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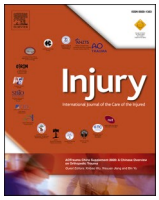

Impact of comorbidities in severely injured patients with blunt chest injury: A population-based retrospective cohort study

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ABSTRACT

Introduction: Blunt chest injuries result in up to 10 % of major trauma admissions. Comorbidities can complicate recovery and increase the mortality rate in this patient cohort. A better understanding of the association between comorbidities and patient outcomes will facilitate enhanced models of care for particularly vulnerable groups of patients, such as older adults.

Aims: i) compare the characteristics of severely injured patients with blunt chest injury with and without comorbidities and ii) examine the relationship between comorbidities and key patient outcomes: prolonged length of stay, re-admission within 28 days, and mortality within 30 days in a cohort of patients with blunt chest injury admitted after severe trauma.

Methods: A retrospective cohort study using linked data from the NSW Trauma Registry and NSW mortality and hospitalisation records between 1st of January 2012 and 31st of December 2019.

Results: After adjusting for potential confounding factors, patients with severe injuries, chest injuries, and comorbidities were found to have a 34 % increased likelihood of having a prolonged length of stay (OR = 1.34, 95 %*I* = 1.17–1.53) compared to patients with no comorbidities. There was no difference in 30-day mortality for patients with a severe chest injury who did or did not have comorbidities (OR = 1.05, 95 %CI = 0.80–1.39). No significant association was found between comorbidities and re-admission within 28 days.

Conclusion: Severely injured patients with blunt chest injury and comorbidities are at risk of prolonged length of stay.

Introduction

The global burden of trauma is immense, with approximately six million deaths globally each year from trauma [1] with blunt chest injuries resulting in 10 % of injury admissions [2]. Despite advancements in trauma care over the last 20 years, the impact of trauma is still very high, especially in younger age groups [3]. Understanding the epidemiology of morbidity and mortality after trauma is vital to improving the outcomes of the injured patient presenting to the emergency department.

Comorbid conditions, present prior to a patient's current injury, can impact patient outcomes in severely injured patients [4]. Cardiopulmonary disease in patients with blunt chest injury has previously been associated with mortality [5]; but effects of overall comorbidities were less clear. Health comorbidities may complicate recovery from severe injury, increasing the likelihood of complications in hospital, and lead to poorer outcomes after discharge in the community [4]. The role that pre-existing medical conditions on hospital outcomes, such as

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re-admissions to hospital and resource utilisation, remain poorly understood. A better understanding of the association between comorbidities and patient outcomes will facilitate better models of care for vulnerable groups of patients.

This paper is part of a program of research seeking to better understand the patterns and trends of comorbidities and their association with length of stay, re-admission rates, and mortality in patients admitted after severe injury in New South Wales (NSW) Australia [6–9].

Previous studies have investigated patient outcomes and risk factors following rib fractures or blunt chest injury in the general or older patient cohorts [10]. However, there is limited research examining the impact of comorbidities in a severely injured blunt chest injury cohort and their health outcomes. This paper focuses on severely injured patients presenting to hospital with blunt chest injury.

The aims of this study are to i) compare the characteristics of severely injured patients with chest injury with and without comorbidities and ii) examine the relationship between comorbidities and key patient outcomes: prolonged length of stay, re-admission within 28 days, and mortality within 30 days in a cohort of patients with blunt chest injury admitted after severe trauma. Ethical approval and a waiver of consent was obtained from the NSW Population Health Services and Research Ethics Committee (2017/HRE0602).

Methods

This was a retrospective cohort study of severely injured patients with blunt chest injury admitted to trauma hospitals in NSW between 01/01/2012 and 31/12/2019. Data from the NSW Trauma Registry was linked to NSW mortality and hospitalisation records. Guidelines for studies involving data linkage were used [11] (Supplementary file 1) and the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) Statement: guidelines for reporting observational studies [12] was followed (Supplementary file 2).

Setting

New South Wales (NSW) is the most populous state in Australia across a land area over 850,000 km^2s. NSW is located on Australia's east coast and has an estimated 8.1 million (31 %) people [13]. The NSW trauma system has three levels of service – major and regional trauma services and local hospitals. The NSW trauma system includes seven adult and three paediatric major trauma services. There are 10 regional trauma services in NSW. Study participants were admitted to one or more major and/or regional trauma services in NSW.

