INJURY RESEARCH & STATISTICS

AIHW

Hospitalisation due to traumatic brain injury, Australia 1997–98

Peter O'Connor

Hospitalisation due to traumatic brain injury (TBI), Australia 1997–98

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Contents

Introduction

Each year thousands of Australians are affected by brain injury from traumatic causes (TBI), principally from falls and road crashes. Severe TBI has a high mortality rate (O'Connor & Cripps, 1999). The survivors of severe and moderate TBI often require health, welfare and social services for the rest of their lifetime. Psychological disorders (e.g. mood swings) are common. Family life and economic prospects are often dramatically disrupted. Even mild TBI can have dramatic effects for some individuals, affecting their capacity to return to work or studies. Often the effects of brain injury are not immediately recognisable during hospitalisation but appear after discharge.

The importance of this health condition was recognised in the *Better Health Outcomes for Australians* report (Commonwealth Department of Human Services and Health, 1984). However, no indicator, nor target, was specified. The most recent report on the National Health Priority Areas for Injury Prevention and Control (Commonwealth Department of Health and Family Services, 1998), foreshadowed an indicator for brain injury, but this had not been addressed until recently (O'Connor & Cripps, 1999). The recent report indicated that there was a need for the routine reporting of rates of TBI based on hospital separations data. The present report addresses this need.

Case definition

In order to facilitate national and international comparisons, the case definition that has been adopted for the reporting of TBI in Australia is the US Centers for Disease Control (CDC, 1995) clinical definition:

Table 1: International standard for the surveillance of TBI (CDC, 1995)

CDC definition, based on ICD-9-CM
800.0–801.9 Fracture of the vault or base of the skull
803.0–804.9 Other and unqualified and multiple fractures of the skull
850.0–854.1 Intracranial injury, including concussion, contusion, laceration, and haemorrhage

This report presents statistical information on hospitalisation due to TBI in Australia in 1997–98. The focus is on estimated new incident cases, excluding readmission and inter-hospital transfers. The specification of estimated new incident cases is presented in the 'Data Issues' section.

Terms used in the report are defined in the Glossary.

Overview of TBI

From Table 2 it can be seen that the age-standardised incidence rate of TBI in 1997–98 was about 141 per 100,000 of population. This figure is based on case selection according to the international data standard for the surveillance of TBI. Rates based on this standard will differ from rates based on other criteria. The rate is substantially below the State rates reported in Australia in the 1970s and 1980s in three studies (Woodward et al., 1984; Selecki et al., 1981; Hillier et al., 1997), but higher than reported in a fourth study (Tate et al., 1998). This may not reflect a decrease in the incidence of TBI because the studies used differing case selection criteria. One reason that the figures reported by Selecki et al. (1981) and Woodward et al. (1984) are higher, is that no adjustment was made for multiple admissions and a wider set of ICD codes (World Health Organization, 1977) were used (included code 802 which refers to injury to the bones of the face). Hillier et al. (1997) adjusted for multiple admissions and excluded facial injury, however they included code 348 (anoxic brain damage). Tate et al. (1998) excluded readmissions and facial injuries but included codes 310 (specific non-psychotic mental disorders due to organic brain damage), 905.0 (late effect of fracture of skull and face bones) and 907.0 (late effect of intracranial injury without mention of skull fracture). Unlike the other studies, the study by Tate et al. (1998) was based only on the principal diagnosis and not on any of the additional diagnoses, which explains to some extent, the low rate that they reported. As there are State to State differences in the rate of TBI in Australia (Figure 3), the rates reported for individual States in the studies cited above cannot be taken as an indicator of the national rate prevailing at the time.

Table 2: Summary information on TBI, hospital separations; Australia 1997–98 (based on estimated incident cases)

Indicator	Males	Females	Persons
Cases	17,504	7,958	25,464*
Percent of all injury hospital separations, based on estimated incident cases	8.2%	5.4%	7.1%
Crude rate per 100,000 population	189	85	137
Age standardised** rate per 100,000 population	194	87	141

** Two cases had unspecified gender.*

*** Standard population in Australia 1991.*

Table 3: Incidence of TBI, hospital separations. Rates reported in other Australian studies

Location of study	Data Year	Crude rate of TBI per 100,000 of population
New South Wales (Selecki et al., 1981)	1977	392***
South Australia (Woodward et al., 1984)	1980–81	470
South Australia (Hillier et al., 1997)	1987	322
New South Wales (Tate et al., 1998)	1988	100

Trends in TBI

Whilst brain injury was stated to be an important topic in the 'Better Health Outcomes for Australians' report (Commonwealth Department of Human Services and Health, 1984), to date no indicator has been specified. The most recent report on the National Health Priority Areas for Injury Prevention and Control (Commonwealth Department of Health and Family Services, 1998), foreshadowed an indicator for brain injury. A recent report of TBI (O'Connor & Cripps, 1999) recommended adoption of the CDC/WHO case definition, based on hospital separations, as the NHPA indicator. This recommendation will be put to the National Health Priority Action Council in the near future for endorsement, in a report being prepared by the Research Centre for Injury Studies (Harrison & Steenkamp, 2001, Draft).

