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Critical care resource use, cost, and mortality associated with firearm-related injuries in US children's hospitals☆

Pradip P. Kamat [a,*], Mathew T. Santore [b], Katherine E.M. Hoops [c], Martha Wetzel [d], Courtney McCracken [d], Dennis Sullivan [e], Matthew Hall [f], Jocelyn R. Grunwell [a]

[a] Department of Pediatrics, Division of Critical Care Medicine, Emory University School of Medicine, Atlanta, GA
[b] Department of Surgery, Division of Pediatric Surgery, Emory University School of Medicine, Atlanta, GA
[c] Department of Anesthesiology and Critical Care Medicine, Johns Hopkins Medicine, Baltimore, MD
[d] Department of Pediatrics, Emory University School of Medicine, Atlanta, GA
[e] Children's Healthcare of Atlanta, Atlanta, GA
[f] Children's Hospital Association, Kansas City, MO

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ABSTRACT

Background/Purpose: To assess trends and resource use attributable to firearm-related injuries in US pediatric intensive care units (PICUs).
Methods: Retrospective data from Pediatric Health Information Systems (PHIS) database from 2004 to 2017.
Results: Of 5,984,938 admissions to 28 children's hospitals, 3707 were for firearm injuries. A total of 1088 of 3707 hospitalizations (29.9%) required PICU admission. Median PICU length of stay was 2 days (IQR, 1–6 days), and the median cost for PICU patients was $37,569.31 (IQR, $19,243.83–$77,856.32). Use of mechanical ventilation (674/1088 admissions [61.9%]), surgical procedures (744/1088 admissions [68.3%]), blood transfusions (429/1088 admissions [39.9%]), and intracranial pressure monitoring devices (30/1088 admissions [2.8%]) increased in PICU patients. Computed tomography showed an overall increase (197/287 [68.6%] to 138/177 [78%], $P = .037$) from 2004 to 2007 to 2016–2017. Mortality among PICU patients (140/1058 [13.23%]) attributable to firearm-related injuries increased insignificantly (34/285 (11.93%] to 25/172 [14.53%], $P = .746$).
Conclusions: Using PHIS data, we found a significant increase in median cost per hospitalization and an increase in critical care resource use, including the frequency of invasive mechanical ventilatory assistance, neuromonitoring, operations performed, and transfusion of blood products. Further research is needed to continue to characterize the burden of pediatric critical firearm injury.
Type of Study: Retrospective cohort study.
Level of Evidence: Level III.

Firearms are the second leading cause of death among children and adolescents in the United States, making pediatric firearm injury a major public health problem [1]. Based on the World Health Organization mortality database, in 2016 the rate of firearm-related deaths was higher in the United States than in all other countries with available data: 36.5 times higher than 12 other high-income countries and 5 times higher than the overall rate in 7 low- to middle-income countries [2]. Firearm injuries account for 15.4% of all youth deaths in the United States, second only to motor vehicle crashes, which account for 20.0% of overall youth deaths [1]. The overall rate of deaths from firearm injuries has remained unchanged from 2007 to 2016 at 3.54 per 100,000 children and adolescents, but recent data reveal a relative increase in the mortality rate of 28% between 2013 and 2016 reflecting an increase in deaths due to firearm homicide and firearm suicide [1]. Furthermore, nearly one-third of US households with children and adolescents have at least one firearm, and fewer than half of gun owners report storing all their firearms safely [3,4].

Data from the Web-based Injury Statistics Query and Reporting System of the Centers for Disease Control and Prevention (CDC) estimate the overall cost (in 2010 US dollars) of treating those younger than 21 years for firearm-related injuries to be more than $330 million [5]. In a recent study, Gani et al. reported increasing charges (in 2018 US dollars) that amounted to $2.5 billion (emergency department, $259 million; inpatient, $2.24 billion) or a mean of $270 million per year attributable to firearm-related injuries [6]. Prior studies have failed to

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* Corresponding author at: Emory University School of Medicine, Department of Pediatrics, Division of Critical Care Medicine, Emory University School of Medicine + Children's Healthcare of Atlanta at Egleston. 1405 Clifton Road NE, Atlanta, GA 30322. Tel.: +1 404 277 8010.
E-mail address: pradip.kamat@choa.org (P.P. Kamat).

