Disability-Adjusted Life Years and cost of health loss of hospitalised major trauma patients in New Zealand

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ABSTRACT

AIMS: The aims of this study were to quantify the burden, and the cost of health loss, following hospitalisation for major trauma in New Zealand.

METHOD: Hospitalised major trauma patients injured between July 2017 and June 2020 were extracted from the New Zealand Trauma Registry. Case-mix of major trauma in each year was summarised using descriptive statistics. Disability-Adjusted Life Years (DALYs) were calculated for the cohort. A cost per DALY was applied to estimate the cost of health loss.

RESULTS: A total of 6,629 major trauma cases were recorded, rising from 2,072 in 2017–2018 to 2,191 in 2019–2020. The patient case-mix remained relatively consistent over the timeframe while the in-hospital mortality rate declined from 9.2% to 7.3%. Hospitalised major trauma patients accrued 22,718 DALYs (average 7,573 DALYs per year) at an estimated health loss cost of $1.02 billion ($341 million per year). The cost of health loss per case declined from $162,747 in 2017–2018 to $143,577 in 2019–2020.

CONCLUSION: The burden of major trauma is high. As injury is a preventable condition, the findings highlight the need for dedicated investment in both primary prevention and trauma care in New Zealand to reduce these avoidable costs.

Injury remains one of the top five contributors to disease burden, accounting for 252 million Disability-Adjusted Life Years (DALYs) and 10% of the global burden of disease in 2017.[1] In New Zealand, injury is the leading cause of death in people aged 1 to 34 years, and 2,534 people were hospitalised with major trauma at a rate of 51 per 100,000 population in the 2020–2021 financial year.[2] Understanding the burden of injury is needed to help plan and introduce prevention measures, and evaluate and inform improved trauma system design and injury care.

A key intervention for improving trauma care and outcomes has been the introduction of a contemporary trauma system in New Zealand.[3] Contemporary trauma systems are designed to expedite the transport of seriously injured patients to major trauma centres to reduce preventable mortality and morbidity. There is widespread evidence that contemporary, organised trauma systems save lives.[4–6] However, there is also growing evidence from longitudinal cohort studies that hospitalised major trauma patients can experience long recovery times and persistent disability.[7–10] Measuring the impact of trauma system implementation and maturation, and patterns in trauma burden, in New Zealand requires population-based studies which consider both mortality and measures of morbidity. The aims of this study were to quantify the burden, and the cost of health loss, of hospitalised major trauma patients in New Zealand.

Method

Study design

A registry-based observational study was undertaken. Existing data only were used for this study and no additional information was sought from participants.

New Zealand Trauma Registry (NZTR)

The NZTR collects data about patients admitted to hospital in New Zealand with an Injury Severity Score (ISS) >12, meeting the threshold for serious injury and major trauma.[3] All district health boards (DHBs) have participated in the registry from the 2017–2018 financial year. Data are collected under the auspices of quality improvement. Requests for use of the data are considered and approved by the Data Governance Group (DGG) of the National Trauma Network and approval for this project was received from the DGG and the Monash University Human Research Ethics Committee.

Inclusion criteria

Participants were included if they were registered on the NZTR and had a date of injury from 1 July 2017 to 30 June 2020.

Procedures

Trauma registry data

For this study, a limited selection of NZTR variables were extracted, and these included age at the time of injury, sex, cause of injury, date of injury, the Injury Severity Score, Abbreviated Injury Scale (AIS) diagnosis codes, discharge disposition and length of hospital stay.

Injuries sustained by the major trauma patients were mapped to eight injury groups based on the combination of AIS injuries sustained and their severity. The cause of injury ICD-10-AM code was used to group cases into key mechanism of injury categories, including road traffic injuries, falls, self-harm and other.

Burden of injury measurement

The measure of burden used for this study was the DALY. The DALY was specifically developed to quantify the burden of disease in populations, enable comparison across populations and guide resource allocation.[11] This metric is widely used for measuring disease burden or "health loss".[12–14] The DALY combines Years of Life Lost (YLLs) and Years Lived with Disability (YLDs) to generate DALYs for conditions.

