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ORIGINAL ARTICLE

Readmission and reinjury patterns in pediatric assault victims

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Abstract

Introduction Repeated pediatric assault should be a never event. The purpose of this study was to evaluate the readmission and reinjury patterns in pediatric victims of assault including readmissions to different hospitals across the US.

Methods The 2010–2014 Nationwide Readmissions Database was queried for all nonelective admissions for patients under the age of 18 years. Primary outcomes were readmission or reinjury within 1 year. Results were weighted for national estimates.

Results Assault-related injury occurred in 46,294 pediatric patients with 11.4% of patients being readmitted within 1 year. Of those readmitted, 35.2% presented to a different hospital. Reinjury within 1 year occurred in about 1% of patients, with 14.8% of those presenting to a different hospital. Age < 13 years, firearm-injury, ISS > 15, female gender, and leaving AMA were found to be independent prognostic indicators of readmission within 1 year among pediatric assault patients.

Conclusion Care of children who are admitted and discharged for assault injuries is more fragmented that previously thought. Quality metrics fail to capture this previously hidden population. Our results identify treatable factors which could improve the care of children after assault.

Keywords Assault · Reinjury · Recidivism · Readmission · Recurrent trauma

Introduction

Traumatic injuries are the leading cause of morbidity and mortality among the pediatric population in the United States. The CDC estimates that injuries in children account for 225,000 hospitalizations annually and cost $94 billion in lifetime medical and work-loss expenses [1, 2]. Injuries incurred during childhood produce detrimental impacts on health status, functional outcomes, and productivity in subsequent years of life, producing staggering costs to families and society [3]. Epidemiological analysis of injuries by their mechanisms and intent is valuable for raising awareness and guiding primary and secondary prevention strategies against additional injuries [4].

Assault is the third leading cause of death among the United States population aged 0–18 years old [1]. Buicko et. al identified risk factors for index assault episodes and risk factors for readmission, and has been stated that survivors of assault are at increased risk of repeated assault [5, 6]. Among the adult literature, the lifetime incidence of recurrent assault widely ranges from 20 to 38% based on estimates from single-center studies [6, 7]. However, this problem remains understudied in pediatric age groups [6, 8].

A hospital readmission for repeated assault in infants, children, and adolescents should be a never event. The index hospital admission after assault is an opportunity for secondary prevention [9]. Prior studies of readmission for recurrent assault injuries in the pediatric population are limited by small sample size or geography, are single-center studies, fail to capture readmissions to different hospitals, or have brief follow-up periods. Inability to track readmissions to different hospitals significantly limits prior studies as trauma readmissions occur at a different hospital in approximately one in four cases [9]. The purpose of this study was to

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calculate the readmission rate for recurrent assault and to assess national readmission patterns among pediatric assault victims, including readmissions to different hospitals.

Methods

The Healthcare Utilization Project (HCUP) is a nationally representative United States database that provides national encounter-level healthcare data through the largest Federal-State-Industry partnership. The project provides researchers with a comprehensive family of databases including the Nationwide Readmissions Database (NRD). The NRD extends the capability of the Nationwide Inpatient Sample (NIS) by utilizing a unique identifier to track patients across admissions including admissions to different hospitals within the same state. During the years of study inclusion, the NRD included data from 22 states representing 2,048 hospitals and included all payment models [10]. HCUP performs extensive processing of NRD data to improve its accuracy. This characteristic is essential for reinjury studies that utilize population level data where it is possible that readmissions related to the index injury could be miscoded as a new injury [10]. The NRD reduces this possibility by collapsing multiple records into one if they involve a transfer or same-day event such as discharge and admission between different hospitals [11].

