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Ten-year health service use outcomes in a population-based cohort of 21 000 injured adults: the Manitoba Injury Outcome Study

CM Cameron,[a] DM Purdie,[b] EV Kliewer,[c] & RJ McClure[a]

Objective To quantify long-term health service use (HSU) following non-fatal injury in adults.

Methods A retrospective, population-based, matched cohort study identified an inception cohort (1988–91) of injured people who had been hospitalized (ICD-9-CM 800-995) aged 18–64 years (*n* = 21 032) and a matched non-injured comparison group (*n* = 21 032) from linked administrative data from Manitoba, Canada. HSU data (on hospitalizations, cumulative length of stay, physician claims and placements in extended care services) were obtained for the 12 months before and 10 years after the injury. Negative binomial and Poisson regressions were used to quantify associations between injury and long-term HSU.

Findings Statistically significant differences in the rates of HSU existed between the injured and non-injured cohorts for the pre-injury year and every year of the follow-up period. After controlling for pre-injury HSU, the attributable risk percentage indicated that 38.7% of all post-injury hospitalizations (*n* = 25 183), 68.9% of all years spent in hospital (*n* = 1031), 21.9% of physician claims (*n* = 269 318) and 77.1% of the care home placements (*n* = 189) in the injured cohort could be attributed to being injured.

Conclusion Many people who survive the initial period following injury, face long periods of inpatient care (and frequent readmissions), high levels of contact with physicians and an increased risk of premature placement in institutional care. Population estimates of the burden of injury could be refined by including long-term non-fatal health consequences and controlling for the effect of pre-injury comorbidity.

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Voir page 808 le résumé en français. En la página 809 figura un resumen en español.

يمكن الاطلاع على الملخص بالعربية في صفحة 809.

Introduction

Burden of disease estimates are increasingly being used to support health-policy decisions relating to clinical, preventive and health services activity.[1,2] With advances in medical technology and an increasing number of people surviving serious injury, studies of the burden and cost of injury need to include long-term morbidity indicators.[3] Current estimates of the burden of non-fatal injury have largely been derived from the opinions of expert panels.[4,5] It has been shown, however, that panel predictions of the outcomes of injury in populations are unreliable.[6] We did a systematic review and noted that there have been few population-based studies of long-term outcome of non-fatal injury from which accurate empirical estimates of the burden of injury could be derived.[7] In part, this is because large population-based samples of people with all injury types are logistically complex and costly to recruit and follow up over long periods. In addition, the nature of morbidity and disability outcomes from injury are poorly conceptualized and difficult to measure.[8,9] Greater efforts to obtain accurate empirical information on population outcomes from injury are vital.

Counts and rates of hospitalizations, length of stay (LOS) in hospital, emergency department visits, admissions to rehabilitation programmes and physician services are considered to be valid measures of disease outcomes.[10–12] While limitations to the usefulness of administrative data exist,[13,14] and caution must be applied in the interpretation of findings, these data are still of considerable value.[10,13] One advantage is that they are available from existing systems making them relatively inexpensive. Patterns of service use (e.g. hospitalization rates and LOS) have a face validity, with service patterns which, at least to some extent, reflect patient care needs.[14–16] Administrative health data can also provide sound information on the presence of comorbid conditions.[17]

The aim of this study was to quantify health service use (HSU) for 10 years post-injury, controlling for demographic factors and pre-existing comorbidities. Furthermore, we examined the differential risk of HSU on the basis of severity and type of injury.

Materials and methods

Study design

The Manitoba Injury Outcome Study is a population-based retrospective matched cohort study with a follow-up period of 10 years, which uses linked administrative health data from Manitoba, Canada. The study was approved by the University of Manitoba Research Ethics Board, Manitoba Health's Health Information Privacy Committee and the University of Queensland Ethics Committee.

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Setting and data sources

Canada is a high-income country where the provision of health care is based on a system of universal health insurance known as Medicare. This entitles all eligible residents to access publicly provided or insured health services, such as hospital, physician and extended-care services. As there are no fees, non-participation in the health-care plan is rare. We have analysed population-based data on the 1.14 million residents of Manitoba.[18,19]

A population registry of those eligible for health-care cover and databases of claims made by health providers for reimbursement of services (hospital, physician and extended-care) are managed by the provincial health department and data can be linked using unique identification numbers.[18,20] The population registry contains demographic information and biannual snapshots of a person's health coverage status in the province, as well as reasons for any cancellation of cover, such as leaving the province or death. The databases have been used extensively in health services research and are described in detail elsewhere.[21]

Participants

All persons aged 18–64 years, resident in the province of Manitoba, who were hospitalized with an injury between 1 January 1988 and 31 December 1991 were identified (n = 21 032). The cohort included all individuals who had an *International statistical classification of diseases*, ninth revision, clinical modification (ICD-9-CM) injury code 800-995 (excluding late effects from injury 905-909, and allergies from within 995), in the first or second diagnostic fields of their hospital record. During the inception period, the first injury-related hospital admission was designated as the index case record.

A comparison cohort of people not hospitalized for an injury during the same period was randomly selected from the total remaining study population, identified from the Manitoba population registry. A non-injured person was matched on aboriginal status, age, gender and geographical location of residence (partial postcode) at the date of admission of the injured case. Excluded from both cohorts were residents of care homes, patients in extended hospital care and persons not resident in the province for 12 months before the admission date on the index record.

