Estimating the cost of injury using the Western Australian Data Linkage System and Injury Cost Database

Diana Rosman

Data Linkage Unit, Health Information Centre, Department of Health (WA)

Delia Hendrie

Injury Research Centre, Department of Public Health, The University of WA

Abstract

Injury is a major cause of death and disability in Australia. The overall burden from injury ranks third when measured as years of life lost due to premature mortality and fifth when measured as disability adjusted life years. It has also been estimated that in Western Australia, injuries account for nearly 10% of hospital bed-day costs or about $50 per head of population per year.

The Data Linkage System, comprising linked hospital admission and death records for all of WA since 1970, is unique to Western Australia. This resource allows injury index admissions and all subsequent related admissions to be accumulated across this time period. In addition, an Injury Cost Database has been established in WA from injury compensation claims and other related sources. A severity scoring program developed at Johns Hopkins University (ICDMAP) provides the link between the diagnosis codes recorded in hospital admission records and injury costs components in the Cost Database.

This paper describes a process for using the tools described above to attach cost estimates when available information is limited to unlinked hospital admission records. The resultant total cost estimates are presented for injuries resulting from road crashes and from falls over the three-year period July 1994 to June1997 (with follow-up to June 1999).

Aim

To develop models of total injury cost using linked morbidity and death records, severity scores and injury cost components.

Motivation

Injury is a major cause of death and disability in Australia. The overall burden from injury ranks third when measured as years of life lost due to premature mortality and fifth when measured as disability adjusted life years (Mathers C et al, 2001). It has also been estimated that in Western Australia, injuries account for nearly 10% of hospital bed-day costs or about $50 per head of population per year (Unwin & Codde, 1998).

Data sources

The WA Hospital Morbidity Data System (HMDS) consists of details of all admissions to public or private hospitals in WA since 1970. These records are entered into the data systems within each hospital, summarised at discharge and transmitted to the Department of Health where they undergo rigorous consistency checking before entering into the HMDS.

The Registrar General maintains records of all birth, marriage and death registrations in WA.

The Data Linkage System, comprising linked hospital admission and death records for all of WA since 1970, is unique to Western Australia (Holman et al, 1999). This resource allows the initial or index admission for any diagnosis to be isolated and all subsequent related admissions to be extracted for any given time period. All deaths relating to the set of cases of interest can also be extracted using the links system.

The Injury Cost Database was established in WA from injury compensation claims and other related sources (Hendrie et al, 1999). Component costs including hospital/medical; rehabilitation; economic loss; general damages; legal expenses; long term home care costs are available.

A severity scoring program developed at Johns Hopkins University (ICDMAP) provided the link between the diagnosis codes recorded in hospital admission records and injury costs components in the Cost Database by mapping diagnoses to AIS severity scores (Rosman et al, 1996).

Methods

All injury admission records for the five year period July 1, 1994 to June 30, 1999 were selected from the WA Department of Health's Hospital Morbidity Data System (HMDS). There were 97,082 such injury records with diagnosis codes in the range 800.00 to 999.99 (ICD 9 CM) or external cause of injury codes between E800.0 and E999.9 in the first three years and 29,269 additional injury records in the follow-up period from July 1, 1997 to June 30 1999. Of the 97,082 admission records for injury, 54,768 did not have a previous injury admission record and were selected as the 'index' admission. For that case. There were 4,712 injury admission records for these 54,768 cases that occurred within

2 years of the index admission and had the same external cause of admission as the initial (index) event.