For this study, the NRD for January 1, 2010 to December 31, 2014 was queried for all hospital admissions for patients age under 18 years experiencing an assault-related injury. These admissions were identified by International Classification of Diseases, Ninth Revision, (ICD-9) E-code corresponding to assault-related injury [12]. The primary outcomes were readmission within 1 year and readmission within 1 year with a new assault-related injury (reinjury). Secondary outcomes included readmission and reinjury to a different hospital and readmission primary diagnosis. Readmissions with an E-code corresponding to "late effects" of injury (E9290, E9291, E9292, E9293, E9294, E9295, E9298, E9299, E959, E969, E977, E989, E9990, E9991) were excluded. This was done to reduce the possibility that the readmission was due to the index injury [10, 13]. Patients were excluded if they died during the initial admission or if the record was composed of collapsed records involving a transfer to a short-term hospital. This was necessary since in these cases it is not possible to identify a single index hospital and subsequently determine if a readmission is to an index or different hospital. Similarly, patients were also excluded if the discharge disposition was listed as transfer to a short-term hospital. This can occur if the patient is transferred to a hospital in a different state or if the transfer was listed to occur on different days at the different hospitals as would happen in an overnight transfer and was therefore not automatically collapsed into a single record [7].

Full variable definitions are available on the NRD Description of Data Elements website [10]. Major operating room procedure is defined by HCUP as a major therapeutic or major diagnostic procedure, as indicated by procedure class and categorized by ICD-9 code. Teaching status refers to whether the hospital is a teaching hospital or not, and if it is in a metropolitan area. Bedsize categories are based on hospital beds, and vary by hospital location and teaching status.

Univariable analysis was performed for each outcome using demographic, clinical, and hospital-related variables during the index admission. Demographic variables included age, sex, median household income, and insurance status. Clinical variables included penetrating injury, firearm-related injury, New Injury Severity Score (NISS), major operating room procedure occurrence, Charlson Comorbidity Index (CCI), length of stay, and disposition. Major operating room procedure is defined by HCUP as a major therapeutic or major diagnostic procedure, as indicated by procedure class and categorized by ICD-9 code. Hospital-related variables included hospital ownership, hospital bed size, and urban hospital teaching status. The NISS and the CCI were calculated for each patient using the ICDPIC version 3.0 software package implemented in Stata/SE version 12.0 for Mac (StataCorp, College Station, Texas) [11]. Results were weighted for national estimates according to HCUP standards [7]. Multivariable logistic regression was performed for each outcome using all significant variables with a p value less than 0.05 on univariable analysis. Categorical variables were compared using a Chi-squared test and are presented as median with interquartile range. Continuous variables were compared using Student's t test and are presented as mean with standard deviation. Statistical analysis was performed using SPSS Statistics version 24 (IBM Corp., Armonk, NY). The Institutional Review Board of the University of Miami waived the requirement for approval of this study since the NRD contains deidentified, publicly available data and its use are not considered human subjects research.

Results

During the study period, there were 46,294 patients < 18 years old admitted for an assault-related injury. The all-cause readmission rate within 1 year was 11.4% ($n = 5,278$). Of the readmissions within 1 year, 35.2% ($n = 1,795$) were to a different hospital. Reinjury-related admissions within 1 year occurred in 409 patients (0.9%), accounting for 7.8% of readmissions. Of those, 14.8% ($n = 59$) presented to a different hospital. Other common

causes of readmission not related to reinjury included pneumonia ($n=303$, 5.7%), acute bronchiolitis ($n=274$, 5.2%), pyelonephritis ($n=273$, 5.2%), respiratory syncytial virus (RSV) ($n=211$, 4.0%), attention to colostomy ($n=83$, 1.6%), and postoperative infection ($n=62$, 1.2%).