Data sources

Two data sources were linked to the NSW Trauma Registry for this study: the NSW Admitted Patient Data Collection (APDC) and NSW Registry of Births, Deaths, and Marriages (RBDM). The NSW Trauma Registry routinely collects clinical, hospital and discharge outcome data on all major trauma patients presenting to trauma services in NSW. The NSW Trauma registry includes patients who have severe injury (Injury Severity Score (ISS) >12) or were admitted to an intensive care unit (ICU) or, who died in hospital due to traumatic injury. Therefore, if a patient had ISS <12 but died in the hospital or admitted to ICU, they would be in the registry. The registry includes information on patient demographics, the mechanism of injury (e.g., road trauma), injuries sustained, and treatments and procedures. The NSW APDC provides patient level data from hospitals such as hospital admission and discharge, ICU and mechanical ventilation days, and principal and up to 50 additional diagnosis codes according to International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-AM). The NSW RBDM records fact and date of death.

Study population

Patients were included in the cohort if they:

1) had severe injury as per the NSW Trauma Registry definition (severe injury (Injury Severity Score (ISS) >12) or were admitted to ICU or, who died in hospital because of traumatic injury);
2) had any blunt chest injury as defined by the abbreviated injury scale (AIS) code for chest injuries;
3) were admitted to an NSW trauma service during the study period; and
4) were aged ≥15 years.
5) Any blunt chest injury included single and multiple rib and sternal fractures, pneumothoraces, haemothoraces, lung lacerations and pulmonary contusions. The injuries were scored as per the AIS with a higher number indicating higher injury severity. Patients with penetrating injuries were excluded.

Data linkage

Data linkage was performed by the Centre for Health Record Linkage (CHeReL) based on data elements such as facility, date of admission and discharge, age, home postcode and sex using deterministic linkage. The data linkage rate was 87 %.

Identification of comorbidities

Comorbidities were identified using the Charlson comorbidity Index (CCI) definitions [14] according to their ICD-10-AM codes to determine 16 health conditions [15]: acute myocardial infarction, congestive heart failure, peripheral vascular disease, cerebrovascular disease, dementia, rheumatic disease, peptic ulcer disease, mild liver disease, diabetes without chronic condition, diabetes with chronic complication, hemiplegia or paraplegia, renal disease, any malignancy, moderate or severe liver disease, metastatic solid tumour, and AIDS / HIV (Supplementary file 3). Patients were grouped into the with and without comorbidities group based on the presence or absence of these conditions.

Socio-economic status

Relative socio-economic disadvantage was allocated using the patients Statistical Local Area (SLA) of residence within the APDC and the Socio-Economic Indexes for Areas (SEIFA), specifically the Statistical Local Area, Indexes, SEIFA 2011 [16]. The values were partitioned into quintiles from most (i.e., 1) to least disadvantaged (i.e., 5). Socio-economic disadvantage is derived from Australia's population census using information such as income, education, employment, and occupation [16].

Data management

There were 29,043 Trauma Registry records during 2012 to 2019 (inclusion criteria 1–4). A total of 9516 trauma records had a chest injury meeting the above inclusion criteria (32.7 %) which were linked to the appropriate APDC admissions.

Patients with injury date less than 7 days from admission were considered as linked. Following initial data linkage, the team removed duplicates and, for continuous variables outliers >3 standard deviations from the mean were removed.

Records with multiple 'episodes of care' within the dataset were identified and linked into a period of care based on matching episode start and end dates, to identify the admission and discharge dates from hospital. The index admission due to chest injury for each patient was identified based on start date and chest injury diagnosis classification. These were cross checked by three authors (ML, SK, TW).

Outcome measures

Hospital length of stay (LOS) was based on the start date of the index episode and the end date of the last consecutive episode.

Prolonged LOS for the purpose of this study it was defined as a hospital stay of >30 days [17].

Re-admission was defined as an unplanned return to hospital within 28 days of discharge from the index admission [18]. 'Unplanned readmission' was derived by identifying whether the unique identifier was present in the dataset within 28 days of last inpatient discharge and reason for admission checked by investigators.

Mortality was defined as death within 30 days of date of admission.

Confounding variables

Covariates were those known in the literature [19] and available in the data and included age, sex, SEIFA, ISS, whether patient sustained polytrauma or sustained a head injury with AIS >2, primary cause of injury, whether there was a trauma call, major limb injuries; and the performance of the following procedures: Intercostal catheter, thoracoscopy, exploratory thoracotomy, the presence of the following health conditions: pneumonia, urinary tract infection and delirium, whether the patient was admitted to ICU and whether the patient was intubated.