Table 1. **Baseline demographic characteristics, measures of pre-existing health status and health service use for 12 months before the injury event for injured and matched comparison cohorts**

	Injured (n = 21 032)		Comparison (n = 21 032)		Significance[a]
Demographics at the time of the injury event	n	%	n	%	
Sex					
Males	13 441	63.9	13 441	63.9	P = 1.0
Females	7591	36.1	7591	36.1	
Age in years[b]					
18–24	5410	25.7	5422	25.7	
25–34	6014	28.6	5990	28.6	
35–44	3959	18.8	3972	18.8	P = 0.99
45–54	2805	13.3	2799	13.3	
55–64	2844	13.5	2849	13.5	
Place of residence[b]					
Urban	8687	41.3	8799	41.9	
Rural	8167	38.8	8208	39.0	P = 0.21
Remote	4178	19.9	4025	19.1	
Health status and service use in the 12 months before date of injury event					
Charlson comorbidity index (score ≥ 1)	1235	5.9	254	1.2	P< 0.001
No. of persons with a mental health condition[c]	1498	7.1	423	2.0	P< 0.001
No. of persons with a musculoskeletal condition[c]	1236	5.9	580	2.8	P< 0.001
No. of persons with a prior injury/ poisoning[c]	1978	9.4	530	2.5	P< 0.001
Mean number of physician claims[d]	3.9	(0–295)[e]	2.2	(0–127)	P< 0.001
Mean number of hospitalizations[d]	0.12	(0–19)	0.09	(0–12)	P< 0.001
Cumulative length of stay in days	0.36	(0–248)	0.18	(0–258)	P< 0.001

[a] Determined by Mann–Whitney U test or χ^2 test.
[b] Age-matched on year of birth and place of residence on partial postcode; thus there are small differences in actual numbers of injured and non-injured.
[c] Presence of moderate–severe condition defined by four or more physician claims or at least one hospitalization for that condition in the 12 months prior to the injury date.
[d] Geometric mean calculated due to non-normal distributions.
[e] Figures in parentheses are the range.

Pre-injury use of health services and comorbidity measures

Pre-existing health conditions at the time of the index injury were quantified as a potential confounder when investigating injury as a risk factor for subsequent health service use. Pre-existing health conditions were determined from HSU records during the 12-month period prior to the index injury for both the injured and comparison cohorts.[22] Group differences were identified by classifying primary diagnoses under the 18 disease chapters of ICD-9-CM and combining the frequency of use of hospital and ambulatory physician services for each of these conditions. Two levels of severity of comorbidity were then defined. A "mild condition" was one which involved one to three physician claims and no hospital discharges; a "moderate–severe condition" was defined as four or more physician claims or at least one hospitalization for that condition. Individuals were coded as not having a condition if they had no contact with the health services. The Dartmouth–Manitoba version of the Charlson comorbidity index[23] was also used to quantify pre-existing comorbidity for the two cohorts.

Injury classification

The cohort of injured people was analysed by the nature of injury codes (ICD-9-CM 800–995), and subgroup comparisons were made with the matched comparison group. Seven subgroups were created across ICD subchapter

Table 2. **Measures of pre-existing health status and health service use for 12 months before the injury event for injured and matched comparison cohorts by injury type**

Injury subgroups	Charlson comorbidity index[a]		Physician claims		Hospitalizations		Cumulative length of stay in days	
	n (%)		Mean[b] (range)		Mean[b] (range)		Mean[b] (range)	
	Injured	Comparison	Injured	Comparison	Injured	Comparison	Injured	Comparison
Brain injury (*n* = 1290)	71 (5.50)	15 (1.16)	3.46 (0–161)	2.28 (0–118)	0.13 (0–6)	0.09 (0–6)	0.28 (0–103)	0.18 (0–55)
Spinal injury (*n* = 95)	2 (2.11)	1 (1.05)	3.28 (0–31)	2.52 (0–26)	0.14 (0–2)	0.17 (0–4)	0.25 (0–19)	0.35 (0–36)
Burns (*n* = 524)	33 (6.30)	6 (1.15)	3.56 (0–173)	1.86 (0–46)	0.17 (0–7)	0.07 (0–10)	0.36 (0–248)	0.12 (0–39)
Long bone fractures (*n* = 2515)	206 (8.19)	42 (1.67)	3.40 (0–73)	2.42 (0–127)	0.13 (0–8)	0.10 (0–7)	0.28 (0–194)	0.19 (0–258)
Poisonings (*n* = 2169)	202 (9.31)	29 (1.34)	7.93 (0–295)	2.75 (0–56)	0.40 (0–13)	0.14 (0–8)	1.09 (0–188)	0.28 (0–108)
Internal Injuries (*n* = 593)	26 (4.38)	7 (1.18)	3.20 (0–93)	2.05 (0–48)	0.11 (0–3)	0.10 (0–4)	0.21 (0–69)	0.19 (0–110)
Other (*n* = 13 846)	695 (5.02)	154 (1.11)	3.64 (0–170)	2.16 (0–115)	0.15 (0–19)	0.09 (0–12)	0.29 (0–199)	0.17 (0–235)

[a] Score ⩾1.
[b] Geometric mean calculated due to non-normal distributions.

headings (brain injury, spinal injury, burns, long-bone fractures, poisonings, internal injuries and other). Injury severity scores (ISS) were generated by ICDMAP-90 software (Johns Hopkins University, Baltimore, MD, USA). An ISS of ⩾16 was considered to be a major injury, an ISS of 9–15 a moderate injury, and a mild injury was defined as an ISS of 1–8.[24,25] Not all cases of injury were scored according to their severity as ICDMAP-90 maps only some of the ICD-9-CM codes for Injury and Poisonings.