Age

Patients under age 13 years comprised 44.2% ($n=21,628$) of patients in this study. The readmission rate for patients < 13 was higher than the overall rate (14.5% versus 11.4%, $p<0.01$, Table 1). Younger patients also had a higher rate of different hospital readmission within 1 year (41.4% versus 35.2%, $p<0.01$, Table 1). After controlling for confounding factors through multivariable logistic regression, patients less than 13 years old were at increased risk for readmission within 1 year (OR 1.18 [95different% CI 1.10–1.28], Table 3). However, age < 13 years was not a significant risk factor for readmission to a hospital ($p=0.78$). Patients < 13 years

Table 1 Overall patient characteristics with results of univariable analysis for readmission within 1 year and different hospital readmission

Characteristic	Total hospitalizations 2010–2014	Readmitted within 365 days	*p* value	Readmitted to different hospital	*p* value
Total	46,294 (100)	5278 (11.4)	*	1795 (35.2)	
Ownership of hospital					
Public	9671 (20.9)	875 (9)	< 0.01	218 (26.3)	< 0.01
Not-for-profit	33,796 (73)	4,163 (12.3)	*	1503 (37.2)	
Investor-owned	2828 (6.1)	241 (8.5)	*	73 (31.7)	
Age < 13 years	20,616 (44.5)	2962 (14.4)	< 0.01	1188 (41.4)	< 0.01
Penetrating	12,585 (27.2)	959 (7.6)	< 0.01	170 (18.6)	< 0.01
Firearm	7638 (16.5)	772 (10.1)	< 0.01	132 (17.8)	< 0.01
ISS > 15	11,776 (25.4)	1921 (21.9)	< 0.01	665 (37)	0.06
Female	13,548 (29.3)	2075 (15.3)	< 0.01	969 (47.5)	< 0.01
Major OR procedure	13,720 (29.6)	1463 (10.7)	< 0.01	208 (14.9)	< 0.01
LOS > 7 days	8893 (19.2)	1952 (21.9)	< 0.01	392 (21.6)	< 0.01
Bed size of hospital					
Small	3417 (7.4)	409 (12)	< 0.01	57 (14.2)	< 0.01
Medium	11,142 (24.1)	1903 (17.1)	*	1092 (58.8)	
Large	31,735 (68.6)	2966 (9.3)	*	646 (22.8)	
Hospital teaching status					
Metropolitan non-teaching	6392 (13.8)	765 (12)	< 0.01	327 (43.9)	< 0.01
Metropolitan teaching	39,024 (84.3)	4449 (11.4)	*	1432 (33.4)	
Non-metropolitan	878 (1.9)	64 (7.3)	*	36 (56.3)	
Median household income					
$1–$37,999	19,374 (41.8)	1959 (10.1)	< 0.01	351 (18.3)	< 0.01
$38,000–$47,999	11,107 (24)	1255 (11.3)	*	441 (36.6)	
$48,000–$63,999	9480 (20.5)	889 (9.4)	*	188 (23)	
$64,000 or more	5611 (12.1)	1133 (20.2)	*	803 (72.2)	
Unknown	723 (1.6)	43 (59)	*	12 (27.9)	
Private insurance					
Yes	10,436 (22.6)	1455 (13.9)	< 0.01	787 (55.4)	< 0.01
Disposition of patient					
Routine	42,698 (92.2)	4627 (10.8)	< 0.01	1688 (37.8)	< 0.01
Skilled nursing facility	1582 (3.4)	310 (19.6)	*	47 (15.8)	
Home health care	1675 (3.6)	300 (17.9)	*	42 (14.5)	
Against medical advice	176 (0.4)	36 (20.5)	*	13 (36.1)	
Destination unknown	164 (0.4)	5 (3)	*	5 (100)	
CCI ≥ 1	4881 (10.5)	646 (13.2)	< 0.01	121 (20)	< 0.01

Total hospitalization characteristics are presented as number (percent of total), readmissions within 365 days are presented as number (percent of total), and readmissions to different hospital are presented as number (percent of readmissions within 365 days). *Values less than 11 redacted according to NRD data use agreement

had lower rates of reinjury (0.8% versus 0.9%, $p < 0.01$) and decreased rates of readmission to a different hospital for reinjury (7.2% versus 14.8%, $p < 0.01$, Table 2). Logistic regression revealed that age < 13 years was not a significant risk factor for reinjury ($p = 0.36$), however, these patients were at decreased risk for reinjury presentation to a different hospital (OR 0.11 [95% CI 0.05–0.28], Table 4).