Statistical analysis

Analysis was performed using SPSS v26 (IBM SPSS). Patients' characteristics were compared using chi-squared tests for categorical variables, and independent *t*-tests or Mann-Whitney U tests for continuous variables depending on the distributions.

Bivariate association of comorbidities with the three outcome measures and all potential confounding variables were examined using Chi-square test, independent sample T-test and Mann-Whitney U test where appropriate. Variables found to have an association with comorbidities at a 0.05 level were included in the next step of the analysis. Logistic regression was used to examine the association of comorbidities with each of the outcome variables adjusting for the effect of confounders.

Results

There were 9516 severely injured patients with a blunt chest injury. There was a higher proportion of males experiencing a chest injury than females ($p < 0.0001$) and older patients experienced a higher proportion of comorbidities than younger patients (15–24: 2.8% vs ≥65 57.5 %). (Table 1).

Severely injured patients with chest injury and comorbidities had a higher proportion of minor injuries ($p < 0.0001$), head injury ($p < 0.0001$), rib fractures ($p < 0.0001$), and falls ($p < 0.0001$) than patients who had no comorbidities. Severely injured patients with chest injury and comorbidities also had a higher proportion of pneumonia, urinary tract infection, delirium, and intubation during their stay than patients who did not have any comorbid health conditions ($p < 0.0001$) (Table 2).

Table 3 presents a summary of the bivariate association between comorbidities and the three outcome variables. Significant bivariate association was found between comorbidities and prolonged LOS and mortality within 30 days ($p < 0.0001$); however, not for re-admission within 28 days ($p = 0.371$).

After adjustment, there was an increased odds for severely injured patients with chest injury with comorbidities to have a prolonged length of stay by 34 % (OR = 1.34, 95 %CI = 1.17–1.53, $p < 0.0001$) compared to severely injured chest injury patients without comorbidities (Table 4).

There was no association between comorbidities and mortality within 30 days, after adjusting for the possible effects of potential confounding variables (OR = 1.05, 95 %CI = 0.80–1.39 (Table 5).

Table 1
Severely (ISS>12 or died or ICU stay) chest injury participant demographics by comorbidity.

Characteristics	No comorbidities (*n* = 7607)	Comorbidities present (*n* = 1909)	P values[1]
	N (%)	N (%)	
Age, years (mean, SD)	51 (20.0)	66 (18.0)	<0.0001
Age group			
15–24	1039 (13.7 %)	54 (2.8 %)	
25–34	891 (11.7 %)	44 (2.3 %)	
35–44	1062 (14.0 %)	153 (8.0 %)	
45–54	1356 (17.8 %)	237 (12.4 %)	
55–64	1251 (16.4 %)	324 (17.0 %)	
≥65	2008 (26.4 %)	1097 (57.5 %)	
Gender			0.001
Female	1888 (24.8 %)	547 (28.7 %)	
Male	5719 (75.2 %)	1362 (71.3 %)	
SEIFA			0.452
1 = Most disadvantaged	1176 (15.9 %)	328 (17.5 %)	
2	1932 (26.1 %)	462 (24.6 %)	
3	1308 (17.7 %)	328 (17.5 %)	
4	1388 (18.8 %)	355 (18.9 %)	
5 = Least disadvantaged	1593 (21.5 %)	402 (21.4 %)	
Cardiac related comorbidity	0 (0 %)	509 (26.7 %)	<0.0001
Respiratory related comorbidity	0 (0 %)	245 (12.8 %)	<0.0001
Dementia	0 (0 %)	133 (7 %)	<0.0001

SEIFA - Socio-Economic Indexes for Areas, ISS – Injury severity score, ICU – Intensive care unit, SD – standard deviation.
[1] T-test or chi square test of independence.

Discussion

In this study we examined the relationship between comorbidities and key patient outcomes in a cohort of patients with blunt chest injury admitted after severe trauma as defined by death, ICU admission, or ISS>12. Perhaps unsurprisingly, there was a significant relationship with comorbidities and prolonged length of stay, however this was not the case for re-admission within 28 days, or mortality within 30 days.

Chest injury is known to be associated with longer length of stay compared to most other body regions [20]. The presence of comorbidities in this cohort, irrespective of other factors such as age, ISS and complications further contributes to prolonged length of stay. Australians are living longer, and chronic conditions are increasing and the blunt chest injury cohort traditionally includes a significant portion of elderly people contributing to patient and health service impacts [20, 21].