Statistical information shows that there has been a reduction in the incidence of TBI, using data based on the indicator recommended by O'Connor and Cripps (1999). Based on the age-standardised rate reported by O'Connor and Cripps for 1995–96 (157 per 100,000 population) it can be calculated that there has been an average annual decline of 5% in the TBI rate to 1997–98 (141 per 100,000 population in 1997–98). Over this period, the decline was fairly even across age groups, with the greatest reduction in 20–24 year olds (down 9% per annum). The decline in motor vehicle traffic accidents involving injury to a motor vehicle occupant was 8% per annum, whereas the decline in falls related TBI was only 4% per annum.

Should a NHPA indicator for TBI be set, and depending on the case definition that is chosen, further work should be undertaken to assess trend over time. In particular, trends should be assessed by severity level, defined according to length of stay or some other indicator. The general issue of severity is discussed in the report mentioned above (Harrison & Steenkamp, 2001, Draft) and will be considered by the National Health Priority Action Council in the near future. There is more potential for trends in low severity cases to be affected by hospital admission practises, suggesting that such cases should be excluded from any incidence measure used for trend analysis.

Age and sex distribution

The age distribution of TBI is presented in Figure 1. It was evident that:

- The case number was highest amongst those aged less than 30 years. With increasing age beyond 15-19 years of age, the number of cases declined exponentially. However, there were differences in the patterns based on case numbers and population based rates for the elderly.
- The highest age-specific rate, occurred in the age group 15–19 years. There were also high rates in the very young (0–4 years) and very old (85 years and older). Rates of TBI were lowest in the age group 50–69 years.

There was a statistically significant excess in the male rate compared with the female rate at all age groups except the very oldest (Figure 2 & Table 2). The sex differential was particularly high in the age group 10–24.

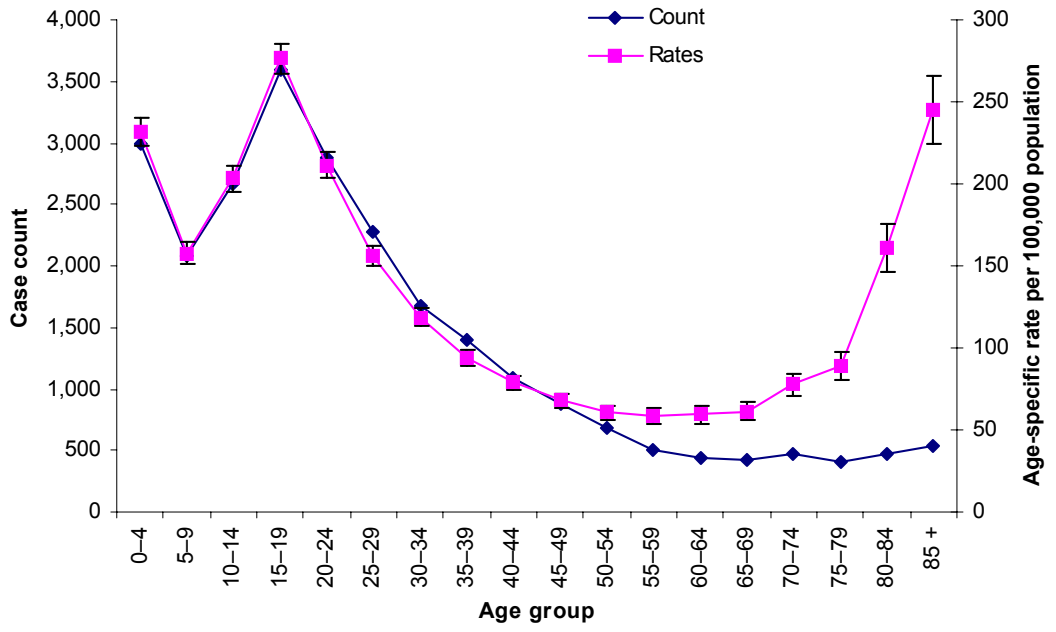


Figure 1: Incidence of TBI by age group (counts and age-specific rates), hospital separations; Australia 1997–98 (based on estimated incident cases)

