Contents lists available at ScienceDirect

Journal of Pediatric Surgery

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

US pediatric trauma patient unplanned 30-day readmissions☆,☆☆

Krista K. Wheeler [a,b], Junxin Shi [a,b], Henry Xiang [a,b,c], Rajan K. Thakkar [a,c,d], Jonathan I. Groner [a,b,c,d,*]

[a] Center for Pediatric Trauma Research, The Research Institute at Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH, 43205
[b] Center for Injury Research and Policy, The Research Institute at Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH, 43205
[c] The Ohio State University College of Medicine, 370 W 9th Ave, Columbus, OH, 43210
[d] Department of Pediatric Surgery, Nationwide Children's Hospital, 700 Children's Drive, Columbus, OH, 43205

ARTICLE INFO

ABSTRACT

Purpose: We sought to determine readmission rates and risk factors for acutely injured pediatric trauma patients.
Methods: We produced 30-day unplanned readmission rates for pediatric trauma patients using the 2013 National Readmission Database (NRD).
Results: In US pediatric trauma patients, 1.7% had unplanned readmissions within 30 days. The readmission rate for patients with index operating room procedures was no higher at 1.8%. Higher readmission rates were seen in patients with injury severity scores (ISS) = 16–24 (3.4%) and ISS ≥25 (4.9%). Higher rates were also seen in patients with LOS beyond a week, severe abdominal and pelvic region injuries (3.0%), crushing (2.8%) and firearm injuries (4.5%), and in patients with fluid and electrolyte disorders (3.9%). The most common readmission principal diagnoses were injury, musculoskeletal/integumentary diagnoses and infection. Nearly 39% of readmitted patients required readmission operative procedures. Most common were operations on the musculoskeletal system (23.9% of all readmitted patients), the integumentary system (8.6%), the nervous system (6.6%), and digestive system (2.5%).
Conclusions: Overall, the readmission rate for pediatric trauma patients was low. Measures of injury severity, specifically length of stay, were most useful in identifying those who would benefit from targeted care coordination resources.
Level of evidence: This is a Level III retrospective comparative study.

© 2017 Elsevier Inc. All rights reserved.

Readmissions are increasingly being scrutinized by public insurers, accountable care organizations, and the American College of Surgeons [1–7]. Trauma readmissions have been promoted as a quality indicator [2,5,8], and they have been used as a metric to compare patient care approaches and hospital outcomes [9–12]. Published work has largely focused on adult trauma patient readmissions [5,8,10–24]. A number of those studies are limited to single institutions that do not track readmissions at different hospitals [13,14,16,19,21]. The readmission studies that have included pediatric trauma patients have described readmissions to the same institutions [25–28], and these may underestimate pediatric trauma readmissions [5,29]. Among adult trauma patients in California, only 55% of the readmissions were in the same hospital as the index admission [12]. While the proportion is likely lower for pediatric patients, currently this is not known. Choi et al. reported a very low pediatric trauma unplanned readmission rate of 0.38% over a 5-year study period in their institution [27]. Brown et al.

in a recent paper compared readmissions of pediatric trauma patients to those admitted to other surgical services; the rate of readmissions to trauma services was among the lowest at 2.3% [28]. However, this comparison did not account for trauma patients that may be admitted to other services, i.e. neurosurgical or orthopedic services.

Older age [20,30], comorbidities [20,30,31], pre-injury medications [19], injury severity [20], body region injured [18,20], length of stay [20], discharge disposition [18,20,30], and social deprivation [15] have all been associated with readmissions in adult trauma patients. Moore et al. reported a 30 day unplanned readmission rate of 5.9% for acutely injured trauma patients (16 years or older), and they estimated that 30% of the 30 day readmissions were due to potential complications of injury [20]. Reduced 30 day and 1 year readmissions for adult trauma patients were found to be associated with primary triage to trauma centers by Staudenmeyer and her colleagues, demonstrating a benefit of trauma center care beyond reduced mortality [12].

This study is the first to provide national estimates of pediatric trauma unplanned all-cause 30-day readmission rates by patient, injury, and hospital characteristics. Details about the readmission visits, including whether patients returned to the same hospital, readmission diagnoses and operative procedures are reported. We sought to identify higher readmission risk populations. We are using the National Readmission Database (NRD), a new Healthcare Cost and Utilization Project

dataset which tracks readmissions across hospitals within participating states. A number of previous US trauma readmission studies have used the state specific datasets that contribute to the NRD [10–12,17,18]. The NRD is useful for studying relatively rare events like readmission after pediatric trauma.

1. Methods

1.1. Data source and patient selection

The 2013 National Readmission Database has discharge records from 21 states. The NRD is a convenience sample of nearly 100% of the discharges in the participating states from those hospitals that are not rehabilitation or long-term acute care facilities. The 2013 dataset contains approximately 14 million hospital discharges; when weighted, it estimates 36 million discharges. The weighting is meant to compensate for under or over-representation of hospitals and patient populations in the target universe derived from American Hospital Association data. Post-stratification weighting accounted for the following hospital and patient characteristics: census region, hospital urban/rural location, hospital teaching status, number of beds, hospital control (public, private not-for-profit, and private for-profit), and patient age and sex [32]. NRD documentation provides details about excluded records and missing data imputation [32].