The impact on prolonged length of stay is important to consider. Prolonged length of stay has an impact on Health Related Quality of Life (HRQoL) and patient outcomes both physically, such as increased infection risk, and psychologically [22]. The psychological impacts following injury are common, particularly post-traumatic stress disorder (PTSD), depression and anxiety especially with prolonged LOS [23]. Prolonged length of stay negatively impacts hospital services resulting in increased healthcare costs and leading to increased pressure on the health care system, resulting in reduced resources and equipment [24]. Effects of prolonged LOS may be complex contributing to overcrowding in the emergency department [25]. Planning for discharge should start early for complex trauma patients and should involve the patient.

Clinicians and policy makers need to be aware of the impacts of comorbidities on patients with blunt chest injury and the need for early, targeted interventions for this cohort [26]. Other factors that contribute to prolonged LOS and 30-day mortality included pneumonia, urinary tract infections and delirium, but by the time these problems present it may be too late to prevent the negative outcomes. Implementation of targeted interventions for chest injury and the involvement of the

Table 2
Injury and presentation characteristics by comorbidity.

Characteristics	No comorbidities (n = 7607)	Comorbidities (n = 1909)	P values[2]
	N (%)	N (%)	
ISS group			<0.0001
*Minor***	316 (4.2 %)	146 (7.6 %)	
Moderate (ISS 13–15)	2307 (30.3 %)	519 (27.2 %)	
Serious (ISS 16–24)	3162 (41.6 %)	745 (39.0 %)	
Severe (ISS 24–40)	1381 (18.2 %)	399 (20.9 %)	
Critical (ISS 41–74)	441 (5.8 %)	100 (5.2 %)	
Trauma			
Polytrauma[+]	1306 (17.2 %)	318 (16.7 %)	0.610
Head injury (AIS>2)[+]	1053 (13.8 %)	352 (18.4 %)	<0.0001
Rib fractures ≥3	4214 (55.4 %)	1151 (60.3 %)	<0.0001
Primary cause of injury			<0.0001
Falls	2125 (27.9 %)	876 (45.9 %)	
Road related	4733 (62.2 %)	903 (47.3 %)	
Motor vehicle	1969	489	
Motorcycle	1472	191	
Cyclist	565	48	
Pedestrian	501	143	
Transport other	226	32	
Animal-related	221 (2.9 %)	21 (1.1 %)	
Assault	171 (2.2 %)	48 (2.5 %)	
Mechanical force/ contact	196 (2.6 %)	26 (1.4 %)	
Intentional self-harm	126 (1.7 %)	31 (1.6 %)	
Other	35 (0.5 %)	4 (0.2 %)	
Trauma call			<0.0001
Yes	5597 (73.6 %)	1233 (64.6 %)	
No	1537 (20.2 %)	512 (26.8 %)	
Not known	473 (6.2 %)	164 (8.6 %)	
Procedure n (%)			
Intercostal catheter	1021 (13.4 %)	254 (13.3 %)	0.910
Thoracoscopy	65 (0.9 %)	12 (0.6 %)	0.392
Exploratory thoracotomy	77 (1.0 %)	25 (1.3 %)	0.263
Other diagnosis			
Pneumonia	463 (6.1 %)	286 (15.0 %)	<0.0001
Urinary tract infection	336 (4.4 %)	225 (11.8 %)	<0.0001
Delirium	415 (5.5 %)	367 (19.2 %)	<0.0001
ICU admission	3073 (40.4 %)	994 (52.1 %)	<0.0001
LOS (hours) Median (IQR)	0 (0–45)	8 (0–113)	<0.0001
Intubation	1695 (22.3 %)	520 (27.2 %)	<0.0001
Total intubation hours (Median (IQR))	59 (20–161)	135 (41–258)	<0.0001
Re-intubation	95 (5.6 %)	50 (9.6 %)	0.002

** Only ICU or died are in cohort, ICD-10-AM codes for Intercostal catheter (38,806–00), Thoracoscopy (38,436–00), Exploratory Thoracotomy (38,418–00). ISS- injury severity score, ICU – Intensive care unit, LOS – length of stay.
[2] Mann-Whitney U test or chi square test of independence.

Table 3.
Bivariate association between outcomes and comorbidity.