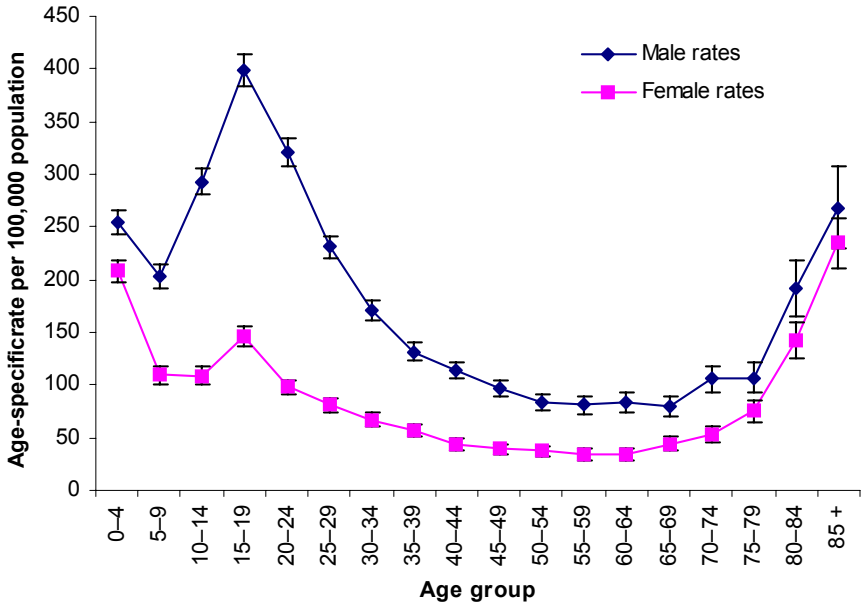


Figure 2: Incidence of TBI by age group and sex (age-specific rates), hospital separations; Australia 1997–98 (based on estimated incident cases)

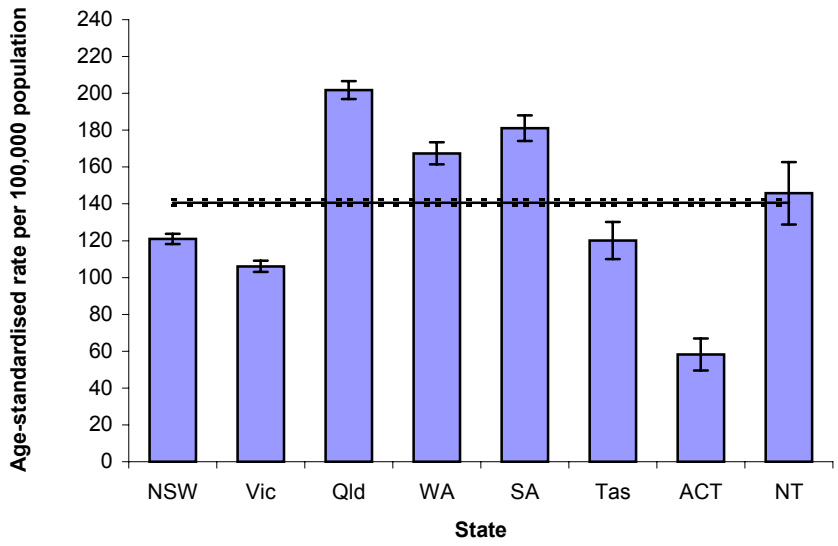
Table 4: Incidence of TBI by age group and sex (counts and age-specific rates per 100,000 population), hospital separations; Australia 1997–98 (based on estimated incident cases)

	Male		Female		Total	
Age group	**Count**	**Rate**	**Count**	**Rate**	**Count**	**Rate**
0–4	1683	254	1305	208	2988	232
5–9	1374	203	705	110	2079	158
10–14	1970	293	698	109	2668	203
15–19	2665	399	930	147	3595	276
20–24	2224	322	654	98	2878	212
25–29	1691	231	589	81	2280	156
30–34	1204	170	477	67	1681	119
35–39	975	132	424	57	1399	94
40–44	790	114	304	44	1094	79
45–49	628	96	253	39	881	68
50–54	476	83	205	37	681	60
55–59	356	81	149	35	505	58
60–64	307	84	127	35	434	59
65–69	267	80	154	44	421	61
70–74	300	106	176	53	476	78
75–79	208	107	197	75	405	89
80–84	209	192	255	143	464	161
85 +	177	268	356	235	533	245
Total	**17,504**	**189**	**7,958**	**85**	**25,462**	**137**

State or Territory of usual residence

Figure 3 shows the age-standardised rate of TBI by State or Territory of usual residence.

- It was evident from the 95% confidence intervals on the rates, based on the Poisson distribution, that some of the States had a statistically significant excess rate when compared to other States and the national rate. In particular, the Queensland rate was significantly higher than any other State. The ACT rate was substantially lower than any other State. These differences may not reflect differential incidence, but could reflect different hospital admission policies. As will be seen later (Figure 9), there were no State rate differences for very severe cases. As there is likely to be less variation from State to State in the admission of serious cases, those cases are more likely to represent an incidence measure.



Note: Error bars indicate 95% confidence intervals for rates.

Figure 3: Incidence of TBI by State (age-standardised rates), hospital separations; Australia 1997–98 (based on estimated incident cases)

Factors associated with the TBI event

In addition to collecting information on the demographic features of cases, the hospital separations data also includes information about factors associated with the injury event such as external cause of injury and type of place of injury.

External cause of injury

The external cause of TBI is presented in Figure 4 by age group. It was evident that:

- The TBI rate due to falls was high in many age groups, especially in the very young (0–4 yrs.) and the elderly (85 years and over).
- The TBI rate of occupants in motor vehicle traffic accidents was highest in 15–24 year olds.
- The TBI rate due to homicide was higher than the rate of occupant TBI in motor vehicle traffic accidents in the age group 20–49 years.

TBI due to falls in the elderly

In the elderly (i.e. those aged 65 years and over), 75% of the TBI's were due to falls. The male rate of TBI due to falls was significantly higher than the female rate in 65–69 year olds and 70–74 year olds, but not in the older age groups (Figure 5).