YLLs were calculated as the age in years at time of injury subtracted from the life expectancy for a person of that age and sex in New Zealand and multiplied by the number of deaths at that age to calculate the lost life expectancy. Life expectancy was obtained from the New Zealand standard life table for 2018.[15] The total lost life expectancy years for each age were summed and summarised by year of injury. As the purpose was to calculate the burden of hospitalised major trauma patients, only in-hospital deaths were used.

The YLD component is calculated by multiplying the number of incident cases in the time period by the average duration of the condition (years expected to live in the disabled state) and a disability weight which reflects the severity of the disease on a scale from zero (perfect health) to one (dead).[16] Typically, the disability weights used for calculating YLDs are from panel-based studies where a lay description is provided to the panel members to represent the health impact of the condition of interest on a hypothetical affected individual.[16] This has been shown to under-estimate burden when compared to disability weights derived from standardised measures of quality of life reported by injured people in large cohorts.[12] For this reason we chose to use patient responses to the EuroQol five-dimensions – three-level (EQ-5D-3L) from the REcovery after Serious Trauma – Outcomes, Resource Use and Patient Experiences (RESTORE) study to generate disability weights.[8, 17] The RESTORE study shared consistent inclusion criteria to the New Zealand Trauma Registry and comparable EQ-5D data from New Zealand were not available at the time of this study.

The RESTORE study included all major trauma patients managed in the Victorian State Trauma System from July 2011 to June 2012. The EQ-5D-3L responses of 2,412 survivors to hospital discharge were used to generate the disability weights and were calculated by subtracting the patient (or proxy) EQ-5D-3L utility score from the corresponding age and gender norm for the population. The average weight at each follow-up time point for each injury group was calculated. The average differences between the patient responses and population norms at 6, 12 and 24 months were used to create a time-weighted disability weight for the first 24 months after injury.[12] The mean 24-month weight was considered the long-term weight for the injury group—i.e., the expected disability for the remaining life expectancy. Patients or their proxy respondent provided a rating of the patient's level of disability prior to injury and at follow-up on a five-point scale from none to severe disability.[18] Residual disability at 24 months was confirmed if the level of disability reported at this time point was greater than pre-injury disability, and was considered permanent for the purposes of calculating YLDs. The proportion of patients in each injury group with residual disability at 24 months was calculated.

Total DALYs were calculated as the sum of the YLDs and YLLs. Age discounting was not used, while economic discounting at 3% was used for consistency with World Health Organization recommendations for burden of disease studies.

Calculating the cost of major trauma burden

Establishing the cost of health loss requires a dollar cost per DALY. For this study, we used the New Zealand Gross Domestic Product (GDP) cost per DALY of $45,000, which is commonly used in economic evaluations of interventions.

Data analysis

Summary statistics were used to describe the patient population overall, and by year. For cate-

gorical variables, frequencies and percentages were used. Normally distributed continuous variables were summarised with means and standard deviations (SD) while continuous variables not following a normal distribution were summarised using the median and interquartile (IQR) range. Anonymised data were analysed and stored on the secure Monash University Server Secure eResearch Platform (SeRP), a secure data safe haven. All analyses were performed using Stata MP, Version 16.

Results

Population characteristics

From July 2017 to June 2020, there were 6,629 major trauma patients recorded on the NZTR. The number of patients on the registry was 2,072 in the 2017–2018 financial year, with 2,191 cases in the 2019–2020 financial year (Table 1). The mean age of major trauma patients was highest in 2019–2020. The proportion who had sustained a serious head injury (AIS severity score 3+), with or without injuries to other body regions, declined by 1.9% over the 3-year period, while the proportion without neurotrauma (serious head injury or spinal cord injury) increased by 2.2%. The in-hospital mortality rate declined from 9.2% to 7.3%.