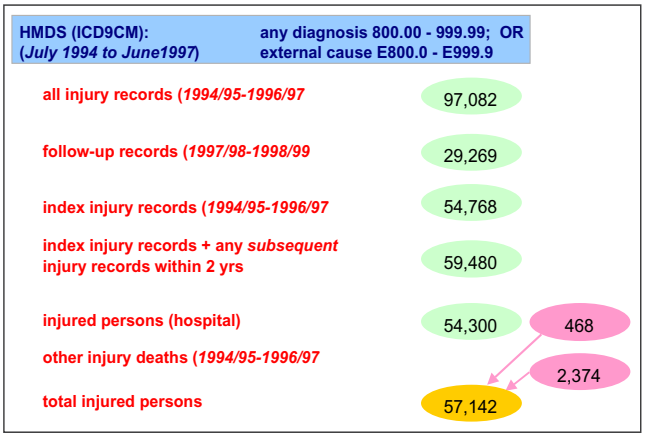

Figure 1 Injury case selection process

Linkage to death records revealed that 468 of the selected 54,768 injury had died during the follow-up period. In addition, 2,374 persons died from injury related causes in the three year selection period without being admitted to hospital. These 57,142 (54,768+2,374) persons formed the set of cases for the estimation of the cost of injury in WA over a three-year period.

The Johns Hopkins ICDMAP mapping tables were used to assign an AIS severity (1 to 5) and body region (1 to 10) to each injury diagnosis for each of the injury admission records. Regardless of the initial assignment, an AIS severity level of six was assigned to all cases with a link to an injury death record. The AIS standard nine body regions (head, spine, neck, face, chest, abdomen, upper extremities, lower extremities, external) was extended for costing work. The lower extremities were subdivided into upper leg (lower extremity (T)) and lower leg (lower extremity (F)) due to the large difference in the costs associated with injuries to upper leg compared with the lower leg.

A suite of person-based costs drawn from the Injury Cost Database was added to each injured person records. Three costs were assigned to each injury case. The first used the AIS severity and body region of the principal diagnosis, the second used the AIS values for the most severe injury recorded in the first six diagnoses on the index record. The third cost was assigned from the most severe injury recorded on any linked hospital admission within two years of the index record or upgraded to 'fatal' if linked to a death record.

Standard linear regression models were built for total (overall) length of stay and cost based on the initial length of stay (or cost) from the index admission.

Results

The length of stay in hospital, the set of injury severity scores based on the diagnosis codes and the costs associated with each injured case were analysed. Simple regression models were built to describe the accumulated length of stay in hospital and the estimated cost (including fatalities) from the information available on the index record alone.

Length of stay

Figure 2 displays the distribution of hospital bed days for both the index admission and the total for all accumulated admissions within 2 years.

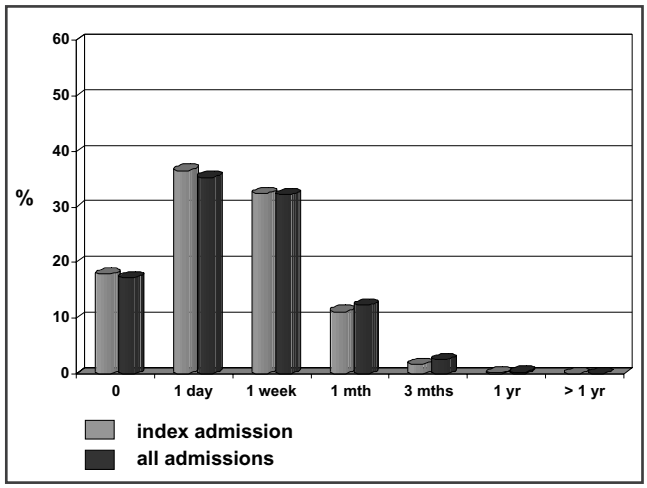

Figure 2 Distribution of inpatient length of stay for injury, WA 1994/95 to 1996/97

The chart shows the expected increase in length of stay when all admissions for individual cases were taken into account (ie, there were fewer cases staying less than one month and more cases staying longer than one month than could be determined from the first admission).

Models of total length of stay, as a function of index length of stay, were developed for road crash, falls and other injuries (Table 1). On average the total length of stay for a road crash casualty was estimated to be 9% longer than the initial length of stay (slope~1.09), while the total length of stay for those injured in a fall was about 15% longer than for the initial admission (slope~=1.15).

	slope (a)	Intercept (b)
road crashes	1.0924	1.2025
falls	1.1557	0.4690
all injuries	1.0993	0.4488

Table 1 Model of total length of stay (days) based on index length of stay

(total los = a*index los + b)

Injury severity

The severity of the injuries sustained by each casualty was assessed from the principal diagnosis, the first six diagnoses on the first admission, and the most severe diagnosis of injury for all admissions during the follow-up period. Both AIS severity and body region were mapped using ICDMAP and the distribution of the three AIS severity levels is shown in Figure 3.