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report on the use of pediatric critical care resources separate from overall hospital cost [5,6]. To understand the burden of pediatric critical violent firearm injury, it is imperative that we understand what life-sustaining resources are used and the financial contribution of these intensive, multiple organ-supporting interventions provided in the pediatric intensive care unit (PICU) for firearm-related injury.

The objectives of this study were to assess the trends in pediatric hospitalization for firearm-related injuries in a cohort of patients from US children's hospitals and, specifically, to evaluate the effect on pediatric intensive care resource use. We hypothesized that firearm-related admissions to the PICU, as well as critical care resource use and cost, have increased over time.

1. Materials and methods

1.1. Data source and study design

This retrospective cohort study used data from the Pediatric Health Information System (PHIS) database, which contains administrative and billing data from 49 tertiary care children's hospitals located in 27 states and the District of Columbia. The PHIS database is maintained by the Children's Hospital Association (CHA; Lenexa, KS), which along with participating hospitals jointly ensures data integrity and quality. Hospitals associated with the CHA account for 20% of all tertiary care admissions in US children's hospitals. The PHIS hospitals provide discharge data, including patient demographics, diagnoses, and procedures for all inpatient, observation, emergency department, and ambulatory surgery encounters. Billing data include medications, radiologic imaging studies, laboratory tests, and supplies charged to each patient. The PHIS database contains encounter-level data, including demographics, up to 41 *International Classification of Diseases, Ninth Revision* (*ICD-9*) and *International Classification of Diseases, 10th Revision* (*ICD-10*) diagnoses, and up to 41 *ICD-9* and *ICD-10* procedure codes. The Children's Healthcare of Atlanta Institutional Review Board and the CHA Board determined this study to be exempt from review because all patient-related data were deidentified before review and analysis.

1.2. Population and selection criteria

All inpatient and observation encounters of individuals younger than 21 years from January 1, 2004, to December 31, 2017, were identified from the 32 hospitals that provided continuous data for each year of the study period. In conjunction with the CHA, consistency of external cause of injury code submission was reviewed. Four hospitals were subsequently excluded based on inconsistent code submission, and an additional hospital was excluded from PICU-specific analyses because of hospital-specific issues with the PICU indicator. The final sample included 28 hospitals.

Admissions with firearm injuries were identified using *ICD-9*, and *ICD-10* code lists developed from the CDC external cause of injury classification tables (Appendix Table 2).[10] The CDC lists were augmented to include injuries caused by firearm malfunctions. To limit admissions to the initial visit, we excluded sequelae and subsequent visit diagnosis codes.

1.3. Outcome measures

The primary outcome measure was the rate of PICU admission for firearm-related injuries per 10,000 PICU admissions during the study period. Secondary outcomes included in-hospital mortality, PICU-associated costs, length of stay, the use of vasopressors, mechanical ventilatory support, dialysis, imaging modality, invasive procedures or monitoring, need for blood transfusions, and surgery. Hospital costs were estimated from charges by using hospital- and year-specific cost-to-charge ratios and inflated to 2017 dollars using the medical component of the Consumer Price Index.[11] Admission to a PICU, mechanical ventilatory assistance, and surgery were identified using billing data (Supplemental Table 1: Appendix A). *ICD-9*/*ICD-10* codes were used to identify the type of firearms (handgun, hunting rifle, shotgun, other/unspecified) and the intent of injury (unintentional, assault, self-harm, legal, undetermined) (Supplemental Table 1: Appendix B). Vasopressors included the following: dobutamine hydrochloride, dopamine hydrochloride, epinephrine, isoproterenol hydrochloride, milrinone lactate, norepinephrine bitartrate (levarterenol), phenylephrine hydrochloride, and vasopressin. Primary diagnoses were grouped using the Clinical Classification System developed by the Agency for Healthcare Research and Quality. [12,13]

1.4. Statistical analysis

Study years were grouped into epochs: 2004–2007, 2008–2011, 2012–2015, and 2016–2017. Categorical variables were summarized with frequencies and percentages and compared across epochs using χ^2 tests. Continuous variables were summarized with medians and interquartile ranges (IQRs) and compared with Wilcoxon rank sum tests. Trends in the annual rates of firearm-related hospitalizations and procedures were assessed with Cochran-Armitage trend tests across epochs. Trends on the length of stay and costs were assessed using Jonckheere-Terpstra tests. All statistical analyses were performed in SAS statistical software, version 9.4 (SAS Institute Inc., Cary, NC), and $P < .05$ was considered statistically significant.