Disability weights

The disability weights used to calculate the YLDs are shown in Table 2 along with the percentage continuing to report disability at 24 months post-injury. The highest disability weights, and prevalence of ongoing disability, were for patients with spinal cord injury. The lowest disability weights and prevalence of disability at 24 months post-injury were for patients who sustained abdominal and thoracic injuries, but without orthopaedic injuries or serious neurotrauma.

Disability-Adjusted Life Years

There were 552 deaths and 6,071 survivors to hospital discharge. No AIS codes were recorded for 6 survivors to hospital discharge, precluding allocation of a disability weight and inclusion in the YLD calculations. The 6,623 hospitalised major trauma patients accrued 22,718 DALYs at an estimated health loss cost of $1.02 billion, using the New Zealand GDP cost of $45,000 per DALY. The cost of health loss per patient declined from $162,747 in 2017–2018 to $157,003 in 2018–2019 to $143,577 in 2019–2020. The decline in cost of health loss per patient reflects the declining in-hospital death rate in the later years.

Discussion

In this study of 6,623 hospitalised major trauma patients in New Zealand, an average of 7,573 DALYs were lost each year at a cost of more than $341M. While the overall incidence of hospitalised major trauma has risen,[2] lower mortality rates and lower DALYs and cost of health loss per patient were observed. The costs of health loss observed in this study build on the direct healthcare costs for injury in New Zealand. In the 2019–2020 financial year, the Accident Compensation Corporation (ACC) expended $2.9 billion on injury treatment and rehabilitation services.[19] The ACC contribution to Vote Health represented 2.9% of the total health expenditure through this scheme. Together, the cost of health loss from this study, combined with the direct costs of healthcare, would exceed $3.2 billion per year.

Direct comparison of the health loss observed for New Zealand major trauma patients with other studies is challenging as prior studies have focused predominantly on road trauma,[20,21] or have focused on hospitalised injury rather than major trauma.[14] Prior authors reported an average of 9.7 DALYs and $486,425 AUD per case which was higher than the 3.4 DALYs and $154,366 NZD per patient observed in our study. However, important differences are noted. The study by Gabbe and colleagues included road trauma only which tend to be younger and more severely injured patients, and the prior study also included pre-hospital deaths.[21] Notwithstanding, the pattern observed in our study of decreasing mortality and a reduction in DALYs per patient over time was similar to previous studies focused on road trauma in Victoria, Australia.[20,21]

There were a number of strengths to this study. The New Zealand Trauma Registry provides whole of population coverage of hospitalised major trauma in the New Zealand and high-quality data with little missingness. The study used disability weights derived from a comparable population of trauma patients, precluding the need to use panel-based weights, which are known to under-represent the disability experienced by injury patients.[12,22]

Importantly, the underlying assumption was made that the disability weights derived from the Victorian population would reflect disability experienced by New Zealand major trauma patients and this assumption could not be confirmed. Ethnicity has been shown to influence EQ-5D reporting in New Zealand,[23] and presenting results for Māori vs non-Māori on the basis of the

Table 1: Characteristics of major trauma patients in New Zealand, 2017–2018 to 2019–2020.