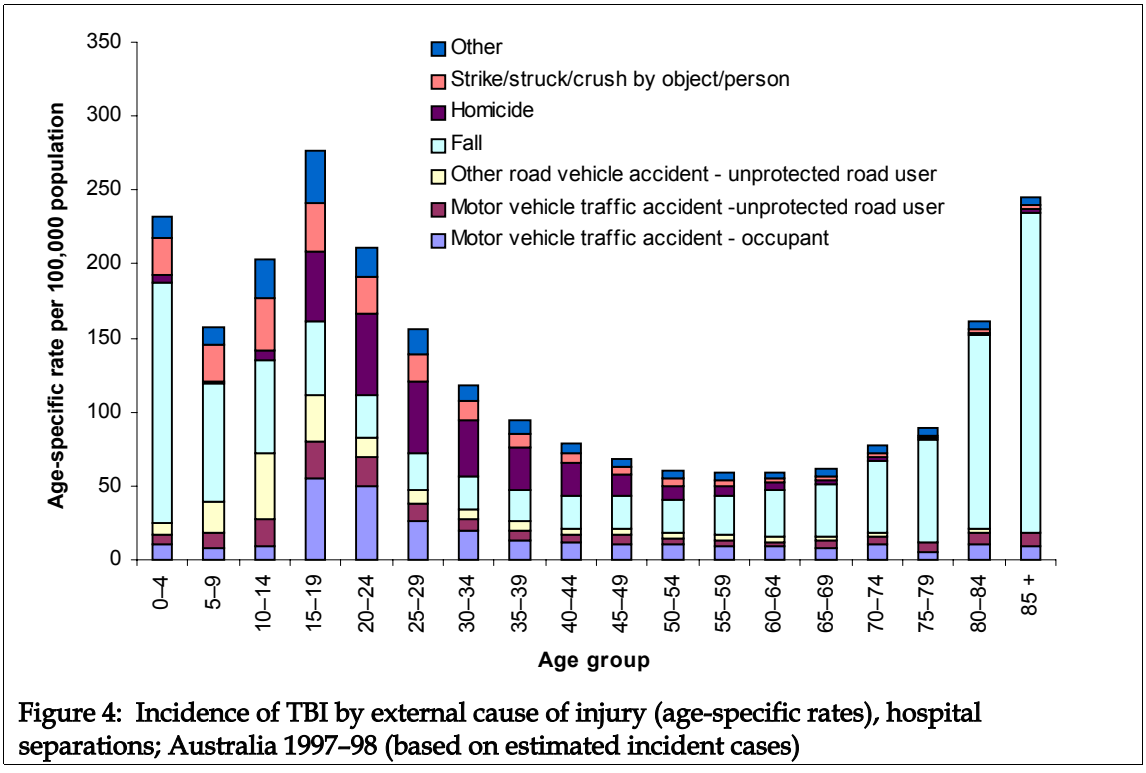


Figure 4: Incidence of TBI by external cause of injury (age-specific rates), hospital separations; Australia 1997–98 (based on estimated incident cases)

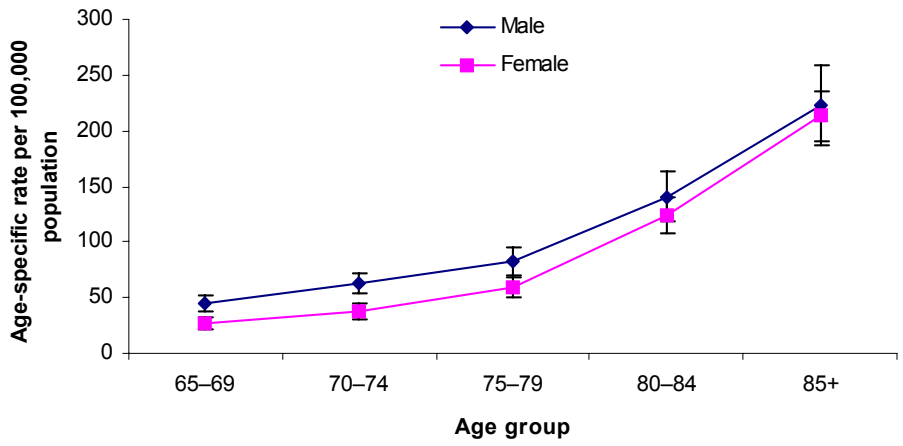


Figure 5: Incidence of TBI due to falls in the elderly by sex (age-specific rates), hospital separations; Australia 1997–98 (based on estimated incident cases)

Table 5: Incidence of TBI by external cause of injury (age-specific rates per 100,000 population), hospital separations; Australia 1997–98 (based on estimated incident cases)