	No comorbidities (n = 7607)	Comorbidities present (n = 1909)	P values
	N (%)	N (%)	
Outcomes			
Prolonged LOS (>30days)	1436 (18.9 %)	625 (32.7 %)	<0.0001
Readmission within 28 days	601 (7.9 %)	163 (8.5 %)	0.371
Mortality within 30 days	480 (6.3 %)	226 (11.8 %)	<0.0001

LOS – length of stay.

multidisciplinary team to ensure adequate oxygenation and ventilation [27] and pain management [28]. Protocols for blunt chest injury may be an important strategy to improve outcomes in patients with chest injury, considering their comorbidities [29,30].

Table 4
Logistic regression results of comorbidities and prolonged length of stay.

Characteristics	Univariate		Multivariate	
	OR	**95 % CI**	**Adjusted OR**	**95 % CI**
Comorbidity	**2.09**	**1.87–2.34*****	**1.34**	**1.17–1.54*****
Age				
35–44	0.99	0.82–1.19	1.37	1.11–1.7**
45–54	0.92	0.78–1.1	1.44	1.18–1.75***
55–64	1.09	0.92–1.29	1.65	1.35–2.01***
≥65	1.76	1.54–2.02***	2.45	2.05–2.94***
Female	1.70	1.53–1.89***	1.48	131–1.68***
SEIFA				
2	1.15	0.98–1.33	1.17	0.98–1.39
3	1.05	0.89–1.24	1.18	0.96–1.43
4	1.10	0.93–1.30	1.13	0.94–1.37
5 = Least disadvantaged	1.26	1.08–1.48*	1.32	1.10–1.59*
ISS group				
Moderate (ISS 13–15)	0.68	0.51–0.90*	1.80	1.30–2.48***
Serious (ISS 16–24)	1.47	1.12–1.93*	3.00	2.16–3.96***
Severe (ISS 24–40)	3.86	2.93–5.10***	4.05	2.94–5.57***
Critical (ISS 41–74)	4.89	3.59–6.68***	3.00	2.04–4.42***
Trauma				
Polytrauma	3.57	3.19–4.01***	1.44	1.21–1.71***
Head injury (AIS>2)	2.63	2.33–2.97***	–	–
Rib fractures ≥3	0.84	0.76–0.93**	–	–
Femoral/Neck fracture	3.67	2.80–5.36***	2.62	1.80–3.81***
Pelvic fracture	3.78	3.19–4.49***	2.12	1.72–2.62***
Primary cause of injury				
Road related	1.13	1.01–1.26*	1.26	1.10–1.45**
Animal-related	0.36	0.23–0.57***	0.50	0.30–0.82*
Assault	0.36	0.22–0.58***	0.57	0.34–0.97*
Mechanical force/ contact	0.57	0.38–0.85*	0.78	0.5–1.21
Intentional self-harm	3.30	2.39–4.58***	2.42	1.63–3.60***
Other	0.56	0.22–1.44	0.53	0.19–1.50
Trauma call	1.96	1.74–2.21***	1.36	1.18–1.58***
Other diagnosis				
Pneumonia	4.99	4.28–5.82***	2.67	2.23–3.21***
Urinary tract infection	6.26	5.25–7.47***	3.81	3.10–4.68***
Delirium	4.59	3.95–5.34***	2.06	1.72–2.47***
ICU admission	4.13	3.72–4.59***	2.13	1.86–2.45***
Intubation	4.38	3.94–4.87***	1.82	1.56–2.12***

[+]Reference groups – Comorbidity, ICU Admission, Intubation, other diagnosis, procedure Trauma – No; Age group – 15–34; Gender – male; SEIFA – 1; ISS group – minor; cause of injury – Fall; Trauma call – No/Unknown. *$p < 0.05$, **$p < 0.001$, ***$p < 0.0001$.
SEIFA - Socio-Economic Indexes for Areas, ISS – Injury severity score, ICU – Intensive care unit, OR – odds ratio, 95 % CI – 95 percent confidence interval.

Interestingly, this study identified no increase in 30-day mortality or 28-day readmission for severely injured patients with blunt chest injury and comorbidities. However, similar findings related to mortality have been reported in other studies [8]. Advancements in care and trauma centres with multidisciplinary teams may be contributing to better outcomes. Our study did not include pre-hospital deaths which may underestimate overall mortality.

Strengths and limitations

This study included all severely injured trauma patients in NSW, Australia. A broad range and depth of data was drawn. The results of this study will be generalizable to patients who sustain major trauma in jurisdictions with similar trauma systems.