Our index event was pediatric trauma admission based on the principal diagnosis in children 1–17 years old. We did not include children under the age of 1, because the unique patient identifiers are not consistently reported across all states and their readmissions cannot be as readily tracked [32]. We defined hospitalized pediatric trauma patients using the National Trauma Data Standard Definition for trauma patients, International Classification of Diseases, Ninth Revision (ICD-9) injury diagnoses 800–959.9, excluding patients with codes only for late effects of injury, foreign bodies, or superficial injury [33]. We also excluded burn patients, as they are a distinct category of trauma patients with different transfer and readmission patterns [34,35]. To capture acute injury events, patients with planned (elective) index admissions were excluded. Elective and non-elective readmissions were derived from the type of admission (emergency/urgent versus elective), and this variable is provided in the NRD for all admissions. Index events in which patients died were excluded. Patients admitted in December were also excluded, so that 30 days of follow-up were available for all patients. We also excluded patients with cancer and psychoses (1.2% of the sample). These conditions substantially increased the risk of readmission, and these types of exclusions are a recommended practice when evaluating readmissions in large sample populations [32]. Rather than exclude patients with other commonly occurring chronic conditions and comorbidities, we describe readmissions in these patients using the Chronic Condition Indicator (CCI) and the comorbidity measures provided in the NRD.

1.2. Transfers

Patients were tracked across hospitals within a state using patient linkage numbers and combined records for transferred patients. Combined transfer records were provided in the NRD and included the following: diagnoses from the latter discharge and combined lengths of stay (LOS) from the two discharges. We chose to combine the LOS for a small group of transferred patients (n = 14) not considered same day events (LOS ≤1 day for their first admission and the second admission was within one day). The latter admission date was used as the date of the index event.

1.3. Readmission rates

We report 30 day all-cause unplanned readmission rates by patient, injury, and hospital characteristics. We have included readmission rates for the top five comorbid conditions, as well as readmission rates based on the number of chronic conditions listed among the secondary diagnoses. Descriptions of the readmission visit are provided, including the proportion returning to different hospitals, those requiring readmission for major operative procedures, and descriptions of the operative procedures. The readmission principal diagnoses were categorized using a list (Appendix A) developed and used by other researchers describing trauma readmissions [20,36]. We have added updates to this trauma-related diagnosis list based on the readmission principal diagnoses seen in this sample of pediatric trauma patients.

1.4. Severity measures

Injury Severity Scores (ISS) and Abbreviated Injury Scores (AIS) were generated using a validated and publicly available Stata program, ICD Programs for Injury Categorization (ICDPIC) [37]. Hospital trauma level is not in the NRD, so we generated a trauma patient hospital volume variable using quartiles of the annual volume of trauma patients (all ages) with ISS >15. The All Patient Refined Diagnosis Related Groupings (APR-DRGs), developed by 3M™ Health Information Systems, were provided in the NRD, and we utilized its severity of illness measure because it takes into account age, comorbidities, and complications.

1.5. Statistical methods

Using SAS Enterprise Guide 7.1 (SAS Institute Inc., Cary, NC, USA), we produced 30 day all-cause unplanned readmission rates with 95% confidence intervals across patient, injury, and hospital factors. Multivariable logistic regression was used to evaluate risk factors for readmission.

2. Results

From January – November 2013, there were 21,594 index admissions and 381 readmissions in the sample (Table 1). When weighted, these represent an estimated 67,168 US pediatric trauma patients and 1166 readmissions, producing a national unplanned readmission rate of 1.7% (95% CI: 1.5–1.9). Readmission rates were similar across patient demographic categories. Across age categories, the highest rate was in 15–17 year olds, 2.1% (95% CI: 1.7–2.5). Readmissions were seen in patients with all types of principal injury diagnoses. Wide confidence intervals were seen in some categories because of small sample sizes. Only those with crushing injuries had a rate that was statistically higher (2.8% (95% CI: 2.1–3.4)) than the overall rate. Among pediatric patients with AIS scores ≥3, the highest readmission rate was seen in those with injuries to the abdominal and pelvic contents, 3.0% (95% CI: 2.2–3.8). Readmission rates increased with increasing injury severity scores. Patients with an ISS ≥25 had a readmission rate of 4.9% (95% CI: 2.8–6.9). Patients with extreme loss of function, as measured by the APR-DRG, also had a higher readmission rate of 5.9%.

Across the top five most common comorbidities, only those with fluid and electrolyte disorders had higher readmission rates, 3.9% (95% CI: 2.6–5.2). Chronic conditions were seen in 31.7% of the children in the sample, and those with two or more chronic conditions had a higher readmission rate of 2.8% (95% CI: 2.1–3.5). Across the mechanisms of injury categories, there were small numbers of readmissions in some categories, limiting the estimate reliability. Pediatric patients with firearm injuries had a higher readmission rate of 4.5% (95% CI: 2.8–6.2). The readmission rates were similar for patients with and without a major operating room procedure in the index visit. Patients with an index LOS greater than a week also had higher readmission rates, and for patients with LOS ≥15 days, the readmission rate was 6.9% (4.5–9.2). Patients transferred to short-term hospitals, home health, and other facilities (i.e. skilled nursing facilities and intermediate care facilities) also had higher rates of readmission.

Table 2 shows readmission rates across the following hospital characteristics: trauma patient volume, children's hospitals versus non-