Outcome measures

Hospital discharge data provided two outcome measures: the total number of hospitalizations and cumulative LOS for the 10 years post-injury. Although hospitalization for the index injury was not included in the number of hospitalizations, the resulting number of days' stay in hospital was included in the LOS following the injury event. The number of claims by ambulatory physicians for the 10 years post-injury provided the third HSU measure. The fourth outcome measure was the time from the index injury until the first admission to a care home during the 10-year follow-up period.

Calculation of person–years at risk

Using the information from the population registry, we calculated the total time a person was in the province, alive and eligible for health coverage for the 10 years following the date of the index injury.

Analysis

Analysis was done using SAS version 8.2 and STATA version 8. The statistical significance of differences between groups for rates of HSU and presence of comorbid conditions was assessed by χ^2 test statistics for categorical data and with the Mann–Whitney U test for continuous data because of non-normal distributions. All tests were two-sided with a 5% level of significance.

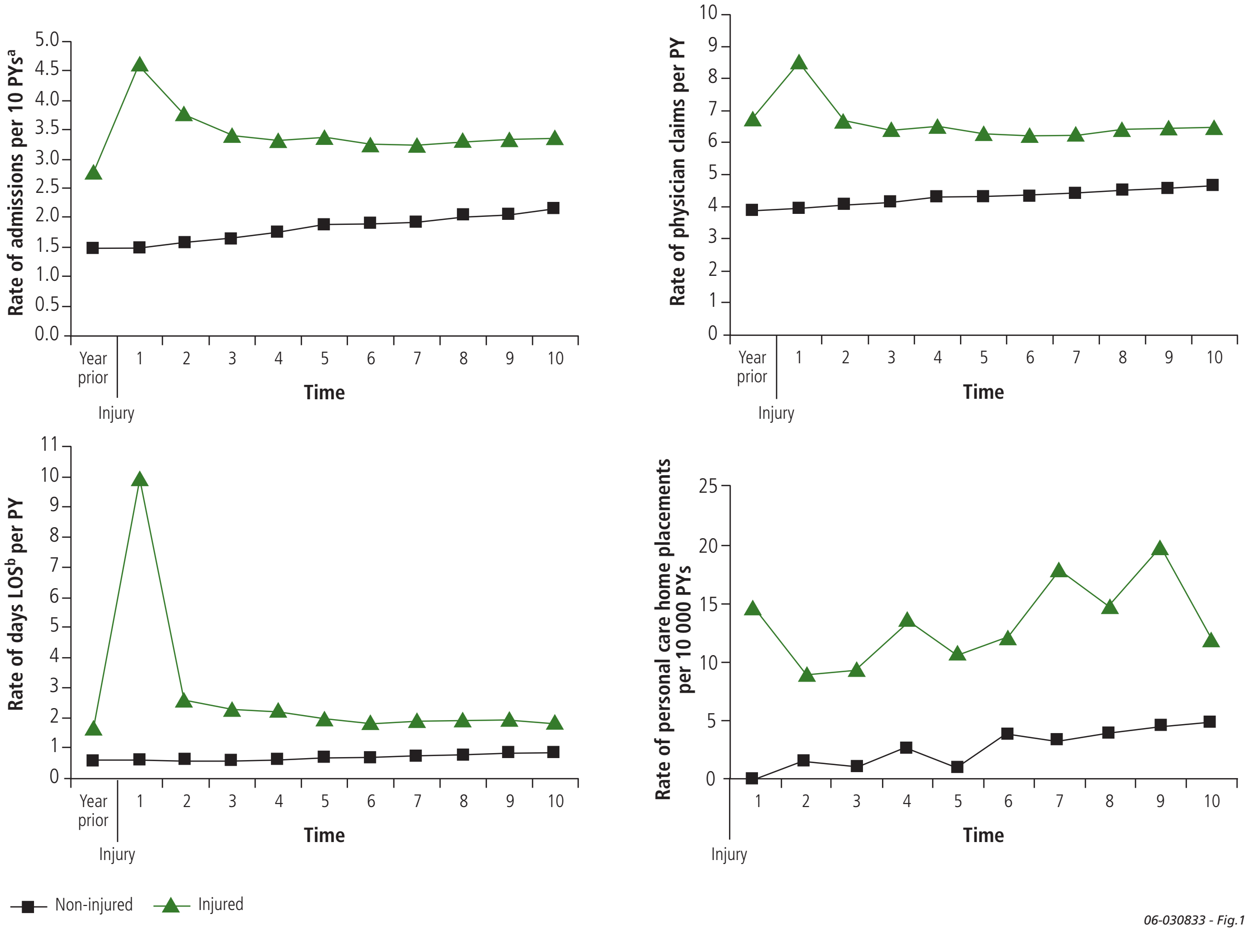
Consistent with a matched cohort study design, negative binomial regression was used to estimate crude and adjusted rate ratios (RRs) between exposure (injury) and outcome (HSU) for hospital discharges and the number of claims made by physicians.[26,27] Examining the frequency distribution and the goodness of fit revealed that the negative binomial regression model was a better fit for the hospital and physician claims data. The post-injury LOS data showed a better fit with the model estimated using over-dispersed Poisson regression.