	External cause						
Age group	Motor vehicle traffic accident - occupant	Motor vehicle traffic accident -unprotected road user	Other road vehicle accident - unprotected road user	Fall	Homicide	Strike/struck/ crush by object/person	Other
0–4	10.0	7.1	7.8	162.6	5.3	24.8	14.3
5–9	7.5	10.9	21.5	79.8	1.3	24.5	12.1
10–14	8.8	19.1	44.0	63.3	6.3	35.4	26.7
15–19	54.4	25.1	31.8	50.2	46.4	33.9	34.5
20–24	50.4	18.7	12.9	29.4	55.3	24.4	20.5
25–29	26.5	11.4	10.0	24.0	48.8	18.6	16.9
30–34	19.2	8.8	5.5	22.4	38.7	12.6	11.3
35–39	13.2	7.0	5.6	21.3	29.5	8.6	8.9
40–44	11.3	5.3	4.9	21.6	22.7	6.8	6.2
45–49	11.1	5.8	4.2	22.7	13.8	5.3	5.1
50–54	10.0	4.7	4.0	22.4	9.3	4.3	5.7
55–59	9.2	3.9	3.5	26.2	6.4	3.9	5.2
60–64	9.4	3.0	2.7	32.5	4.9	3.0	3.7
65–69	7.6	5.3	2.6	35.9	2.5	3.1	4.5
70–74	10.3	5.2	2.4	49.3	2.1	3.1	5.2
75–79	5.3	5.9	0.0	69.7	1.5	1.3	5.0
80–84	10.8	7.3	2.8	130.6	2.1	2.1	5.6
85 +	8.7	9.2	0.9	215.9	2.8	2.3	5.1

Place of injury

For 39% of the cases of TBI the place of injury was classified as 'other and unspecified', which provides poor information. Of the remaining cases, the primary places where TBI occurred were the road environment and the home (Figure 6).

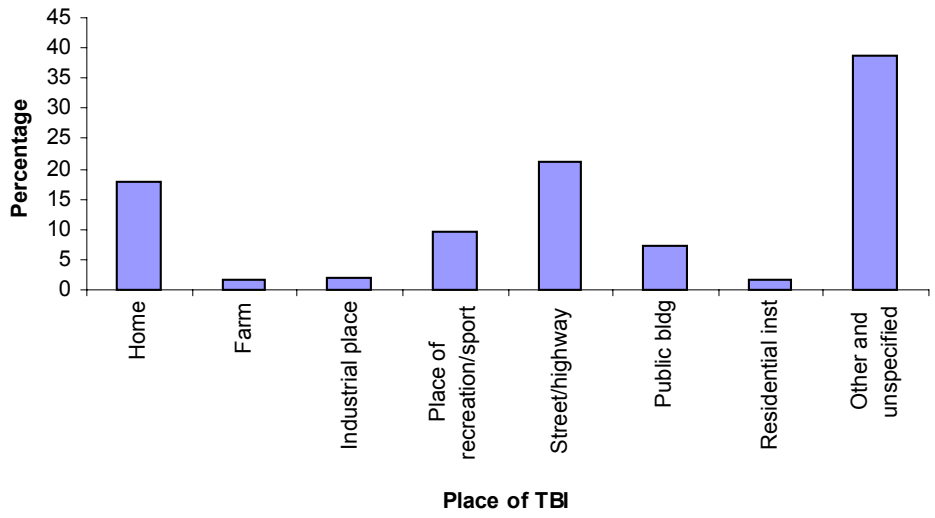


Figure 6: Place of TBI (percentage), hospital separations; Australia 1997–98 (based on estimated incident cases)

High severity cases

There is no direct measure of the severity of brain injury recorded in the hospital separations data. However, cases with prolonged loss of consciousness and possibly those having a long hospital stay could be classed as high severity.

Length of stay in hospital

One measure of the healthcare burden of TBI is the total hospital bed days consumed. However, estimation of this quantity is not straightforward.

The first episode of care of a newly incident case will commence with admission to a hospital. Prior to discharge, the case may be transferred to another hospital. Each hospital only records the number of days that the case spent in their care. To determine the total bed days for an episode of care requires these to be added across hospitals. In addition, as some cases may be readmitted for further episodes of care related to the injury, these must also be added in order to calculate the total burden that arises from the newly incident cases. As there is no case linkage across hospitals in national data, the length of stay cannot be calculated for individual cases. Rather it can only be estimated in aggregate. An estimate of the total burden can be made by

adding the length of stay for all separations having the relevant poisoning E-code, which will include separations of newly incident cases as well as readmissions and transfers.

The total bed days for TBI was 117,988 in 1997–98, arising from 29,443 separations of which 25,464 were estimated incident cases. Sixty-nine percent of TBI separations followed a stay in hospital of no more than one day (Figure 7). Only 11% of separations were for a week or more. The average length of stay for TBI was 4.6 days, based on total bed days for all head injury separations divided by estimated incident cases.

The elderly were more prominent amongst cases having a long length of stay (i.e. at least one week — 26%) than amongst other cases (8%). Amongst the cases having a long length of stay, the rate of TBI due to falls in the elderly was substantial (Figure 8). The elderly falls cases comprised only 16% of the falls cases having a short length of stay (a week or less) but made up 59% of the falls cases having a long length of stay (more than a week).