2. Results

Of 5,984,938 admissions to 28 children's hospitals during the study period, 3707 (6 per 10,000) children were admitted for firearm-related conditions. The number of firearm-related hospitalizations slightly increased across the first three 4-year epochs from 986 to 1027, with an estimated increase to more than 1300 patients in the first 2 years of the fourth and final epoch (Table 1). Regional variation existed in the incidence of firearm-related hospitalizations during the study period (Fig. 1). Rates of firearm-related hospitalizations were highest in the Midwest, until 2016, when the rate in the Southern states eclipsed the Midwest. The Southern states generally demonstrated an increase in firearm-related hospitalizations across the study period. By contrast, firearm-related hospitalizations decreased in the Northeastern states and were low throughout the Western region. The insurance coverage of most of the children with firearm-related injuries (2620 of 3707 [70.6%]) was provided by Medicaid (Table 1).

Although most firearm-related hospitalizations were of children between 10 and 19 years of age in all periods, hospitalizations of children younger than 10 years increased from the first to the final epoch (Table 1). In most cases, the type of firearm was unknown; however, in 25% to 30% of admissions, a handgun was identified as the type of firearm used in the injury. The combination of unintentional injury and assault accounted for more than 85% of the firearm-related admissions. There was an increase in the rate of self-harm from the first to the final epoch (Table 1). Unintentional firearm-related injuries predominated for children up to 14 years of age, whereas assault was the leading intent for teenagers 15 to 19 years of age (Fig. 2). Self-harm emerged as a reason for firearm injury in children 10 years and older (Fig. 2). Internal injury, intracranial injury, and open wounds of the head, neck, and trunk were the primary diagnoses of children admitted to the PICU with firearm-related injuries (Fig. 3) and supplemental Table 2.

A total of 1088 of 3707 firearm-related hospitalizations required admission to a PICU (Tables 1 and 2). Although the rate of PICU admission was relatively constant during the study period, the length of hospital stay for PICU patients increased from a median of 7 days (IQR, 3–16 days) to 9 days (IQR, 4–17 days) in the first half of the fourth epoch (Table 2). The median cost of admission for children requiring PICU admission increased from $28,753 (IQR, $16,458–$61,059) in the first epoch to $40,481 (IQR, $24,136–$79,115) in the fourth epoch

Table 1
Patient demographics and characteristics of firearm-injuries related hospitalizations.

Characteristic	Overall ($n = 3707$)	2004–2007 ($n = 986$)	2008–2011 ($n = 1008$)	2012–2015 ($n = 1027$)	2016–2017 ($n = 686$)	*P* Value for Trend
Age. Y	14 (10–16)	14 (12–16)	14 (10–16)	14 (9–15)	14 (9–15)	<.001
Age group, y						
0–4	446 (12.1)	85 (8.62)	114 (11.31)	157 (15.29)	90 (13.12)	<.001
5–9	428 (11.61)	98 (9.94)	106 (10.52)	132 (12.85)	92 (13.41)	.008
10–14	1311 (35.57)	346 (35.09)	366 (36.31)	351 (34.18)	248 (36.15)	.967
15–19	1501 (40.72)	457 (46.35)	422 (41.87)	387 (37.68)	256 (37.32)	<.001
Sex						
Male	2893 (78.59)	775 (78.76)	790 (78.84)	797 (78.44)	531 (78.2)	.751
Female	788 (21.41)	209 (21.24)	212 (21.16)	219 (21.56)	148 (21.8)	.751
Race/ethnicity						
Black, non-Hispanic	2282 (66.71)	617 (67.36)	636 (67.73)	603 (64.7)	426 (67.19)	.530
White, non-Hispanic	799 (23.36)	192 (20.96)	213 (22.68)	240 (25.75)	154 (24.29)	.034
Hispanic or Latino	340 (9.94)	107 (11.68)	90 (9.58)	89 (9.55)	54 (8.52)	.044
Payer						
Government	2620 (70.68)	650 (65.92)	685 (67.96)	760 (74)	525 (76.53)	<.001
Private	693 (18.69)	171 (17.34)	214 (21.23)	189 (18.4)	119 (17.35)	.748
Other	394 (10.63)	165 (16.73)	109 (10.81)	78 (7.59)	42 (6.12)	<.001
Gun						
Handgun	1060 (28.59)	284 (28.8)	289 (28.67)	315 (30.67)	172 (25.07)	.322
Rifle	114 (3.08)	31 (3.14)	37 (3.67)	34 (3.31)	12 (1.75)	.142
Legal	22 (0.59)	6 (0.61)	5 (0.5)	8 (0.78)	3 (0.44)	.938
Shotgun	328 (8.85)	119 (12.07)	94 (9.33)	80 (7.79)	35 (5.1)	<.001
Other	2183 (58.89)	546 (55.38)	583 (57.84)	590 (57.45)	464 (67.64)	<.001
Intent						
Unintentional	1742 (46.99)	437 (44.32)	431 (42.76)	506 (49.27)	369 (53.79)	<.001
Assault	1573 (42.43)	421 (42.7)	477 (47.32)	425 (41.38)	250 (36.44)	.003
Self-harm	115 (3.1)	21 (2.13)	31 (3.08)	36 (3.51)	27 (3.94)	.025
Legal	22 (0.59)	6 (0.61)	5 (0.5)	8 (0.78)	3 (0.44)	.938
Unknown	1742 (46.99)	101 (10.24)	64 (6.35)	53 (5.16)	37 (5.39)	<.001
PICU Admissions	1088 (29.87)	287 (29.96)	308 (30.95)	316 (31.13)	177 (26.26)	.212