Those factors shown to be associated with both the exposure and the outcomes in univariate analysis were included in the model as potential confounders. Co-linearity existed between the numbers of hospitalizations, cumulative LOS and number of hospital-defined comorbidities; and also the number of physician claims and the number of physician-defined comorbidities. On the basis of clinical relevance, only cumulative LOS and the number of physician claims were included in the multivariate analyses. Matching variables were included in the model, because it has been shown that where cohort members have different lengths of follow-up, confounding by matching variables may occur over time.[28] The final model included age, gender, place of residence, Charlson comorbidity index, pre-injury cumulative hospital LOS, pre-injury physician claims, generated scores for pre-injury mental health, musculoskeletal conditions and previous injuries.

Survival analysis was conducted using the Kaplan–Meier method and Cox proportional hazards model to analyse the time from the injury event until the first admission to a care home. Hazard ratios estimated from the Cox regression were used as measures of rate ratios. A group-by-time interaction term was added to test the proportional hazards assumption for the injured versus non-injured cohorts.[29] Evidence of non-proportionality was demonstrated ($P<0.001$), thus rate ratios were calculated for each year following the injury, in addition to a pooled estimate for the total 10 years. Owing to the small number of events within single years, only crude year-by-year analyses were conducted.

Attributable risk percentages (AR%) were calculated as the adjusted rate ratio minus one, divided by the adjusted rate ratio, multiplied by 100.[28] The AR% was used to estimate the proportion

Fig. 1. **Rates of health service use for injured and non-injured comparison cohorts, for 12 months before the injury and 10 years post-injury**



[a] PYs = Person-year(s). [b] LOS = Length of stay.

of long-term HSU where injury was a component cause.

Results

Characteristics of the cohort

There was an overrepresentation of males (63.9%) and younger people aged 18–34 years (54.3%) among the 21 032 injured people (Table 1). Four categories of external causes accounted for 80.3% (n = 16 797) of all the injuries: "other" accidents, 28.5%; accidental falls, 22.9%; transport-related accidents, 18.0%; and attempted homicide or injury inflicted by others, 10.9%.

In the 12 months before the injury, members of the injured cohort had higher Charlson comorbidity index scores, more hospitalizations, increased LOS in hospital and a greater number of physician claims than the comparison group (all variables significant; P<0.001) (Table 1). Across all injury types, the poisonings group consistently demonstrated the highest rates of HSU prior to the index injury (Table 2). In both absolute and relative terms, injured people were more likely to have been admitted to hospital or to have seen a physician many times for a mental health condition, musculoskeletal condition or a previous injury in the 12-month period (all variables significant; P<0.001) (Table 1). Further details of these results have been published elsewhere.[22]

Ten-year follow-up

Over the 10-year follow-up period, fewer members of the injured cohort left the province or were unable to be located (10.9%) than members of the comparison cohort (14.2%). Of the injured cohort members, 8.0% died (n = 1677) compared with 3.6% of the comparison cohort members (n = 754).

Health service use

The members of the injured cohort had higher rates of HSU in every year of the post-injury study period than members of the non-injured cohort, for each of the outcome measures (Fig. 1). Over this time, the non-injured cohort demonstrated a consistent pattern of increasing rates of HSU. The distribution of rates of placement in care homes was less consistent, probably because the overall numbers of placements in care homes were small in both cohorts.

After adjusting for demographic characteristics and pre-existing health status, the injured cohort had 1.63 times the number of all-cause post-injury hospital discharges (95% confidence interval (CI), 1.59–1.68), 3.22 times the number of days' post-injury in hospital for all causes (95% CI, 2.96–3.50), 1.28 times the post-injury physician claims rate (95% CI, 1.26–1.30) and 4.37 times the rate of placements in care homes than the comparison cohort (95% CI, 3.18–6.02). The adjusted AR% suggested that 38.7% of all post-injury hospital discharges (n = 25 183), 68.9%

Table 3. **Ten-year post-injury hospital discharges, rates per 10 person-years (PYs) for injured and non-injured comparison cohorts, by injury subgroups and injury severity**