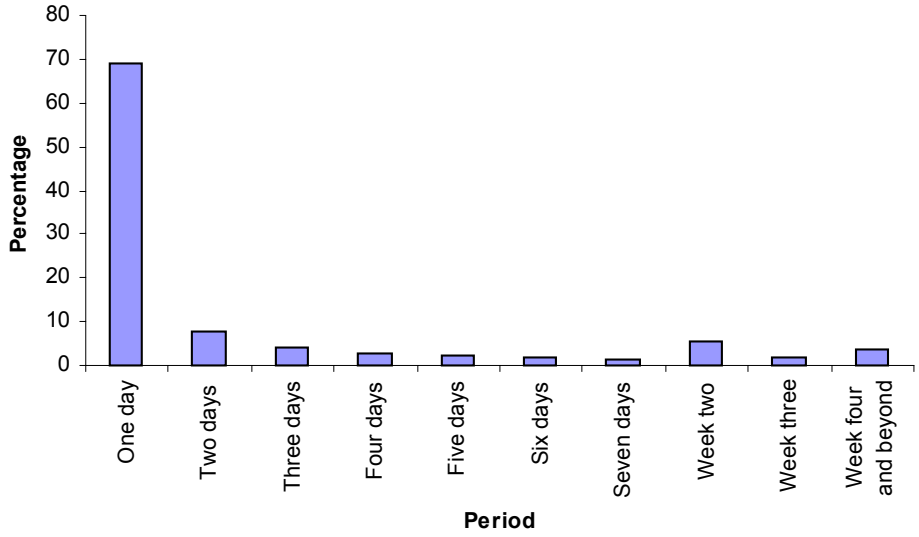


Figure 7: Length of stay in hospital (percentage), hospital separations; Australia 1997–98 (based on all separations, including inter-hospital transfers, readmissions and statistical discharges, n = 29,443 separations)

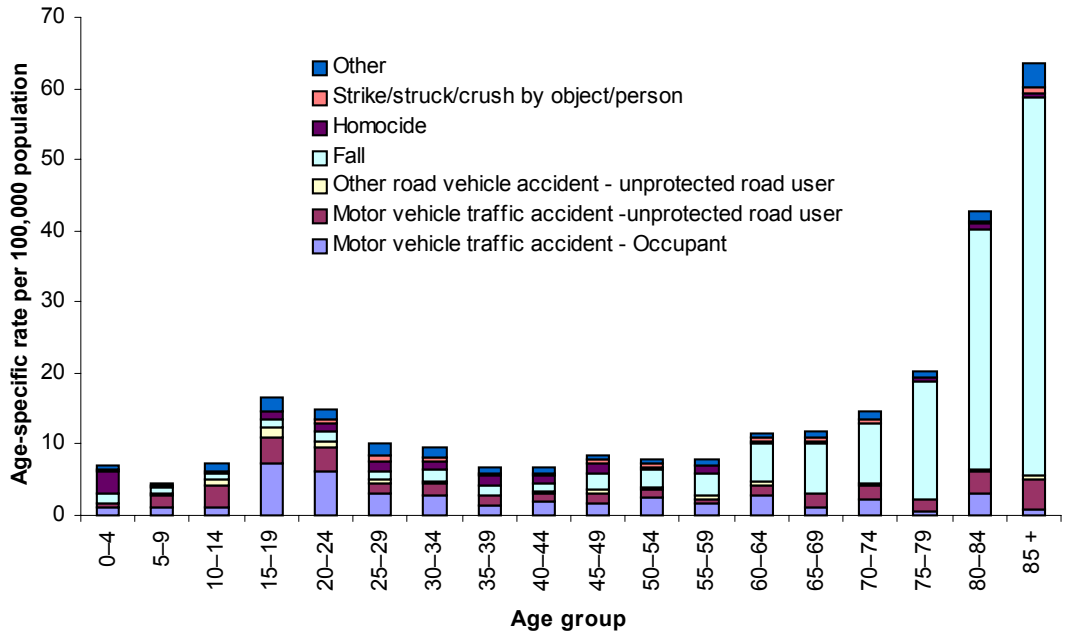
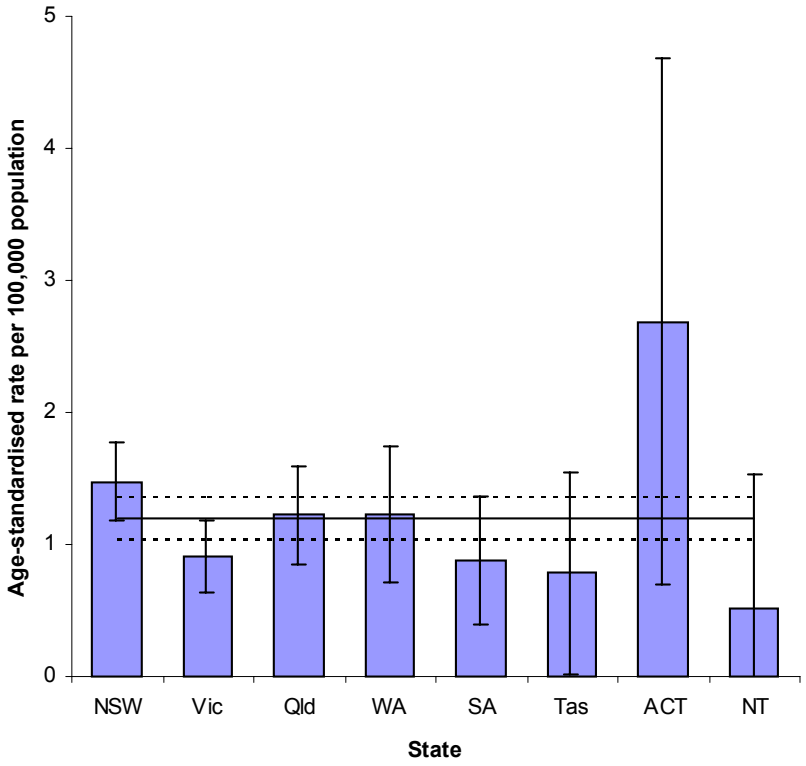