Data are presented as number (percentage). PICU, pediatric intensive care unit.

($P < .001$), for a median cost of $37,569.31 (IQR, $19,243.83–$77,856.32) (Table 2). Overall, 674 of 1088 children (62%) admitted to the PICU required mechanical ventilatory support, which increased over time (154 of 287 [53.7%] in 2004–2007 to 114 of 177 [64.4%] in 2016–2017, $P = .002$). Vasopressor support was required in 477 of 1088 children (43.8%) admitted to the PICU, which also increased over time (103 of 287 [35.9%] in 2004–2007 to 94 of 177 [53.1%] in 2016–2017, $P = .001$). Central venous catheters and arterial catheters were used in 383 (35.2%) and 186 (17.1%) of the cohort. There was an increase in surgical procedures (176 of 287 [61.3%] in 2004–2007 to 119 of 177 [67.2%] in 2016–2017, $P < .001$), blood product transfusions (84 of 287 [29.43%] in 2004–2007 to 76 of 177 [42.9%] in 2016–2017, $P = .003$), and intracranial pressure monitoring (0 in 2004–2007 to 22 of 177 [12.4%] in 2016–2017, $P < .001$) during the study period. In addition, there was an increase in computed tomography (197 of 287 [68.6%] in 2004–2007 to 138 of 177 [78.0%] in 2016–2017, $P = .037$), ultrasonography (77 of 287 [26.8%] in 2004–2007 to 72 of 177 [40.7%] in 2016–2017, $P < .001$), and magnetic resonance imaging (8 of 287 [2.8%] in 2004–2007 to 13 of 177 [7.3%] in 2016–2017, $P = .002$) modalities over time. The overall mortality was 172 (4.7%), and the mortality of children admitted to the PICU for firearm-related injuries was 140 (13.2%) (Table 3).

3. Discussion

Firearm-related injury is now the second leading cause of death in US children behind motor vehicle collisions and is a major public health concern [1,7]. However, firearm injury research has been constrained due to data availability, restrictions on data acquisition, and lack of federal funding. This study using an extensive database such as PHIS can significantly enhance our ability to study outcomes, risk factors, resource needs as well as inform preventive and therapeutic interventions.

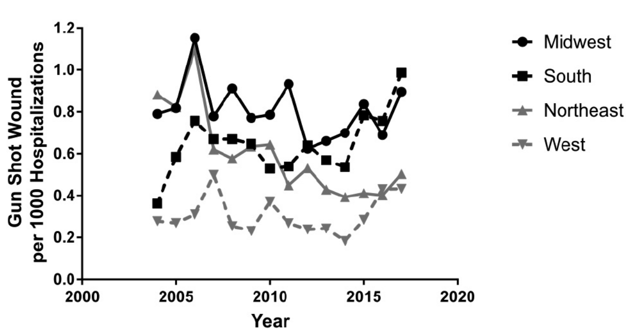

Fig. 1. Firearm-related injuries per 1000 hospitalizations from 2004 to 2017 by region of the country. The Midwest is represented by the solid black line with circular markers; the South by a dashed black line with square markers; the Northeast by a gray solid line with upright triangle markers; and the West by a dashed gray line with downward markers.