Gender

Females comprised 29.2% ($n = 14{,}181$) of patients in this study. They were more frequently readmitted (15.6% versus 11.4%, $p < 0.01$) and more often presented to different hospital (47.5% versus 35.2%, $p < 0.01$, Table 1). Logistic regression revealed that females were at increased risk for readmission (OR 1.43 [95% CI 1.34–1.52]) and presented to different hospital (OR 1.58 [95% CI 1.36–1.84], Table 3). Reinjury rates were lower in females (0.5% versus 0.9%,

Table 2 Results of univariable analysis for reinjury within 1 year and presentation to a different hospital

Characteristic	Total hospitalizations 2010–2014	Reinjury within 365 days	*p* value	Reinjury to different hospital	*p* value
Total	46,294 (100)	409 (0.9)		59 (14.8)	
Ownership of hospital					
Public	9671 (20.9)	77 (0.8)	0.18	15 (19.5)	< 0.01
Not-for-profit	33,796 (73)	298 (0.9)		33 (11.5)	
Investor-owned	2828 (6.1)	33 (1.2)		11 (33.3)	
Age < 13 years	20,616 (44.5)	152 (0.7)	< 0.01	11 (7.2)	< 0.01
Penetrating	12,585 (27.2)	109 (0.9)	0.81	13 (11.9)	0.32
Firearm	7638 (16.5)	86 (1.1)	0.01	< 11*	< 0.01
ISS > 15	11,776 (25.4)	74 (0.6)	< 0.01	16 (22.2)	0.05
Female	13,548 (29.3)	73 (0.5)	< 0.01	18 (25.7)	< 0.01
Major OR procedure	13,720 (29.6)	139 (1.1)	0.05	28 (20.1)	0.03
LOS > 7 days	8893 (19.2)	50 (0.6)	< 0.01	< 11*	0.3
Bed size of hospital					
Small	3417 (7.4)	53 (1.6)	< 0.01	< 11*	0.18
Medium	11,142 (24.1)	103 (0.9)		13 (12.9)	
Large	31,735 (68.6)	253 (0.8)		42 (17.1)	
Hospital teaching status					
Metropolitan non-teaching	6392 (13.8)	55 (0.9)	0.38	18 (32.7)	< 0.01
Metropolitan teaching	39,024 (84.3)	350 (0.9)		37 (10.9)	
Non-metropolitan	878 (1.9)	< 11*		< 11*	
Median household income					
$1–$37,999	19,374 (41.8)	206 (1.1)	< 0.01	37 (18.3)	0.12
$38,000–$47,999	11,107 (24)	26 (0.2)		< 11*	
$48,000–$63,999	9480 (20.5)	146 (1.5)		13 (9.3)	
$64,000 or more	5611 (12.1)	31 (0.6)		< 11*	
Unknown	723 (1.6)	< 11*		4 (12.9)	
Private insurance					
Yes	10,436 (22.6)	69 (0.7)	< 0.01	13 (19.4)	0.24
Disposition of patient					
Routine	42,698 (92.2)	375 (0.9)	< 0.01	55 (15.1)	0.33
Skilled nursing facility	1582 (3.4)	< 11*		< 11*	
Home health care	1675 (3.6)	18 (1.1)		< 11*	
Against medical advice	176 (0.4)	< 11*		< 11*	
Destination unknown	164 (0.4)	< 11*		< 11*	
CCI ≥ 1	4881 (10.5)	61 (1.2)	< 0.01	< 11*	0.01

Characteristics are presented as number (percent of total). Reinjury within 365 days are presented as number (percentage of readmissions within 365 days) and reinjury to different hospital are presented as number (percent of reinjury within 365 days). *Values less than 11 redacted according to NRD data use agreement