Table 5
Logistic regression results of comorbidities and mortality within 30 days.

Characteristics	Univariate		Multivariable	
	OR	**95 % CI**	**Adjusted OR**	**95 % CI**
Comorbidity				
Yes	0.53	0.43–0.66***	–	–
Age				
35–44	0.13	0.06–0.27***	0.24	0.1–0.58*
45–54	0.08	0.04–0.16***	0.19	0.08–0.43***
55–64	0.06	0.03–0.12***	0.21	0.1–0.46***
≥65	0.06	0.03–0.11***	0.41	0.2–0.84*
Female	1.02	0.83–1.27	–	–
SEIFA				
2	0.97	0.71–1.33	–	–
3	0.92	0.66–1.30	–	–
4	0.83	0.59–1.17	–	–
5 = Least disadvantaged	0.85	0.61–1.17	–	–
ISS group				
Moderate (ISS 13–15)	0.17	0.11–0.27***	0.13	0.08–0.22***
Serious (ISS 16–24)	0.31	0.21–0.47***	0.19	0.12–0.31***
Severe (ISS 24–40)	1.55	1.02–2.36*	0.56	0.33–0.96*
Critical (ISS 41–74)	10.92	5.78–20.65***	2.46	1.08–5.62*
Trauma				
Polytrauma	6.65	5.04–8.76***	–	–
Head injury (AIS>2)	6.14	4.78–7.89***	1.89	1.32–2.71**
Rib fractures ≥3	0.48	0.39–0.59***	0.71	0.55–0.94*
Primary cause of injury				
Road related	2.54	2.05–3.15***	0.98	0.72–1.33
Animal-related	1.22	0.43–3.48	0.79	0.21–2.93
Assault	0.66	0.23–1.84	0.24	0.06–0.90*
Mechanical force/ contact	4.41	1.54–12.65**	1.8	0.47–6.94
Intentional self-harm	3.84	1.84–8.00***	1.09	0.41–2.92
Other	9.18	1.07–79.00*	1.37	0.07–26.94
Trauma call	3.84	3.03–4.87***	1.59	1.15–2.20*
Other diagnosis				
Pneumonia	0.68	0.51–0.90*	–	–
Urinary tract infection	0.17	0.11–0.26***	0.23	0.14–0.39***
Delirium	0.30	0.22–0.41***	0.49	0.33–0.72***
ICU admission	2.04	1.66–2.51***	0.55	0.39–0.76***
Intubation	7.40	5.84–9.37***	4.17	2.91–5.99***

[+]Reference groups – Comorbidity, ICU Admission, Intubation, other diagnosis, procedure Trauma – No; Age group – 15–34; Gender – male; SEIFA – 1; ISS group – minor; cause of injury – Fall; Trauma call – No/Unknown. *$p < 0.05$, **$p < 0.001$, ***$p < 0.0001$.
SEIFA - Socio-Economic Indexes for Areas, ISS – Injury severity score, ICU – Intensive care unit, OR – odds ratio, 95 % CI – 95 percent confidence interval.

This is a data linkage study and is associated with limitations. The linkage rate is lower than expected as the APDC was not limited to injury-related hospitalisations first. Therefore, there were matches between the trauma registry and APDC for people who were of the same age, sex, hospitalised on the same day at the same hospital, but for totally different diagnoses (i.e. not injury). We mitigated risk of incorrect linkage by hand checking the linkages with potential errors and excluding the non-injured. We were limited by the data available in the APDC and the trauma database to what variables were included. Further, data linkage studies are limited by the accuracy of the data inputted to the registries. In NSW, the trauma registry is maintained by trauma nurses who are trained in data collection entry and management.

We did not control for specific comorbidities in the analysis, which we acknowledge would help clinicians target more specifically, and may have contributions to the mortality and readmission being insignificant. This also may have influenced the result showing that comorbidities did not result in a higher likelihood of death within 30 days. This may present an opportunity in future research.

Severely injured patients with chest injuries and co-morbidities had a higher proportion of pneumonia, urinary tract infection, delirium and intubation. Unfortunately, within this dataset it was not possible to establish if these were present on arrival or as a result of their hospital stay.