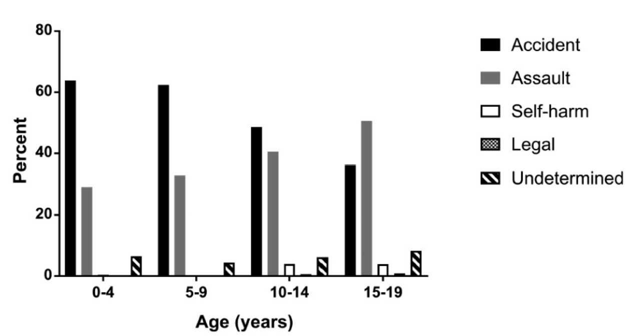

Fig. 2. The percentage of firearm-related injury hospitalizations by intent and age group. Unintentional injuries (black bars) predominate at the younger age groups. Assaults (gray bars) predominate for adolescents 15 to 19 years of age. Self-harm (white bars) begins to appear for children 10 years and older. Undetermined intent (diagonal lined bars) occurs in all age groups. Legal intent (checkered bars) occurs at a low level in children 10 years and older.

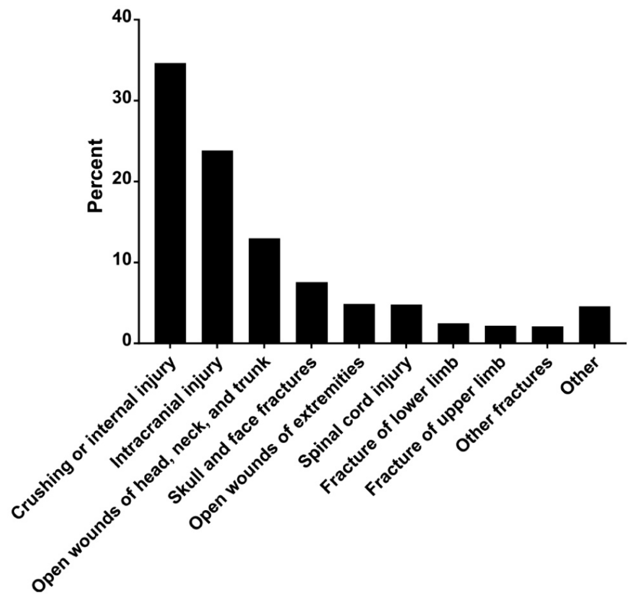

Fig. 3. Primary diagnoses of patients hospitalized with firearm-related injuries throughout the study period.

While we did not find a significant increase in PICU admissions during the study period, we found a significant increase in median cost per hospitalization and an increase in critical care resource use. The critical care interventions included the frequency of invasive mechanical ventilatory support, vasopressor use, invasive and noninvasive neuromonitoring, operations performed, transfusion of blood products, and radiologic imaging. However, our analysis did not reveal any patterns of injuries on the initial presentation that could be attributed to the increase in PICU resource utilization due to the firearm-related injuries.

Although the median number of days in the PICU stayed the same, the duration of hospital length of stay increased by 2 days over time. As a result, the median cost of care increased significantly during the study period likely because of the longer hospital stay and increased use of intensive monitoring, imaging, and therapies administered to patients. However, the financial burden noted in this study does not include the cost of care outside the hospital, such as the need for rehabilitation (inpatient or outpatient), lifestyle modification for patients or their families because of disability, loss of economic potential, and chronic care requirements. As a consequence, our study likely underestimates the financial burden of firearm-related injuries in PICU patients.

The type of firearm-related injury intent in hospitalized adults, adolescents, and children has been associated with age, sex, and race in prior studies, with no focus on critical care resource use [8–12]. Insurance coverage for most children admitted to the PICU in this study was provided by Medicaid as also shown by a study by Spitzer et al. [13] The percentage of children with firearm-related injuries with Medicaid as the primary payer has increased over time. Reduction in Medicaid funding could have a major effect on the ability to recoup the increasing costs of acute hospital care associated with firearm-related injuries. We also noted regional differences in firearm-related injury admissions in the South and Midwest, regions that have less strict legislation about gun ownership in addition to higher gun ownership because of cultural and occupational factors. Additionally, South Eastern states were more likely to have unsafe storage of firearms (loaded and unlocked) in presence of children and adolescents [3,14].