Table 3 Results of multivariate analysis for readmission and readmission to a different hospital within 1 year

Characteristic	Readmission within 1 year		Readmission to different hospital within 1 year	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Ownership of hospital				
Public	–	–	–	–
Not-for-profit	1.04 (0.96–1.13)	0.32	0.71 (0.57–0.87)	< 0.01
Investor-owned	0.79 (0.67–0.93)	< 0.01	0.92 (0.63–1.34)	0.66
Age < 13 years	1.14 (1.06–1.24)	< 0.01	0.89 (0.74–1.06)	0.19
Penetrating	0.38 (0.32–0.44)	< 0.01	0.89 (0.58–1.36)	0.58
Firearm	2.51 (2.12–2.97)	< 0.01	1.29 (0.83–2.02)	0.26
ISS > 15	1.29 (1.2–1.38)	< 0.01	–	–
Female	1.37 (1.29–1.46)	< 0.01	1.63 (1.39–1.9)	< 0.01
Major OR procedure	0.99 (0.91–1.07)	0.71	0.61 (0.49–0.76)	< 0.01
LOS > 7 days	2.13 (1.97–2.3)	< 0.01	0.31 (0.25–0.37)	< 0.01
Bed size of hospital				
Small	–	–	–	–
Medium	1.61 (1.43–1.82)	< 0.01	5.26 (3.75–7.38)	< 0.01
Large	0.84 (0.75–0.94)	< 0.01	2.22 (1.59–3.08)	< 0.01
Teaching status of hospital				
Metropolitan non-teaching	–	–	–	–
Metropolitan teaching	0.64 (0.58–0.7)	< 0.01	0.54 (0.43–0.67)	< 0.01
Non-metropolitan	0.54 (0.41–0.72)	< 0.01	3.23 (1.77–5.88)	< 0.01
Median household income				
$1–$37,999	–	–	–	–
$38,000–$47,999	1.08 (1–1.17)	0.07	2.21 (1.82–2.7)	< 0.01
$48,000–$63,999	0.89 (0.81–0.97)	< 0.01	1.4 (1.12–1.75)	< 0.01
$64,000 or more	1.85 (1.7–2.03)	< 0.01	5.73 (4.58–7.16)	< 0.01
Private insurance				
Yes	1.12 (1.13–1.3)	< 0.01	1.35 (1.13–1.61)	< 0.01
Disposition of patient				
Routine	–	–	–	–
Skilled nursing facility	1.32 (1.15–1.51)	< 0.01	0.95 (0.64–1.42)	0.82
Home health care	1.18 (1.02–1.36)	0.02	0.71 (0.48–1.05)	0.09
Against medical advice	2.47 (1.66–3.68)	< 0.01	0.54 (0.25–1.16)	0.11
CCI > 1	1.14 (1.03–1.27)	< 0.01	1.12 (0.82–1.78)	0.34

Characteristics are presented as odds ratio (95% confidence interval). *Values less than 11 redacted according to NRD data use agreement

$p < 0.01$) but they more often presented to a different hospital after reinjury (25.7% versus 14.8%, $p < 0.01$, Table 3). Female gender was a protective factor for reinjury (OR 0.55 [95% CI 0.42–0.71]) but the increased risk of reinjury presenting to a different hospital was not statistically significant (OR 2.14 [95% 0.97–4.73] $p = 0.06$, Table 4) after multivariable logistic regression.