Conclusion

Patients with blunt chest injury admitted after severe trauma as defined by death, ICU admission, or ISS>12, had a significant relationship with comorbidities and prolonged length of stay, but not for readmission within 28 days, or mortality within 30 days. Severely injured patients with blunt chest injury and comorbidities are at risk of prolonged length of hospital stay independent of confounding factors (age, sex, SEIFA, ISS, polytrauma head injury, trauma call, intercostal catheter, thoracoscopy, exploratory thoracotomy, pneumonia, urinary tract infection and delirium). The increased length of stay may present impacts to the health service and patient care, which can be investigated in other research.

Declaration of funding

New South Wales Institute of Trauma and Injury Management (ITIM) provided funding for the data linkage component of this study.

Ethical approval

Ethical approval and a waiver of consent was obtained from the NSW Population Health Services and Research Ethics Committee (2017/HRE0602).

CRediT authorship contribution statement

S. Kourouche: Validation, Visualization, Writing – original draft, Writing – review & editing, Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Project administration. **T. Wiseman:** Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft, Writing – review & editing. **MK Lam:** Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **R. Mitchell:** Methodology, Supervision, Validation, Writing – review & editing. **P. Sarrami:** Conceptualization, Methodology, Writing – review & editing. **M. Dinh:** Writing – review & editing, Conceptualization, Supervision. **H. Singh:** Conceptualization, Writing – review & editing. **K. Curtis:** Methodology, Supervision, Writing – review & editing.

Declaration of competing interest

The authors have nothing to disclose.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.injury.2024.111538.

References

[1] World Health Organisation (WHO). The global health observatory 2023 [Available from: https://www.who.int/data/gho.

[2] Rossiter ND. Trauma-the forgotten pandemic? Int Orthop 2022;46(1):3–11. https://doi.org/10.1007/s00264-021-05213-z.

[3] King DR. Initial care of the severely injured patient. N Engl J Med 2019;380(8):763–70. https://doi.org/10.1056/NEJMra1609326.

[4] Hong J, Lee WK, Kim MK, BE Lee, Shin SD, Park H. Effect of comorbidity on length of hospital stay and in-hospital mortality among unintentionally injured patients. Accid Anal Prev 2013;52:44–50. https://doi.org/10.1016/j.aap.2012.12.007.

[5] Battle C, Carter K, Newey L, Giamello JD, Melchio R, Hutchings H. Risk factors that predict mortality in patients with blunt chest wall trauma: an updated systematic review and meta-analysis. Emerg Med J 2023;40(5):369–78. https://doi.org/10.1136/emermed-2021-212184.

[6] Shu CC, Dinh M, Mitchell R, Balogh ZJ, Curtis K, Sarrami P, et al. Impact of comorbidities on survival following major injury across different types of road users. Injury 2022;53(10):3178–85. https://doi.org/10.1016/j.injury.2022.07.005.

[7] Mitchell RJ, Harris IA, Balogh ZJ, Curtis K, Burns B, Seppelt I, et al. Determinants of long-term unplanned readmission and mortality following self-inflicted and non-self-inflicted major injury: a retrospective cohort study. Eur J Trauma Emerg Surg 2022;48(3):2145–56. https://doi.org/10.1007/s00068-021-01837-3.

[8] Hamdard K, Harris IA, Sarrami P, Shu CC, Brown J, Singh H, et al. Falls from ladders in New South Wales: a data-linkage study. Injury 2023;54(2):442–7. https://doi.org/10.1016/j.injury.2022.11.061.

[9] Bath S, Dinh MM, Casley S, Sarrami P. Predictors of mortality in older patients with isolated severe head injury: a data linkage study from New South Wales, Australia. Aust Health Rev. 2022;46(1):107–14. https://doi.org/10.1071/ah21131.

[10] Baker JE, Millar DA, Heh V, Goodman MD, Pritts TA, Janowak CF. Does chest wall organ injury scale (OIS) or abbreviated injury scale (AIS) predict outcomes? An analysis of 16,000 consecutive rib fractures. Surgery 2020;168(1):198–204. https://doi.org/10.1016/j.surg.2020.04.032.

[11] Bohensky MA, Jolley D, Sundararajan V, Evans S, Ibrahim J, Brand C. Development and validation of reporting guidelines for studies involving data linkage. Aust N Z J Public Health 2011;35(5):486–9. https://doi.org/10.1111/j.1753-6405.2011.00741.x.

[12] von Elm E, Altman DG, Egger M, Pocock SJ, Gøtzsche PC, Vandenbroucke JP. Strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies. BMJ 2007;335(7624):806–8. https://doi.org/10.1136/bmj.39335.541782.AD.