The opioid crisis in the United States has resulted in state and federal initiatives aimed at improving prescribing practices and more closely surveilling trends through scientific and public health research. The gun violence crisis is also a public health problem with public health solutions [15].

The public and legislative focus on the current US opioid crisis has identified key drivers for opioid-related pediatric morbidity. [16] [15]A similar approach could be applied to gun violence related to pediatric

Table 2
Resource Use for Firearm-injuries Related in Patients Admitted to the PICU.

Characteristic	Overall (n = 1088)	2004–2007 (n = 287)	2008–2011 (n = 308)	2012–2015 (n = 316)	2016–2017 (n = 177)	*P* Value for Trend[a]
Length of stay, median (IQR), d						
Hospital	7 (3–16)	7 (3–13)	7 (3–15)	8 (4–20.5)	9 (4–17)	<.001
PICU	2 (1–6)	2 (1–4)	2 (1–6)	3 (1–7)	2 (1–5)	<.001
Cost per episode, median (IQR), $	37,569 (19,243 – 77,856)	28,735 (16,458 – 61,059)	36,113 (18,696 – 77,009)	43,909 (22,380 – 90,234)	40,481 (24,136 – 79,115)	<.001
Ventilation, No. (%)						
Mechanical	674 (61.95)	154 (53.66)	190 (61.69)	216 (68.35)	114 (64.41)	.002
Noninvasive	76 (7.07)	14 (4.9)	24 (8.03)	27 (8.63)	11 (6.21)	.345
Vasopressor, No. (%)	477 (43.84)	103 (35.89)	132 (42.86)	148 (46.84)	94 (53.11)	<.001
Procedures, No. (%)						
Chest tube	200 (18.6)	49 (17.13)	59 (19.73)	66 (21.09)	26 (14.69)	.888
Dialysis	11 (1.02)	3 (1.05)	1 (0.33)	7 (2.24)	0 (0.00)	.977
EEG	130 (12.09)	17 (5.94)	38 (12.71)	47 (15.02)	28 (15.82)	<.001
ICP monitoring	30 (2.79)	0 (0.00)	0 (0.00)	8 (2.56)	22 (12.43)	<.001
Arterial catheter	186 (17.09)	38 (13.29)	56 (18.73)	69 (22.04)	23 (12.99)	.392
Central venous catheter	467 (42.92)	84 (29.37)	111 (37.12)	130 (41.53)	58 (32.77)	.109
Surgery	744 (68.38)	176 (61.32)	206 (66.88)	243 (76.9)	119 (67.23)	.007
Blood product transfusion	429 (39.91)	84 (29.37)	136 (45.48)	133 (42.49)	76 (42.94)	.003
Imaging, No. (%)						
Angiography	56 (5.15)	20 (6.97)	8 (2.6)	19 (6.01)	9 (5.08)	.720
Computed tomography, any	790 (72.61)	197 (68.64)	224 (72.73)	231 (73.1)	138 (77.97)	.037
Abdomen/pelvis	265 (24.36)	80 (27.87)	79 (25.65)	65 (20.57)	41 (23.16)	.074
Chest	227 (20.86)	63 (21.95)	65 (21.1)	67 (21.2)	32 (18.08)	.393
Head	419 (38.51)	89 (31.01)	132 (42.86)	124 (39.24)	74 (41.81)	.033
Doppler ultrasonography	49 (4.5)	13 (4.53)	14 (4.55)	14 (4.43)	8 (4.52)	.972
Ultrasonography	373 (34.28)	77 (26.83)	102 (38.61)	122 (38.61)	72 (40.68)	<.001
Interventional radiology	58 (5.33)	14 (4.88)	13 (4.22)	21 (6.65)	10 (5.65)	.393
MRI	60 (5.51)	8 (2.79)	12 (3.9)	27 (8.54)	13 (7.34)	.002

EEG = electroencephalography; ICP, intracranial pressure monitor; IQR, interquartile range; MRI, magnetic resonance imaging; PICU, pediatric intensive care unit.
[a] *P* value for association calculated using χ^2 square test. *P* value for trend calculated using Cochran-Armitage trend tests and Jonckheere-Terpstra tests.

Table 3
Discharge Status of Patients Admitted for Firearm related injuries.

