Injury, Int. J. Care Injured 46 (2015) 1257–1261

Contents lists available at ScienceDirect

Injury

journal homepage: www.elsevier.com/locate/injury

Influence of access to an integrated trauma system on in-hospital mortality and length of stay☆

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ARTICLE INFO

Article history:
Accepted 27 February 2015

Keywords:
Injury
Access to care
Trauma system
Mortality
Length of stay

ABSTRACT

Background: Few data are available on population-based access to specialised trauma care and its influence on patient outcomes in an integrated trauma system. We aimed to evaluate the influence of access to an integrate trauma system on in-hospital mortality and length of stay (LOS).
Methods: All adults admitted to acute care hospitals for major trauma [International Classification of Diseases Injury Severity Score (ICISS < 0.85)] in a Canadian province with an integrated trauma system between 2006 and 2011 were included using an administrative hospital discharge database. The influence of access to an integrated trauma system on in-hospital mortality and LOS was assessed globally and for critically injured patients (ICISS < 0.75), according to the type of injury [traumatic brain injury (TBI), abdominal/thoracic, spine, orthopaedic] using logistic and linear multivariable regression models.
Results: We identified 22,749 injury admissions. In-hospital mortality was 7% and median LOS was 9 days for all injuries. Overall, 92% of patients were treated within the trauma system. Globally, patients who did not have access had similar mortality and LOS compared to patients who had access. However, we observed a 62% reduction in mortality for critical abdominal/thoracic injuries (odds ratio = 0.38; 95% CI, 0.16–0.92) and an 8% increase in LOS for TBI patients (geometric mean ratio = 1.08; 95% CI, 1.02–1.14) treated within the trauma system.
Conclusions: Results provides evidence that in a health system with an integrated mature trauma system, access to specialised trauma care is high and the small proportion of patients treated outside the system, have similar mortality and LOS compared to patients treated within the system. This study suggests that the Québec trauma system performs well in its mandate to offer appropriate treatment to victims of injury that require specialised care.

Introduction

In Canada, injuries represent the leading cause of death during the first four decades of life [1]. The benefits of access to a specialised trauma care facility have been fairly well demonstrated [2]. Mortality and functional outcome following injury are better for patients treated in a trauma centres (TCs) compared to non-designated centres (NTCs) [2,3].

However, research to date has evaluated the effects of access to exclusive trauma systems with only level I or II TCs [2,4,5], compared outcomes following the implementation of a trauma centre model [6–9] or compared inclusive to non-inclusive trauma systems [10,11]. Little is known on the population-based effects of access in integrated trauma systems which consist of a network of TCs that cover the whole health service territory and include service corridors with pre-hospital transport and inter-hospital transfer agreements [12,13]. Research has suggested that even in integrated trauma systems, up to 15% of patients with major injuries in some areas are still treated in a non-designated hospital [14].

☆ Financial support: Canadian Institutes of Health Research: young investigator award [LM] and research grant [LM; #110996]; Fonds de la recherche du Québec – Santé: young investigator award [LM].

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http://dx.doi.org/10.1016/j.injury.2015.02.024
0020–1383/

We aimed to assess the population-based influence of access to an integrated trauma system on in-hospital mortality and length of stay (LOS) for major trauma and critically injured patients, globally and according to type of injury.

Methods

Study design and setting

We conducted a population-based retrospective cohort study of all adult acute care admissions for major trauma from 2006 to 2011 in the province of Québec, Canada. With 8 million inhabitants, Québec is the second most populous province in Canada [15]. The province has 110 health establishments [16], including 59 TCs. The Québec trauma system was instated in 1992 and involves regionalised care from urban level I TCs to rural community hospitals including 5 level I, 5 level II, 21 level III and 28 Level IV [16]. Designation levels are based on American College of Surgeons' criteria [17]. Standardised pre-hospital protocols ensure that major trauma cases are taken to these centres and standing agreements regulate interhospital transfers within the system [18].

Data sources and study population

Data were extracted from the provincial medico-administrative hospital discharge database (MED-ECHO), which contains information on all hospital admissions [19]. Multiple admissions for the same traumatic event due to transfer were included according to their index admission, defined as the admission to the TC with the highest designation level or for patients with no TC admission, the admission with the longest length of stay.