Injury subgroups and severity level	Injured (*n* = 21 032)[a]		Comparison (*n* = 21 032)		Un-adjusted rate ratio	95% Confidence interval	Adjusted rate ratio[b]	95% Confidence interval	Adjusted attrib. risk %[b]
	Hosp.	Per 10 PYs	Hosp.	Per 10 PYs					
Injury subgroup									
Brain injury (*n* = 1290)	3505	3.29	2181	1.92	1.77	1.58–1.98	1.54	1.39–1.71	35.1
Spinal injury (*n* = 95)	284	3.45	211	2.47	1.37	0.93–2.03	1.51	1.03–2.20	33.8
Burns (*n* = 524)	1382	3.00	717	1.61	1.95	1.62–2.34	1.36	1.14–1.63	26.5
Long-bone fractures (*n* = 2515)	7162	3.23	4251	1.92	1.76	1.64–1.90	1.64	1.53–1.77	39.0
Poisonings (*n* = 2169)	11 384	6.12	4702	2.43	2.67	2.48–2.88	1.89	1.75–2.05	47.1
Internal Injuries (*n* = 593)	1377	2.68	833	1.63	1.72	1.46–2.03	1.76	1.51–2.05	43.2
Other (*n* = 13 846)	39 978	3.24	20 984	1.72	1.92	1.86–1.99	1.62	1.57–1.68	38.3
Injury severity score (ISS)									
Minor (ISS 1–8) (*n* = 14 599)	39 782	3.04	22 211	1.73	1.79	1.73–1.85	1.54	1.50–1.59	35.1
Moderate (ISS 9–15) (*n* = 1 746)	5082	3.37	2666	1.74	2.06	1.88–2.26	1.87	1.72–2.04	46.5
Severe (ISS ⩾ 16) (*n* = 657)	1474	2.98	997	1.71	1.90	1.61–2.24	1.86	1.59–2.18	46.2
No ISS computed[c] (*n* = 4 030)	18 734	5.41	8005	2.24	2.52	2.37–2.67	1.86	1.76–1.97	46.2

[a] Excludes hospitalization for original index injury.
[b] Adjusted for age, gender, place of residence and comorbidities in 12 months prior to injury date (including Charlson comorbidity index, cumulative LOS, number of physician claims, pre-existing psychiatric condition, pre-existing musculoskeletal condition and previous injuries).
[c] ISS scores not computed for ICD-9-CM codes 930–939 foreign bodies; 958 complications; 960–979 poisonings; 980–989 toxic substances; 990–995 other.

of all years spent in hospital (*n* = 1031), 21.9% of physician claims (*n* = 269 318) and 77.1% of placements in care homes (*n* = 189) in the injured cohort could be attributed to being injured.

For each measure, the greatest difference in HSU between the injured and comparison cohorts occurred in the first year following the injury (Fig. 1). After adjusting for potential confounders, in each subsequent year following the injury, the injured cohort continued to have significantly greater HSU than the comparison cohort for all outcome measures.

Health service use by injury type

Of the seven injury subgroups, members of the poisoning subgroup had the highest rate of all-cause post-injury hospitalizations (6.12/10 person-years), followed by spinal injury (3.45/10 person-years) and brain injury (3.29/10 person-years) (Table 3). After adjusting for demographic characteristics and pre-injury health status, the rate ratios for all-cause post-injury hospitalizations for each injury type ranged from 1.36 to 1.89.

Spinal injury led to the highest rate (12.07/person-year) and the highest adjusted rate ratio of all-cause days LOS in hospital post-injury (RR = 12.31; 95% CI, 2.73–55.62) (Table 4). Of all the measures of HSU, the highest proportion of observed outcome attributable to the injury event, was the post-injury LOS in hospital, for which the AR% was between 62.5% and 91.9% across all injury subgroups.

While the poisonings group had the highest number of post-injury physician claims (11.48/person-year), those with a brain injury had the greatest adjusted rate ratio (RR = 1.44; 95% CI, 1.35–1.53) (Table 5). Those injured with a fracture of a long bone had the highest rate of admissions to a care home (28.67/10 000 person-years) and accounted for almost 26% of all such placements in the injured cohort (results not shown).

Health service use by severity of injury

Hospital discharge rates were similar for each of the three levels of severity of injury, measured by the ISS (Table 3). In contrast, LOS and rate ratios increased with the severity of the injury (Table 4). Those with minor injury had days' LOS of 2.08/person-year (RR = 2.53; 95% CI, 2.34–2.74) compared to 5.07/person-year in those with moderate injuries (RR = 5.52; 95% CI, 4.37–6.99) and 10.49/ person-year in those with an ISS score of ⩾16 (RR = 11.54; 95% CI, 6.34–21.02). Whereas, cohort members with minor injuries accounted for almost 50% of total time in hospital, those who were moderately injured accounted for 14% and those with severe injuries 9.5% of total post-injury LOS.

Rates of all-cause post-injury physician claims increased with increasing severity of the injury, as did the adjusted rate ratios (Table 5). However, fewer of the post-injury physician claims were found to be attributed to the original index injury (between 20.0% and 36.7%). Rates of admission to care homes and rate ratios increased as the severity of the injury increased (results not shown).

Discussion

This study quantifies the population-based, long-term HSU attributable to injury, after controlling for demographic factors and pre-existing comorbidities. Injured cohort members had 1.63 times the rate of hospitalizations, 1.28 times the number of physician claims, 3.22 times the LOS in hospital and a 4.37 times greater likelihood of placement in care homes in the 10 years after the injury than the comparison group. The AR% indicated that 38.7% of all post-injury hospitalizations, 68.9% of all years spent in hospital, 21.9% of physician claims and 77.1% of the placements

Table 4. **Ten-year post-injury hospital length of stay (LOS), rates of days per person-year (PY) for injured and non-injured comparison cohorts, by injury subgroups and injury severity**