Mechanism

Firearm injuries represented 16.9% ($n = 8138$) of the population. These patients had decreased rates of readmission relative to non-firearm injuries (10.0% versus 11.4%, $p < 0.01$) and decreased different hospital readmission (17.8% versus 35.2%, $p < 0.01$, Table 1) relative to non-firearm injuries. However, multivariable logistic regression revealed that firearm-injured patients are at increased risk for readmission (OR 2.50 [95% CI 2.10–2.97], Table 3). Firearm injuries were associated with an increased rate of reinjury (1.2% versus 0.9%, $p = 0.01$). Patients with firearm injuries had decreased rates of different hospital readmission relative to non-firearm injuries (17.8% versus 35.2%, $p < 0.01$, Table 1) with no statistically significant risk demonstrated by logistic regression ($p = 0.26$). These patients had a decreased rate of different hospital readmission for reinjury ($p < 0.01$, Table 3) and were at decreased

Table 4 Results of multivariate analysis for reinjury and reinjury presenting to a different hospital within 1 year

Characteristic	Readmission within 1 year		Readmission to different hospital within 1 year	
	OR (95% CI)	*p*	OR (95% CI)	*p*
Ownership of hospital				
Public	–	–	–	–
Not-for-profit	–	–	0.94 (0.4–2.18)	0.88
Investor-owned	–	–	7.84 (1.2–51.2)	0.03
Age < 13 years	1.02 (0.81–1.28)	0.9	0.04 (0.01–0.16)	< 0.01
Firearm	1.16 (0.89–1.52)	0.27	0.13 (0.04–0.43)	< 0.01
ISS > 15	0.79 (0.6–1.03)	0.08	–	–
Female	0.55 (0.42–0.71)	< 0.01	2.78 (1.13–6.85)	0.03
LOS > 7 days	0.8 (0.57–1.1)	0.017	–	–
Bed size of hospital				
Small	–	–	–	–
Medium	0.5 (0.35–0.7)	< 0.01	–	–
Large	0.46 (0.34–0.63)	< 0.01	–	–
Teaching status of hospital				
Metropolitan non-teaching	–	–	–	–
Metropolitan teaching	–	–	0.82 (0.16–4.28)	0.82
Non-metropolitan	–	–	999 (0–999)	1
Median household income				
$1–$37,999	–	–	–	–
$38,000–$47,999	0.23 (0.15–0.34)	< 0.01	–	–
$48,000–$63,999	1.59 (1.28–1.98)	< 0.01	–	–
$64,000 or more	0.63 (0.43–0.92)	0.02	–	–
Private insurance				
Yes	0.64 (0.49–0.83)	< 0.01	–	–
Disposition of patient				
Routine	–	–	–	–
Skilled nursing facility	0.5 (0.22–1.14)	0.1	–	–
Home health care	1.53 (0.94–2.49)	0.08	–	–
Against medical advice	7.15 (3.64–14.06)	< 0.01	–	–
CCI > 1	1.22 (0.66–2.28)	0.53	0.99 (0.13–7.46)	0.99

Characteristics are presented as odds ratio (95% confidence interval). *Values less than 11 redacted according to NRD data use agreement

risk for different hospital readmission for reinjury (OR 0.11 [95% CI 0.03–0.34], Table 4).

Injury severity

An NISS of > 15 was found in 26.6% ($n = 12{,}819$) of patients in this study (Table 1). Multivariable logistic regression revealed that these patients were at increased risk for readmission (OR 1.39 [95% CI 1.30–1.49]) but a decreased risk for reinjury (OR 0.55 [95% CI 0.42–0.71], Table 4). There was no statistically significant difference in risk for different hospital readmission in patients with an ISS > 15 ($p = 0.06$). A major operating room procedure was involved with 29.9% ($n = 14{,}365$) of patients in this study. These patients were at decreased risk for readmission to a different hospital (OR 0.56 [95% CI 0.45–0.69], Table 3) but increased risk for readmission for reinjury to a different hospital (OR 2.47 [95% CI 1.24–4.93], Table 4).

Hospital characteristics

The majority of patients in this study were treated in not-for-profit hospitals (72.9%). Patients treated in not-for-profit hospitals had higher rates of readmission (12.3% versus 11.4%, $p < 0.01$) and different hospital readmission (37.2% versus 35.2%, $p < 0.01$). However, when controlling for other factors, there was no statistical difference in risk for readmission at not-for-profit hospitals compared to public hospitals, the reference group (OR 1.04 [95% CI 0.96–1.13] $p = 0.09$, Table 3). However, investor-owned hospitals had a decreased

risk for readmission (OR 0.74 [95% CI 0.63–0.88], Table 3). Not-for-profit hospitals had a decreased risk for readmission to a different hospital (OR 0.73 [95% 0.59–0.90] $p < 0.01$, Table 3).