Variable	Overall	2004–2007	2008–2011	2012–2015	2016–2017	*P* Value for Trend
All patients	3647	982	989	1003	673	
Home	3205 (87.88)	890 (90.63)	851 (86.05)	878 (87.54)	586 (87.07)	.050
Died	172 (4.72)	42 (4.28)	52 (5.26)	49 (4.89)	29 (4.31)	.969
Other[a]	270 (7.4)	50 (5.09)	86 (8.7)	76 (7.58)	58 (8.62)	.016
PICU patients	1058	285	299	302	172	
Home	753 (71.17)	226 (79.3)	195 (65.22)	218 (72.19)	114 (66.28)	.016
Died	140 (13.23)	34 (11.93)	44 (14.72)	37 (12.25)	25 (14.53)	.649
Other	165 (15.6)	25 (8.77)	60 (20.07)	47 (15.56)	33 (19.19)	.010

Data are presented as number (percentage) of patients. PICU, pediatric intensive care unit.

[a] Other includes discharged/transferred to an inpatient rehabilitation facility, discharged/transferred to home under care of organized home health service organization in anticipation of covered skilled care, discharged/transferred to a short-term general hospital for inpatient care, discharged to home health services or transferred to intermediate care facility, transferred to skilled nursing facility, or discharged/transferred to a psychiatric hospital or psychiatric distinct part unit of a hospital. Left against medical advice is also included in other.

morbidity and mortality. We hope the findings of this study will provide an opportunity for pediatric surgeons/intensivists as well as other researchers for comparative effectiveness research, which investigates the association between diagnostic and therapeutic interventions and outcomes in this vulnerable population. Additionally, this study will inform surgeons, trauma teams, PICU design experts, and hospital planners to allocate appropriate resources, including PICU beds, trained nursing, and allied staff, to handle the increasing burden of firearms violence.

3.1. Limitations

There are several limitations to using the PHIS database. The PHIS is an administrative database; therefore, although it provides more therapeutic and diagnostic data per patient than most administrative data sets, no physiologic data are available. The patients captured for this study are dependent on the accuracy and completeness of the *ICD-9* and *ICD-10* external cause of injury codes. Given that these codes are not mandatory in all states, there may be underreporting in our study. We took steps to reduce potential bias stemming from inconsistent reporting by limiting the set of hospitals to those that provided data for all years of the study and consistently submitted external cause of injury codes. However, it remains possible some irregularities were not accounted for in this study. Therefore, our estimates of frequency and resource use are likely conservative. Because children's hospitals participating in the PHIS are tertiary and quaternary care facilities in major US metropolitan cities, the data are likely not generalizable to community hospitals or hospitals that do not offer specialty pediatric services. Because PHIS hospitals only represent 20% of hospitals that care for US children, our findings do not represent the complete burden of firearm-related injuries in the United States. However, PHIS member hospitals are likely to be the major regional and state referral centers for children, and our results may underrepresent the true incidence of firearm-related injuries that require PICU care. Furthermore, gunshot wounds that are lethal before or shortly after arrival to the emergency department will not be captured by the PHIS database because these children are not admitted to the hospital, and these missed cases may contribute to the underestimation of the fatality rate attributable to firearms. Similarly, adolescents admitted to adult trauma centers are not captured by the PHIS database. Nevertheless, our results demonstrate increasing problems of morbidity and costs related to gun violence in US children. The high critical care resource use reported by our study places the pediatric intensivist at the nexus of prevention of firearm injuries, advocacy for firearm safety, and firearm research. Pediatric intensivists and pediatric surgeons should embrace this advocacy role and work with community pediatricians, pediatric subspecialists, politicians, and gun organizations to reduce the morbidity, mortality, and resource burden of firearm injuries in children. An opportunity exists for children's hospitals to expand the violence intervention programs present at a few trauma centers in the United States to the PICUs so that multidisciplinary PICU teams can counsel patients, siblings, and other family members about safe and responsible handling of firearms to prevent recurrent injury [17].

4. Conclusion

The high critical care resource use reported by our study places pediatric intensivists at the nexus of prevention of firearm injuries, advocacy for firearm safety, and firearm research. Addressing the gun violence epidemic in the US will require a multidisciplinary and evidence-based approach. Further research is needed to continue to characterize the burden of pediatric critical firearm injury and to devise strategies for the prevention of injury and improvements in outcomes.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jpedsurg.2020.02.016.

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