-related factors such as complications or pre-existing disease. Age was in fact found to be related to death independently of all the other features examined, and this explanation appears to be the main reason for the increased mortality. The elderly are both more liable to develop shock, chest infections, and other complications, and more likely to die from them.

(3) The third possibility is that the ageing brain is itself more vulnerable to trauma. Carlsson, Essen, and Löfgren (1968) examined this question in an elegant manner and found that in a group with severe head injury the mortality from the 'primary trauma' and also the duration of coma among survivors were independent of age. In arriving at this conclusion they omitted from their sample patients with 'surgically oriented' intracranial complications and also subtracted the deaths due to extra-cranial complications. Nearly all the deaths from 'primary trauma' took place within 48 hours. If we limit our comparison to this period and also exclude deaths associated with severe multiple injuries, the number of deaths is substantially reduced, in both the old and the young, and mortality is still considerably higher in the patients over 50. However, the fact that among survivors evidence of residual brain damage, level of consciousness on admission, duration of unconsciousness, and PTA (post-traumatic amnesia) were all independent of age suggests that the ageing brain is not particularly susceptible to lasting damage or dysfunction as a result of trauma, although the ageing individual himself is susceptible to death.

The main hope of reducing mortality after head injury may therefore lie in improving methods of treating shock and other complications in the older age groups.

Preventive Aspects

To a considerable extent the occurrence of head injuries reflects forms of social behaviour, such as consumption of alcohol, which are difficult to alter. From a practical point of view, prevention has to be directed towards minimizing the effects of such behaviour. For example, public opinion now accepts the need to control the drinking driver but is less concerned with protecting drunken pedestrians, who are particularly prone to fatal accidents. The next step, following the introduction of seat belts, improved car design, and the breathalyser, should be to plan new towns and estates in such a way as to separate pedestrian precincts and licensed premises from traffic areas. This would also afford some protection to the elderly who are specially vulnerable as predestrians.

There is also a wide scope for prevention in the home. The importance of this problem is shown by the fact that in 1966, in England and Wales, domestic accidents accounted for 1·3% of all deaths and 39% of all accidental deaths (Registrar General, 1967). Safety measures should be directed towards improvement in interior design and materials, particularly with regard to the dangers of stairs and slippery floors. Old people, many of whom live alone, constitute a particularly vulnerable group (Agate, 1966) whose proportion in the population continues to increase.

Industrial accidents were perhaps less numerous and severe than might have been expected in this area, presumably due to safety regulations. There seems, however, to be a need for further protection, especially from falling objects. Recreations such as climbing and riding accounted for only a small number of accidents, but the routine wearing of protective headgear would further reduce the risks.

Summary

Four hundred and seventy-four patients aged 15 and over were admitted after head injury to the Regional Neurological Centre in Newcastle upon Tyne during the year April 1963 to March 1964. This represents a rate of 5·6 per 10,000 population at risk; 43% of patients fell within the age range 15–29 years. The overall male preponderance of over 4 to 1 was less marked after the age of 60. Divorced persons were over-represented.

The age, sex, and social class distributions varied with the type of accident. Industrial accidents were

relatively common in males of social class IV, assaults in young males of social class V, and domestic accidents in elderly females of this class. The elderly were injured mainly on the roads or in the home.

Recent consumption of alcohol, which was noted in 29% of males and in 10% of females, was commonest in domestic accidents and assaults. One-quarter of pedestrians were affected by alcohol.

Mortality was 10·8%; 14·4% of survivors showed neurological and/or psychiatric signs of residual brain damage. Road accidents accounted for nearly half the injuries and, together with domestic accidents, for 90% of the deaths and for 69% of the brain-damaged cases among survivors.

Discriminant function analysis showed that three features, the severity of the initial brain trauma as measured by the level of consciousness on admission, the presence or absence of surgical shock, and age, together accounted for most of the predicted variance in respect of death or survival. However, the influence of age was important only after the age of 50, when mortality was five times higher than in the younger age groups, and this increase appeared to be due mainly to age-related factors such as complications or pre-existing disease. The prospects of reducing mortality after head injury are therefore probably best in the older age groups, since in younger patients most deaths are associated with severe brain damage.

Protection of pedestrians by separation of traffic areas from licensed premises, and improvement in design and materials in the home, are likely to be the most effective preventive measures possible in the long term.

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