Comorbidities

Patients with a CCI ≥ 1 comprised 10.5% ($n = 5037$) of patients in this study. These patients were at increased risk for readmission (OR 1.29 [95% 1.18–1.42] $p < 0.01$) and decreased risk for readmission to a different hospital (OR 0.62 [95% 0.49–0.79] $p < 0.01$, Table 3). These patients were also at decreased risk for readmission for reinjury to a different hospital (OR 0.17 [95% 0.04–0.74] $p = 0.02$, Table 4).

Discharge disposition

The vast majority of patients in this study were discharged with a routine disposition (92.2%, $n = 42{,}698$). Patients with a disposition of against medical advice (AMA) had a higher rate of readmission (22.0% versus 11.4%, $p < 0.01$) and readmission to a different hospital (36.1% versus 35.2%, $p < 0.01$, Table 1). The risk of readmission was increased for patients with a disposition of AMA (OR 3.52 [95% CI 2.39–5.20], Table 3). There was no statistical difference in risk for readmission to the same ($p = 0.42$) or a different hospital for reinjury for patients leaving AMA ($p = 0.47$). Leaving AMA was also associated with a higher reinjury rate (6.1% versus 0.9%, $p < 0.01$, Table 2) and the highest risk for reinjury (OR 7.45 [95% CI 3.78–14.67], Table 4) after multivariable logistic regression.

Readmission primary diagnosis

Table 5 contains the most common primary diagnosis codes on reinjury readmission as determined by APR-DRG. Four of the ten most common diagnosis involved fractures and the most common diagnosis was closed skull fracture with hemorrhage (6.8%, $n = 29$). Child physical abuse (4.6%, $n = 20$) and nutritional child neglect (3.4%, $n = 15$) were also among the most common diagnoses. Behavioral health diagnoses were also common with unspecified episodic mood disorder (4.5%, $n = 19$) and bipolar disorder (2.4%, $n = 10$) among the ten most common diagnoses.

Table 5 Most common primary diagnosis codes on reinjury admission (*values less than 11 redacted according to NRD data use agreement)

Primary ICD9 diagnosis code on reinjury admission	n	%
Closed fracture of vault of skull with subarachnoid, subdural, and extradural hemorrhage, unspecified state of conscious	29	6.8
Open fracture of one rib	26	6.0
Child physical abuse	20	4.6
Unspecified episodic mood disorder	19	4.5
Methicillin-resistant *Staphylococcus aureus septicemia*	16	3.8
Child neglect (nutritional)	15	3.4
Acute tracheitis without mention of obstruction	12	2.8
Bipolar disorder, unspecified	< 11*	*
Open fracture of shaft of femur	< 11*	*
Closed fracture of mandible, angle of jaw	< 11*	*

Discussion

This study sought to analyze the readmission rate for recurrent assault and to assess national readmission patterns among pediatric assault victims, including readmissions to different hospitals. Previous studies using the Nationwide Readmissions Database to assess readmission trends of pediatric assault victims demonstrate readmission rates less than 5%, but are limited by 1-month follow-up and do not include readmissions to other hospitals [5, 14]. Our multicenter, multiyear analysis is novel and demonstrated that one in ten of pediatric assault victims were readmitted within the following year, with over one-third of these patients presenting to a different hospital. One in twelve readmissions are due to reinjury, with one in seven readmissions for reinjury hidden at different hospitals. Age under 13 years, firearm-injury, ISS > 15, female gender, and leaving AMA were found to be independent prognostic indicators of readmission within 1 year among pediatric assault patients. Furthermore, the most common diagnoses on reinjury readmission were suggestive of assault and included closed skull fracture with hemorrhage, open rib fracture, and child physical abuse.