Characteristic	2017–2018	2018–2019	2019–2020
	N=2,072	N=2,366	N=2,191
Age, mean (SD) years	**46.6 (23.2)**	**46.7 (22.9)**	**47.0 (22.5)**
Sex			
Male	1,448 (69.9%)	1,724 (72.9%)	1,579 (72.1%)
Female	624 (30.1%)	642 (27.1%)	612 (27.9%)
Cause of injury			
Land transport	1,173 (56.6%)	1,333 (56.3%)	1,175 (53.6%)
Falls	559 (27.0%)	640 (27.0%)	622 (28.4%)
Animate and inanimate forces	98 (4.7%)	109 (4.6%)	98 (4.5%)
Heat and smoke	16 (0.8%)	12 (0.5%)	6 (0.3%)
Self-harm	41 (2.0%)	44 (1.9%)	48 (2.2%)
Assault	151 (7.3%)	187 (7.9%)	168 (7.7%)
Other cause	34 (1.6%)	41 (1.7%)	74 (3.4%)
Injury Severity Score (ISS)			
Median (IQR)	17 (14, 25)	17 (14, 25)	17 (14, 25)
Injury group			
Isolated head injury	292 (14.1%)	323 (13.7%)	274 (12.5%)
Head and orthopaedic injuries	282 (13.6%)	338 (14.3%)	292 (13.4%)
Head and other injuries	148 (7.1%)	157 (6.6%)	154 (7.0%)
Spinal cord injury	101 (4.9%)	111 (4.7%)	91 (4.2%)
Orthopaedic injury only	139 (6.7%)	143 (6.0%)	151 (6.9%)
Chest or abdominal injuries with associated orthopaedic injuries	692 (33.4%)	807 (34.1%)	718 (32.8%)
Chest or abdominal injuries with or without other injuries	267 (12.9%)	315 (13.3%)	301 (13.8%)
Other multi-trauma or other injuries	150 (7.2%)	171 (7.2%)	206 (9.4%)
In-hospital death			
No	1882 (90.8%)	2164 (91.5%)	2031 (92.7%)
Yes	190 (9.2%)	202 (8.5%)	160 (7.3%)

Table 2: Disability weights and proportion with lifelong disability by injury group.

Injury group	DW short-term	DW long-term	Percentage with disability at 24 months
Isolated head injury	0.127	0.123	46.8%
Head and orthopaedic injuries	0.163	0.150	61.8%
Head and other injuries	0.083	0.070	50.4%
Spinal cord injury	0.404	0.363	86.0%
Orthopaedic injury only	0.145	0.113	58.6%
Chest or abdominal injuries with associated orthopaedic injuries	0.138	0.129	54.8%
Chest or abdominal injuries with or without other injuries	0.058	0.050	32.7%
Other multi-trauma or other injuries	0.152	0.142	54.4%

Table 3: Burden and cost of health loss for hospitalised major trauma patients in New Zealand—2017–2018 to 2019–2020.

	2017–2018	2018–2019	2019–2020	All years
N (survivors)	1,881	2,163	2,027	6,071
N (deaths)	190	202	160	552
N (total)	2,071	2,365	2,187	6,623
YLDs total	3,734	4,334	3,920	11,988
YLLs total	3,756,	3,917	3,057	10,730
DALYs total	7,490	8,251	6,977	22,718
YLDs/patient	1.99	2.00	1.93	1.97
DALYs/patient	3.62	3.49	3.19	3.43
Total health loss costs	$337,049,987	$371,312,307	$314,003,093	$1,022,365,387
Total health loss cost/patient	$162,747	$157,003	$143,577	$154,366

available weights may not be appropriate. Therefore, ethnicity-based analysis was excluded. In future, disability weight sets based on health-related quality of life of New Zealand major trauma cases will result in improved population burden measures. As the study was observational, we cannot attribute the declining burden per patient directly to the maturation of the trauma system, and the data simply represent the positive change occurring within the major trauma population. Our study did not address the full YLLs of injury in New Zealand as pre-hospital deaths were not included in this study due to data availability issues. These should be included in future burden of injury research to ensure a more comprehensive estimate of major trauma burden.

Overall, the burden of hospitalised major trauma is rising due to the increasing number of major trauma patients in the population, while the burden per patient is declining. This is likely to be due to continuing improvement in the care of seriously injured patients in New Zealand and some changes in case-mix of major trauma. Notably, over the three years of this study, 22,718 DALYs were lost at an estimated health loss cost of $1.02 billion. As injury is a preventable condition, these numbers highlight the ongoing need for investment in primary prevention in New Zealand to reduce these avoidable costs. Additionally, investment in improved trauma care through trauma education and training programs, adequate resourcing and increased capacity in tertiary trauma centres, and optimisation of the National Trauma Network is needed to further enhance survival and reduce preventable morbidity.

COMPETING INTERESTS
Nil.

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