Figure 8: Selected external cause of injury (age-specific rate), hospital separations; Australia 1997–98 (based on estimated incident cases having a length of stay of at least one week)

Cases having prolonged loss of consciousness without return to pre-existing level of consciousness

Two hundred and twenty four cases had brain injuries with prolonged loss of consciousness (based on principal diagnosis), without a return to their pre-existing level of consciousness. There were no State to State differences in the rate of this type of injury (Figure 9). The proportion of cases with this type of injury increased with age (Figure 10). A higher proportion of the unprotected road users had this type of injury when compared to other external cause groups (Figure 11).



Note: Error bars indicate 95% confidence intervals for rates.

Figure 9: Incidence of severe TBI by State (age-standardised rates), hospital separations; Australia 1997–98 (based on estimated incident cases having a principal diagnosis indicating prolonged loss of consciousness without return to pre-existing level of consciousness)

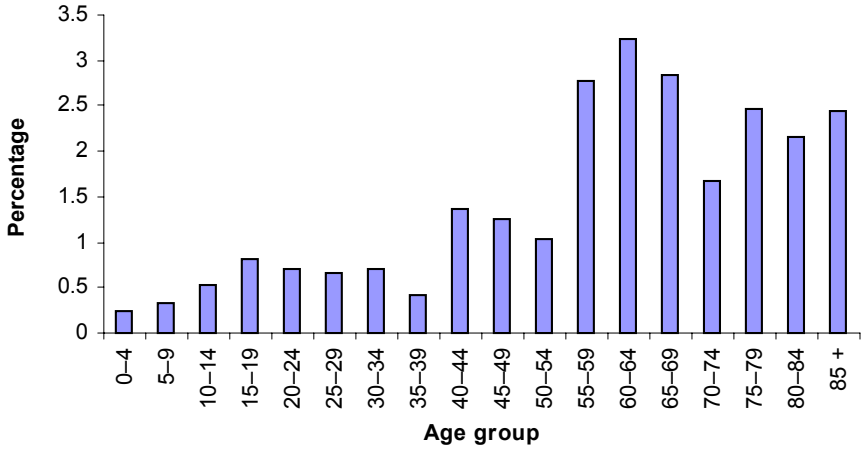


Figure 10: Proportion of cases having prolonged loss of consciousness without return to pre-existing level of consciousness (based on principal diagnosis) by age group, hospital separations; Australia 1997–98 (based on estimated incident cases)

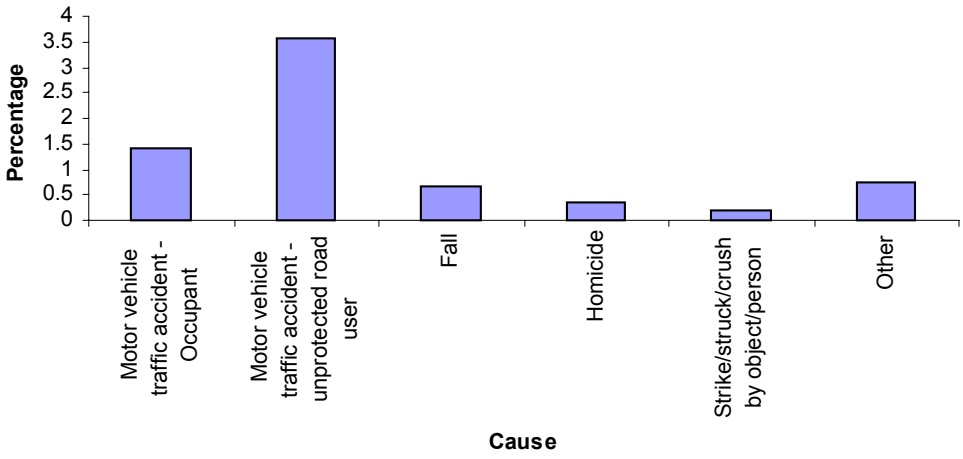


Figure 11: Proportion of cases, in selected external cause groupings, having prolonged loss of consciousness without return to pre-existing level of consciousness (based on principal diagnosis), hospital separations; Australia 1997–98 (based on estimated incident cases)

Summary comments

TBI is a relatively serious and common type of injury. In 1997–98 there were more than 25,000 estimated incident cases of TBI in Australia, based on hospital separations. They comprised 7% of all injury hospital separations in that year. The average length of stay was nearly 5 days, but 11% of cases were admitted for a week or more. The elderly, especially falls cases, were more prominent amongst cases having a long length of stay. Of particular concern are the 224 cases, mainly the elderly and unprotected road users, who had brain injuries with prolonged loss of consciousness that did not return to their pre-existing level of consciousness.