Readmission rates have been increasingly studied as an indicator of healthcare quality [15]. In the care of trauma patients, unplanned hospital readmission is both costly and associated with increased rates of morbidity [6, 16, 17]. Furthermore, preventive interventions that could protect against repeated assault may be missed by disrupted continuity of care [18].

The absence of these preventive interventions likely plays a critical role in explaining our findings. The greatest risk factor for experiencing readmission for reinjury was having an index discharge AMA. Patients discharged from the index hospitalization AMA were also more likely to be readmitted for any cause. Many patients discharged AMA receive foreshortened care and may not receive secondary preventive interventions against readmission or reinjury [17–20]. In a study on patients who left AMA, many left without plans for follow-up care due to the barriers created by abbreviated inpatient stays [18]. Ultimately, adequate time for discharge planning allows for patient education

and interventions to occur, as well as establishing outpatient care plans.

There are multiple possible explanations for the observed increased risk of readmission to a different hospital. Over 95% of this patient cohort experienced the index hospital admission in a metropolitan setting. This suggests that many of the children in this cohort live in an area with high hospital density, therefore creating variability of choices. Families dissatisfied with care provided during the initial admission may seek alternative hospitals for subsequent care. Additionally, children with private insurance, and thus ostensibly more hospital options, were more frequently readmitted to different hospitals. Patients with comorbidities, receiving care at a not-for-profit hospital, having a major procedure, prolonged hospitalization, and those discharged with home health care were the least likely to be readmitted to a different hospital. These factors may be indicative of more complex care requirements. In such circumstances, more communication between patients and providers may occur, and this familiarity could encourage a return to the index hospital during cases of readmission [21].

As demonstrated in Table 5, four of the six most common diagnoses on readmission were suggestive of assault: closed skull fracture with hemorrhage, open rib fracture, unspecified child abuse, and nutritional neglect. Even if some of these admissions do not have an abuse-related etiology, this finding speaks to the larger pattern that pediatric assault often continues after a single hospitalization. Providers must be aware of this finding as their heightened attention to providing sufficient care, prevention, and protection is necessary.

A critical component of our study, firearm injury continues to be a public health issue that affects the pediatric population. Our analysis demonstrates that pediatric assault patients experiencing firearm injury have a greater than twofold risk for readmission within 1 year. This finding is supported by Wheeler et al. [14] who found 30-day readmissions to be significantly higher among pediatric patients presenting with firearm injury compared with other injury mechanisms at their index admission. Our results supplement the existing literature in urging focused prevention for at-risk pediatric patients during their index admission.

The limitations of this study are inherent to the limitations of the NRD. The NRD is not able to track readmissions across state lines and may include coding errors. Additionally, a substantial amount of assault trauma may not require admission. As an inpatient data set, the NRD may introduce sampling error in selecting for the patients with injuries severe enough to justify admission, evidenced by the observation that nearly one third of patients from the index assault admission required surgery and approximately one quarter of all patients had ISS > 15. Our methodologic intent was to exclude very minor injuries which result in discharge from the ED and may inappropriately influence key findings as well. Future studies should work to incorporate pediatric assault data from emergency departments that to not result in admission as to provide the most comprehensive assessment.

Conclusion

One in seven children who are hospitalized multiple times a year for assault will go unrecognized due to readmission to a different hospital. Not only does readmission to a different hospital cause financial burdens on hospital systems, it impacts psychosocial wellbeing of the children, weakens communities, and limits protections against reinjury. Indicators of care complexity, including longer length of stay, major OR procedure, and discharge with home health are associated with lower risk of readmission to a different hospital, while discharge AMA is the strongest predictor of both readmission and reinjury. As such, stronger prevention efforts must be made during the index hospitalization to protect this vulnerable population.

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Compliance with ethical standards

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