Injury subgroups and severity level	Injured (*n* = 21 032)[a]		Comparison (*n* = 21 032)		Un-adjusted rate ratio	95% Confidence interval	Adjusted rate ratio[b]	95% Confidence interval	Adjusted attrib. risk %[b]
	Years LOS	Days/PY	Years LOS	Days/PY					
Injury subgroup									
Brain injury (*n* = 1290)	130.6	4.48	24.3	0.79	5.71	3.29–9.93	5.14	3.29–8.02	80.5
Spinal injury (*n* = 95)	27.2	12.07	2.2	0.96	12.56	4.22–37.42	12.31	2.73–55.62	91.9
Burns (*n* = 524)	47.1	3.74	7.4	0.60	6.19	3.38–11.33	4.57	2.91–7.18	78.1
Long-bone fractures (*n* = 2515)	250.2	4.12	55.2	0.91	4.52	3.54–5.77	4.10	3.41–4.91	75.6
Poisonings (*n* = 2169)	247.7	4.86	44.6	0.84	5.77	4.55–7.33	3.32	2.66–4.13	69.9
Internal Injuries (*n* = 593)	36.7	2.61	11.0	0.79	3.33	2.00–5.55	2.96	1.99–4.41	66.2
Other (*n* = 13 846)	756.8	2.24	233.3	0.70	3.21	2.89–3.56	2.67	2.44–2.91	62.5
Injury severity score (ISS)									
Minor (ISS 1–8) (*n* = 14 599)	743.4	2.08	245.7	0.70	2.97	2.70–3.26	2.53	2.34–2.74	60.5
Moderate (ISS 9–15) (*n* = 1746)	209.2	5.07	33.3	0.79	6.39	4.70–8.68	5.52	4.37–6.99	81.9
Severe (ISS ⩾ 16) (*n* = 657)	141.9	10.49	13.8	0.87	12.12	5.91–24.85	11.54	6.34–21.02	91.3
No ISS Computed[c] (*n* = 4030)	401.8	4.24	85.1	0.87	4.87	4.01–5.91	3.19	2.70–3.78	68.7

[a] Includes hospital LOS for original index injury.
[b] Adjusted for age, gender, place of residence and comorbidities in 12 months prior to injury date (including Charlson comorbidity index, cumulative LOS, number of physician claims, pre-existing psychiatric condition, pre-existing musculoskeletal condition and previous injuries).
[c] ISS scores not computed for ICD-9-CM codes 930–939 foreign bodies; 958 complications; 960–979 poisonings; 980–989 toxic substances; 990–995 other.

in care homes in the injured cohort could be attributed to being injured. Injury type and injury severity were found to have a significant effect on long-term HSU outcomes. This information can be used to derive estimates of the burden of non-fatal injury in the population.

These findings are consistent with the results of the few studies reported in the literature which have used similar methods and a non-injured comparison group.[30–34] Rate ratios of hospitalizations post-injury comparing injured and non-injured populations ranged from 2.0 to 2.6.[30-34] These studies confirmed the observation that, although rates of HSU for the injured people peaked in the first year following injury, their HSU rates consistently remained higher than the rates of the non-injured for many years' post-injury.[30,31,34]

Study limitations and strengths

In this paper we reported HSU for all causes of physician claims, hospitalizations and placements in nursing homes. This information was summarized into counts of physician claims, counts of hospitalizations, LOS in hospital and time elapsed until placement in a nursing home. While this summary process resulted in a loss of detail about the specific reasons underlying each of the HSU presentations, such detail was not required in addressing the research question and hence would not have affected the overall results of the study.

The analytical strategy for this study was based on the assumption that after controlling for confounders, any excess in HSU in the injured (compared to the non-injured) cohort was an outcome principally associated with the incident injury. The use of an unexposed comparison group is a key element for attributing effects which have occurred a considerable time after the exposure.[28] While, to some extent, confounding by factors other than pre-existing morbidity was addressed by the matched study design, some unmeasured potential confounders remain. These include aspects of socioeconomic status, risk-taking and health behaviours associated with both the injury and outcome, over and above the matched variables, which were not included in the administrative datasets. Accordingly, the observed morbidity that was attributed to the injury may have been overestimated.

There are a number of strengths that sets this study apart from previous injury outcome studies. Through its use of linked administrative data, this study demonstrated the ability to overcome some of the design limitations of existing injury outcome studies to conduct a large-scale population-based study with a long follow-up time, accurate pre- and post-injury measures and a sample size sufficient for quantitative analysis. This is one of the few studies that have used a population-based non-injured comparison group.

While the administrative data lacked complex details on individual risk factors, they enabled measurement of health status before injury in the injured cohort, and previous health status in the non-injured group, which circumvented recall biases. Of principal value, was the ability to obtain longitudinal HSU data at the individual level and to link the provincial population registry to provide comprehensive follow-up of the cohorts. Few previous outcome studies have been able to determine the individual burden of hospital readmissions, ongoing outpatient visits, physician visits or long-term care provision following injury.