The primary risk group for TBI is young males (15–19 years). In the high risk young age group, motor vehicle traffic accidents are the main cause of TBI. However, falls are the main cause of TBI overall and in many age groups, especially in the very young and the elderly.

While the TBI rate is cause for concern, there may be reason for some optimism. The incidence rate has declined by an average of 5% annually over a recent two-year period. The motor vehicle occupant TBI rate declined by 8% per annum and the falls TBI rate declined by 4% per annum. It needs to be established whether these declines have been in low severity cases, in response to changes in hospital admission practises, or in all severity categories. Further assessment and monitoring will be required. Bi-ennial reporting of trends in TBI have been foreshadowed (Harrison & Steenkamp, 2001, Draft).

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Glossary

Additional diagnoses: A condition or complaint either coexisting with the principal or arising during the episode of care or attendance at a health care facility. Additional diagnoses gives information on factors which result in increased length of stay, more intensive treatment or the use of greater resources.

Age-specific rate: The number of cases of TBI in any age group is divided by the number of people in the population of that age group.

Age-standardised rate: See 'Data Issues' section.

Estimated incident case of TBI: See 'Specification' in 'Data Issues' section.

External cause of injury or poisoning: Environmental event, circumstance or condition as the cause of injury, poisoning and other adverse effects.

Hospital separation: A record is included for each separation, not for each patient, so patients who separate more than once have more than one record in the database. The term 'separation' refers to the episode of care, which can be a total hospital stay (from admission to discharge, transfer or death), or a portion of a hospital stay beginning or ending in a change of type of care (for example, from acute to rehabilitation).

Principal diagnosis: The diagnosis established after study to be chiefly responsible for occasioning the patient's episode of care in hospital.

Traumatic brain injury: Brain injury may result from traumatic (e.g. from a blow to the head due to a motor vehicle crash or fall) or non-traumatic causes (e.g. from stroke, tumour and infection). The term 'Acquired Brain Injury' refers to brain injury, whatever the cause. The term 'Traumatic Brain Injury' refers to those caused by trauma.

Unprotected road user: A motorcyclist, pedal cyclist or pedestrian.

Note: Other terms are defined in the 'Knowledgebase' on the website of the Australian Institute of Health and Welfare (www.aihw.gov.au).

Data issues

Specification of estimated new incident cases

The following case selection rules were applied to the national hospital separations data:

1. Cases must have an ICD-9-CM diagnosis code (World Health Organization, 1988) within the range specified in the Centers for Disease Control and Prevention 'Guidelines for surveillance of central nervous system injury' (Centers for Disease Control and Prevention, 1995):

800.0–801.9	Fracture of the vault or base of the skull,
800.0–801.9	Other and unqualified and multiple fractures of the skull; and
800.0–801.9	Intracranial injury, including concussion, contusion, laceration, and haemorrhage.

2. The principal diagnosis must have been an injury (i.e. an ICD-9-CM Chapter 17 code for 'injury and poisoning').

3. For incidence estimates, cases were excluded which were transferred from one hospital to another and statistical discharges, both of which are considered to be readmissions rather than new incident cases. These cases are not excluded for estimates of bed-days.

Rates

Incidence rates have been calculated as cases per 100,000 of the usually resident population of Australia. ABS population data were used for this purpose. Annual rates were calculated using finalised population estimates for 1997 (December).

All-ages rates have been adjusted to overcome the effects of differences in the proportions of people at different ages (and different injury risks) in the populations that are compared. Direct standardisation was employed, taking the Australian population in 1991 as the standard.

Sampling errors do not apply to these data. However, the time periods used to group the cases (i.e. calendar years) are arbitrary. Use of another period (e.g. July to June) would result in different rates.

Confidence intervals

Where case numbers are small, the effect of chance variation on rates can be large. Confidence intervals (95%, based on a Poisson assumption about the number of cases in a time period) have been placed around rates as a guide to the size of this variation. Chance variation alone would be expected to lead to

a rate outside the interval only once out of 20 occasions. An extreme rate in a single period of enumeration should not be ignored simply because of a wide confidence interval — a time series may show such a rate to be part of a trend.

Further information

Further information about hospital separations data can be obtained from the publication: Australian Institute of Health and Welfare (2000) Australian Hospital Statistics 1997–98. AIHW, Canberra.

INJURY RESEARCH & STATISTICS

This report examines the incidence of traumatic brain injury (TBI) in Australia in 1997–98, based on hospital separation data. It shows that TBI accounted for 7 per cent of all injury hospital separations. It also includes data on the age-standardised rate of TBI and the main causes of TBI among different age groups (the male rate was higher than the female rate in most age groups).

Statistically significant state rate differences were recorded overall, but not among very severe cases. A recent decline in the rate of TBI was also noted but requires further assessment.