[13] Australian Bureau of Statistics. National, state and territory population 2022 [Available from: https://www.abs.gov.au/statistics/people/population/national-state-and-territory-population/sep-2021#key-statistics.

[14] Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40(5):373–83. https://doi.org/10.1016/0021-9681(87)90171-8.

[15] Sundararajan V, Henderson T, Perry C, Muggivan A, Quan H, Ghali WA. New ICD-10 version of the Charlson comorbidity index predicted in-hospital mortality. J Clin Epidemiol 2004;57(12):1288–94. https://doi.org/10.1016/j.jclinepi.2004.03.012.

[16] Australian Bureau of Statistics. Socio-Economic Indexes for Areas (SEIFA) 2016 technical paper. ABS. Canberra: Commonwealth of Australia; 2018. editor.

[17] Tefera GM, Feyisa BB, Umeta GT, Kebede TM. Predictors of prolonged length of hospital stay and in-hospital mortality among adult patients admitted at the surgical ward of Jimma University medical center, Ethiopia: prospective observational study. J Pharm Policy Pract 2020;13(1):24. https://doi.org/10.1186/s40545-020-00230-6.

[18] Australian Institute of Health and Welfare (AIHW). National healthcare agreement: PI 23–unplanned hospital readmission rates, 2020. 2020.

[19] Aggarwal R, Soni KD, Gupta A, Kumar S. Outcome of patients of chest trauma suffering from chronic obstructive pulmonary disease: experience at level 1 trauma centre. Anaesthesiol Intensive Ther 2016;48(3):162–5. https://doi.org/10.5603/AIT.a2016.0031.

[20] Kashkooe A, Yadollahi M, Pazhuheian F. What factors affect length of hospital stay among trauma patients? a single-center study, Southwestern Iran. Chinese Journal of Traumatology 2020;23(03):176–80. https://doi.org/10.1016/j.cjtee.2020.01.002.

[21] Australian Institute of Health and Welfare (AIHW). Australian burden of disease study 2022. AIHW; 2022.

[22] Wiseman TA, Curtis K, Lam M, Foster K. Incidence of depression, anxiety and stress following traumatic injury: a longitudinal study. Scand J Trauma Resusc Emerg Med 2015;23:29. https://doi.org/10.1186/s13049-015-0109-z.

[23] Wiseman T, Foster K, Curtis K. Mental health following traumatic physical injury: an integrative literature review. Injury 2013;44(11):1383–90. https://doi.org/10.1016/j.injury.2012.02.015.

[24] Savioli G, Ceresa IF, Gri N, Bavestrello Piccini G, Longhitano Y, Zanza C, et al. Emergency department overcrowding: understanding the factors to find corresponding solutions. J Pers Med 2022;12(2). https://doi.org/10.3390/jpm12020279.

[25] Clark J, Islam MS. Hospital access block: a scoping review. J Emerg Nurs 2022;48(4):430–54. https://doi.org/10.1016/j.jen.2022.03.001.

[26] Elgar G, Smiley A, Latifi R. Major risk factors for mortality in elderly and non-elderly adult patients emergently admitted for blunt chest wall trauma: hospital length of stay as an independent predictor. Int J Environ Res Public Health 2022;19(14). https://doi.org/10.3390/ijerph19148729.

[27] Hsu JM, Clark PT, Connell LE, Welfare M. Efficacy of high-flow nasal prong therapy in trauma patients with rib fractures and high-risk features for respiratory deterioration: a randomized controlled trial. Trauma Surg Acute Care Open 2020;5(1):e000460. https://doi.org/10.1136/tsaco-2020-000460.

[28] Ekpe EE, Eyo C. Effect of analgesia on the changes in respiratory parameters in blunt chest injury with multiple rib fractures. Ann Afr Med 2017;16(3):120–6. https://doi.org/10.4103/aam.aam_73_16.

[29] Baker E, Woolley A, Xyrichis A, Norton C, Hopkins P, Lee G. How does the implementation of a patient pathway-based intervention in the acute care of blunt thoracic injury impact on patient outcomes? a systematic review of the literature. Injury 2020. https://doi.org/10.1016/j.injury.2020.06.002.

[30] Curtis K, Kourouche S, Asha S, Considine J, Fry M, Middleton S, et al. Impact of a care bundle for patients with blunt chest injury (ChIP): a multicentre controlled implementation evaluation. PLoS ONE 2021;16(10):e0256027. https://doi.org/10.1371/journal.pone.0256027.