The results of this study can be generalized to other populations from other high-income countries where the demographic characteristics, distribution of injury types, severity of injury, mechanism of injury and health care systems are similar. The distribution of these characteristics broadly reflects those of published data on injury surveillance from Australia, Canada, New Zealand and the United Kingdom.[35–38]

Table 5. **Ten-year post-injury physician claims, rates per person-year (PY) for injured and non-injured comparison cohorts, by injury subgroups and injury severity**

Injury subgroups and severity level	Injured (*n* = 21 032)		Comparison (*n* = 21 032)		Un-adjusted rate ratio	95% Confidence interval	Adjusted rate ratio[a]	95% Confidence interval	Adjusted attrib. risk %[a]
	Claims	Per PY	Claims	Per PY					
Injury subgroup									
Brain injury (*n* = 1290)	69 410	6.51	45 964	4.06	1.68	1.56–1.80	1.44	1.35–1.53	30.6
Spinal injury (*n* = 95)	4 012	4.87	3973	4.65	1.17	0.90–1.51	1.18	0.95–1.46	15.3
Burns (*n* = 524)	28 134	6.11	17 353	3.89	1.67	1.48–1.88	1.31	1.19–1.45	23.7
Long-bone fractures (*n* = 2515)	138 211	6.23	105 407	4.76	1.38	1.32–1.45	1.28	1.23–1.33	21.9
Poisonings (*n* = 2169)	213 529	11.48	97 951	5.07	2.40	2.27–2.53	1.38	1.32–1.45	27.5
Internal Injuries (*n* = 593)	32 669	6.36	22 208	4.35	1.55	1.38–1.73	1.31	1.19–1.44	23.7
Other (*n* = 13 846)	743 796	6.03	503 375	4.13	1.51	1.48–1.54	1.26	1.23–1.28	20.6
Injury severity score (ISS)									
Minor (ISS 1-8) (*n* = 14 599)	776 857	5.95	532 683	4.15	1.48	1.45–1.51	1.25	1.23–1.27	20.0
Moderate (ISS 9-15) (*n* = 1746)	92 842	6.16	69 956	4.57	1.43	1.35–1.52	1.31	1.24–1.37	23.7
Severe (ISS ⩾ 16) (*n* = 657)	32 791	6.63	24 089	4.14	1.75	1.58–1.94	1.58	1.44–1.73	36.7
No ISS computed[b] (*n* = 4030)	327 271	9.45	169 503	4.75	2.09	2.01–2.18	1.36	1.32–1.41	26.5

[a] Adjusted for age, gender, place of residence and comorbidities in 12 months prior to injury date (including Charlson comorbidity index, cumulative LOS, number of physician claims, pre-existing psychiatric condition, pre-existing musculoskeletal condition and previous injuries).
[b] ISS scores not computed for ICD-9-CM codes 930–939 foreign bodies; 958 complications; 960–979 poisonings; 980–989 toxic substances; 990–995 other.

Although generalizing the results of this study requires caution, the study cohort and the consistency of findings across injury types and levels of severity suggest that they are sufficiently robust to be relevant across different communities.

Conclusion

Many people who survive the initial period following injury face long periods of inpatient care (and frequent readmissions), high levels of contact with physicians and an increased risk of premature placement into institutional care. Burden of disease estimates would be enhanced by including more complex measures of the burden from non-fatal injury, to control for pre-existing conditions and account for morbidity over and above that existing in the general population. ■

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Résumé

Effets de l'utilisation des services de santé sur 10 ans dans une cohorte de 21 000 adultes ayant présenté un traumatisme dans la population : la Manitoba Injury Outcome Study

Objectif Quantifier l'utilisation à long terme des services de santé après un traumatisme non mortel chez l'adulte.

Méthodes Une étude rétrospective, en population, de cohortes appariées a permis de recenser une cohorte de départ (1988-1991) de personnes ayant subi un traumatisme et ayant été hospitalisées (CIM-9-MC 800-995), âgées de 18 à 64 ans (*n* = 21 032) et un groupe de comparaison apparié non traumatisé (*n* = 21 032), à partir de données administratives interdépendantes du Manitoba, Canada. Les données relatives à l'utilisation des services de santé à long terme (hospitalisations, durée cumulée du séjour, demandes et placements des médecins dans des services de soins de longue durée) ont été obtenues pour les 12 mois précédant et les 10 années suivant le traumatisme. On s'est servi des régressions binomiales négatives et de Poisson pour quantifier les associations entre traumatisme et utilisation prolongée des services de santé.

Résultats Des différences statistiquement significatives dans les taux d'utilisation des services de santé ont été mises en évidence entre les cohortes traumatisées et non traumatisées au cours de l'année précédant le traumatisme et de chaque année de suivi. Après avoir tenu compte de l'utilisation des services de santé avant le traumatisme, la fraction attribuable du risque a indiqué que 38,7 % de toutes les hospitalisations post-traumatiques (*n* = 25 183), 68,9 % de toutes les années passées à l'hôpital (*n* = 1031), 21,9 % des demandes des médecins (*n* = 269 318) et 77,1 % des placements en maisons de soins (*n* = 189) recensés dans la cohorte traumatisée pouvaient être imputables au fait d'avoir subi un traumatisme.

Conclusion Bon nombre des personnes qui survivent à la période initiale faisant suite à un traumatisme doivent faire face à de longues périodes de soins hospitaliers (et à de fréquentes réadmissions), à des contacts répétés avec les médecins et à un risque accru de placement prématuré dans les structures de soins en établissement. Les estimations en population du poids des traumatismes pourraient être affinées en incluant les conséquences pour la santé à long terme qui ne sont pas mortelles et en neutralisant l'effet d'une morbidité associée avant le traumatisme.

Resumen

Uso de los servicios de salud a lo largo de 10 años en una cohorte basada en la población de 21 000 adultos con traumatismos: Estudio de Manitoba sobre el Desenlace de los Traumatismos

Objetivo Cuantificar la utilización de los servicios de salud (USS) por adultos que han sufrido traumatismos no mortales.