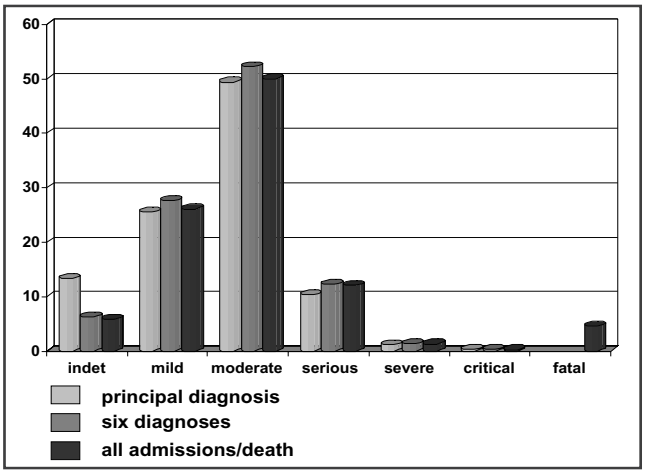

Figure 3 Distribution of injury severity (AIS), WA 1994/95 to 1996/97

For many cases the severity of the injury could not be determined from the principal diagnosis, but was assigned subsequently from the additional diagnoses on the index or subsequent records. Links to death records increased the severity level to 'fatal' for many cases that would otherwise have been assigned to 'moderate', 'serious' and 'severe' categories.

Cost of injury

Table 2 shows the fitted linear regression models for injury cost in road crash, falls and other casualties. On average the cost based on all the admissions for a road crash casualty within two years is estimated to be 20% more than the cost based on the first admission (slope ~=1.20). The overall cost for those injured in a fall is about 15% more than for the initial (index) admission (slope~=1.12).

	slope (a)	intercept (b)
road crashes	1.2020	0.0058
falls	1.1266	-0.0161
all injuries	1.1220	-0.0093

Table 2 Model of total person costs ($100,000) based on index cost
(total cost = a*index cost + b)

Using the person-based costs mapped from the Injury Cost Database, the total cost for the 47,428 persons with principal injury diagnosis severity score matching to costs in the Injury Cost Database was $4,360 million. However, over the three-year period of the study, 57,142 individuals were identified as being injury cases (Figure 1). Consequently, the actual estimated cost of injury in WA was $5,250 million or more than $1000 per head of population per year.

These costs may be overestimated for falls and other injuries as they are based on claims for injuries to (younger) road crash casualties.

Conclusion

This paper has demonstrated the use of a linked system of hospital admission and death records to develop models of length of stay and cost over a two-year follow-up period. These models could be used to estimate overall costs where linked information was not available but the initial or index event could be isolated.

The availability of an injury severity scoring mechanism mapping diagnosis codes (ICD 9CM) to AIS was essential to provide the bridge between diagnosis and costs. A similar mapping mechanism is urgently required for ICD 10 codes so that more recent hospital records can be included in cost estimations.

References

Hendrie D, Mullan N, Ryan GA. "The Development of a Road Injury Cost Database" Road Accident Prevention Research Unit January 1999.

Mathers Colin D, Vos E. Theo, Stevenson Christopher, Begg Stephen J. "The burden of disease and injury in Australia" Bulletin of the World Health Organisation, 2001, 79(1) 1076 – 1084.

Rosman DL, Knuiman MW & Ryan GA. "An evaluation of road crash injury severity measures" Accident Analysis and Prevention 1996,28(2): 163–170.

Unwin E, Codde J. "Estimating the cost of hospital treatment for injuries using linked hospital morbidity data" Aust NZ J Public Health 1998, Aug; 22.