Patients were eligible if they were 16–84 years of age and admitted for major injury, defined as a primary International Classification of Diseases (ICD) injury code between S00 and T14 and an ICD injury severity score (ICISS) under 0.85 [20,21]. ICISS is an accurate method of estimating injury severity using ICD codes present in administrative data bases [22,23] and it has been found to discriminate mortality better than other severity measures based on the Abbreviated Injury Scale [24,25]. We excluded Québec non-residents and patients older than 64 admitted for an isolated hip fracture, defined as a principal diagnosis of hip fracture (ICD-10 codes: S72.0, S72.1 and S72.2) with no secondary injuries of equal or greater severity.

Variables and measurement

The principal outcomes were in-hospital mortality, and hospital LOS. Access to the trauma system was defined either as transportation to a TC from the scene of accident (direct access) or transfer to a TC from a non-designated hospital (indirect access). Potential confounding factors were identified through the literature [2,5,17,26–29] and consultation with the project steering committee comprising physician consultants responsible for the provincial trauma accreditation process, emergency department physicians, critical care physicians and trauma surgeons. These included gender, age, injury severity, number of comorbidities, mechanism of injury, body region of the most severe injury and geographical remoteness. Analyses were stratified by type of injury classified as traumatic brain injury (TBI), abdominal/thoracic, spine, and orthopaedic injuries. We used the body region of the most severe injury to determine the type of injury.

Statistical analyses

The categorisation of continuous variables for analyses was supported by the literature [2,5,17]. LOS was log-transformed and is presented using geometric means which are approximately equivalent to the median [30]. LOS analyses were restricted to patients discharged alive.

We conducted multivariable logistic regression analyses to obtain odds ratios (OR) and 95% Confidence Intervals (CI) of mortality. Multivariable linear regression analyses were used to obtain geometric mean ratios (GMR) and 95% CI of LOS. Analyses were performed for the whole study population, then stratified by type of injury and repeated for critical injuries defined as an ICISS <0.75.

Sensitivity analyses

To evaluate the robustness of our results, we first assessed the effect of access to the trauma system on mortality after excluding all deaths occurring within 24 h of admission. Second, we evaluated the influence of access on LOS by attributing the maximum observed LOS to all fatalities. Third, we repeated the linear regression model with LOS truncated at 90 days to assess the effect of outliers [31]. Fourth we stratified analyses by age (<65; ≥ 65) as previous research has suggested that the benefits of specialised trauma care are less pronounced for geriatric patients [32,33]. Finally, we evaluated the influence of access to level I and II TCs by excluding patients admitted to level III and IV TCs.

Statistical significance was set at 5%, and all analyses were performed using SAS (version 9.3) software. The study was approved by the research ethics board of Laval University (CERUL).

Results

Population characteristics

We extracted 22,749 major injury admissions during the study period, of which 5% were patients admitted more than once for independent traumatic events. Two thirds of cases were men, one third was 65 years of age or older, and 87% of patients were injured in a motor vehicle collision or fall. TBI was the most common type of injury. Overall 20,225 injury cases (88.9%) had direct access and 660 (2.9%) had indirect access to the trauma system. Almost 70% of patients who had access were treated in level I or II TCs. A total of 1591(7%) admissions resulted in death. Median LOS was 9 days with an inter-quartile range of 5–17 days (Table 1). Patients with TBI had the highest in-hospital mortality rate and those with spine injuries, the longest median LOS compared to other types of injury. Mortality and LOS increased with increasing injury severity, age and the number of comorbidities (Table 1). Access to the trauma system was higher for spine injuries and lower for orthopaedic injuries (Table 2).

Multivariable analyses

There were no differences in hospital mortality globally or according to the type of injury between major trauma patients who were treated within the trauma system and those who did not (Table 2). However, we observed a 62% (odds ratio = 0.38; 95% CI, 0.16–0.92) reduction in the odds of mortality for patients with critical abdominal/thoracic injuries treated in the trauma system. Overall, there was a non-significant 4% increase in LOS for major trauma patients who had access to trauma care ($p = 0.07$, Table 3). Patients admitted to the trauma system for TBI had an 8% increase in LOS, and those admitted for abdominal/thoracic injuries had a non-significant 7% decrease ($p = 0.08$). In critically injured patients, LOS was similar overall and according to the type of injury in patients who were treated within the trauma system compared to those who did not.