Métodos Estudio retrospectivo, poblacional, realizado en Manitoba (Canadá), de una cohorte de inicio (1988–1991) de 21 032 adultos de 18 a 64 años hospitalizados con traumatismos (CIE-9-CM 800-995), y de una cohorte de comparación (n = 21 032) de características similares, seleccionada a partir de datos administrativos. Se registraron los datos sobre la USS (hospitalizaciones, duración acumulada de la estancia, facturas médicas y prescripción de servicios asistenciales a largo plazo) en los 12 meses anteriores y los 10 años posteriores al traumatismo. Las asociaciones entre las lesiones y la USS a largo plazo se cuantificaron mediante regresiones binomiales negativas y regresiones de Poisson.

Resultados Las tasas de USS presentaron diferencias estadísticamente significativas entre las dos cohortes, tanto en el año anterior al traumatismo como en cada uno de los años siguientes. Después de controlar los efectos de la USS anterior al traumatismo, el porcentaje del riesgo atribuible indicó que el 38,7% de todas las hospitalizaciones posteriores al traumatismo (n = 25 183), el 68,9% de los años pasados en el hospital (n = 1031), el 21,9% de las facturas médicas (n = 269 318) y el 77,1% de los ingresos en hogares de atención a largo plazo (n = 189) registrados en la cohorte con traumatismos podían atribuirse a los traumatismos.

Conclusiones Muchas personas que sobreviven a un traumatismo sufren largos periodos de hospitalización (y frecuentes reingresos), tienen contactos frecuentes con los médicos y corren mayor riesgo de ingresar de forma prematura en establecimientos de asistencia a largo plazo. Las estimaciones de la carga de traumatismos podrían mejorarse si se incluyeran las consecuencias sanitarias a largo plazo no mortales y se controlaran los efectos de la comorbilidad anterior a la lesión.

ملخص

دراسة مرتكزة على السكان لحصائل انتفاع 21000 من الأتراب البالغين المصابين بالأذيات بالخدمات الصحية على مدى 10 سنوات: دراسة مانيتوبا حول حصائل الأذيات

الهدف: للتعرُّف على المقدار الكمي للانتفاع بالخدمات الصحية الطويل الأمد تلو إصابة البالغين بأذيات غير مميتة.

الطريقة: تعرفت دراسة استعادية مرتكزة على السكان ومتوافقة الأتراب تناولت الفترة 1988 – 1991 على المصابين بأذيات ممن أدخلوا على المستشفيات تحت الرمز 800 – 955 من المراجعة التاسعة المحوَّرة إكلينيكياً (سريرياً) للتصنيف الدولي للأمراض، والذين تراوحت أعمارهم بين 18 و46 عاماً وبلغ عددهم 21032 مصاباً، مع مجموعة مقارنة من غير المصابين بالأذيات بلغ عددهم 21032 من الشواهد، واستمدت الحالات والشواهد من معطيات إدارية مترابطة بدراسة مانيتوبا، كندا. أمّا معطيات الانتفاع بالخدمات الصحية وهي تتعلَّق بالإدخال في المستشفيات، والفترة التراكمية للمكث في المستشفى، والمطالبات التي يقدِّمها الأطباء، وتخصيص الأماكن في خدمات الرعاية الممتدة، فقد غطت 12 شهراً قبل الأذية و10 سنوات بعد وقوعها. وقد استخدمنا طرق التحوّف الثنائي الحد وتحوّف بويسون لتقدير كمية الترافق بين الأذيات وبين الانتفاع الطويل الأمد بالخدمات الصحية.

النتائج: ثمة اختلافات ذات أهمية إحصائية بين معدلات الانتفاع بالخدمات الصحية لدى الأتراب الذين أصيبوا بالأذيات ولدى غيرهم ممن لم يصب بها خلال السنة التي تسبق الإصابة وكل سنة تتلو الإصابة بالأذية. وبعد أخذ الشواهد للانتفاع بالخدمات الصحية قبل الإصابة بالأذيةبالحسبان، أشارت النسبة المئوية للخطر المعزوّ إلى أن 38.7% من جميع حالات الإدخال إلى المستشفيات التالية للإصابة بالأذيات، وعددها 25183 حالة، و68.9% من جميع السنوات التي قضيت في المستشفيات وعددها 10341 سنة، و21.9% من المطالبات التي قدَّمها الأطباء وعددها 269318 مطالبة، و77.1% من تخصيص الأماكن في خدمات الرعاية الممتدة وعددها 189 تخصيصاً في الأتراب المصابين بالأذيات يمكن أن تعزى إلى إصابتهم بالأذية.

الاستنتاج: يواجه الذين يُكْتَب لهم البقاء تلو إصابتهم بالأذية المبدئية فترة طويلة من الرعاية داخل المستشفيات وإدخال متكرر في المستشفيات، وتماس مكثف مع الأطباء وزيادة في خطر تخصيص مبكر للأماكن لهم في مؤسسات الرعاية. ويمكن الحصول على تقديرات أكثر دقة بإدراج العواقب الصحية غير المميتة والطويلة الأمد وبدراسة الشواهد حول التأثير السابق للإصابة على المراضة المرافقة.

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