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Undertriage of Pediatric Major Trauma Patients in the United States

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Abstract

Although trauma undertriage has been widely discussed in the literature, undertriage in the pediatric trauma population remains under-studied. Using the 2009–2013 Nationwide Emergency Department Sample, we assessed the national undertriage rate in pediatric major trauma patients (age≤16 and injury severity score [ISS]>15), and identified factors associated with pediatric trauma undertriage. Nationally, 21.7% of pediatric major trauma patients were undertriaged. Children living in rural areas were more likely to be undertriaged (P=0.02), as were those without insurance (P=0.00). Children with life-threatening injuries were less likely to be undertriaged (P<0.0001), as were those with chronic conditions (P<0.0001). Improving access to specialized pediatric trauma care through innovative service delivery models may reduce undertriage and improve outcomes for pediatric major trauma patients.

Keywords

undertriage; pediatric major trauma; access to pediatric trauma care

Introduction

Regionalized trauma systems have been developed in the U.S. to improve the triage and treatment of trauma patients. Ideally, patients with major trauma should receive the highest level of trauma care at level I or II trauma centers. Patients with major trauma are undertriaged when treated at non-trauma centers or level III trauma centers which lack trauma experts and resources. Undertriaged patients are at 25% higher risk of mortality (1). The undertriage rate is an important quality indicator of trauma systems. An undertriage rate

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of less than 5% is desirable according to the American College of Surgeons Committee on Trauma (ACS-COT) (2). Nationally, the undertriage rate of major trauma patients is 34% (3). In 18 states, the undertriage rate in adult trauma patients is 36.5% (4). However, undertriage in the pediatric trauma population is under-studied. Only two studies reported the undertriage rates of pediatric major trauma patients (3, 5). No study has exclusively examined pediatric trauma undertriage on the national level. It remains unclear what factors contribute to undertriage in pediatric major trauma patients.

A major barrier to examining trauma undertriage has been a dearth of national data sources that include identifiers of trauma center designation and data from non-trauma centers. The Kids' Inpatient Database (KID) is a national database of pediatric inpatient encounters (6). An analysis of KID showed that 89% of injured children receive care at adult hospitals (7); however, the undertriage rate was not reported because trauma center designation was not available in the KID. The National Trauma Data Bank® (NTDB) provides detailed patient information from U.S. trauma registries (8). However, only trauma centers voluntarily submit data to the NTDB; it does not capture data from non-trauma centers. The Nationwide Emergency Department Sample (NEDS) can address these limitations, because 1) it captures a nationally representative sample of ED encounters from both trauma centers and non-trauma centers, and 2) it classifies hospitals as trauma centers or as non-trauma centers (9).

Using the 2009–2013 NEDS, we aimed 1) to examine the national rate of undertriage among pediatric major trauma patients, and 2) to identify factors associated with undertriage among those patients. We hypothesized that children with less severe injuries and those living in rural areas were more likely to be undertriaged. Better understanding the factors associated with undertriage will allow for development of interventions to further optimize trauma systems and improve outcomes for severely injured children.

Materials and Methods

Data Source

The Nationwide Emergency Department Sample (NEDS) is one of the Healthcare Cost and Utilization Project (HCUP) databases produced by the Agency for Healthcare Research and Quality. The NEDS is the largest all-payer emergency department (ED) database in the United States. The NEDS contains about 30 million ED discharges annually, representing more than 67% of all ED patients. The NEDS provides weighting and sampling variables for calculating national estimates. Along with standard administrative data, the NEDS contains a variable that identifies hospitals as non-trauma centers or as trauma centers (level I, II, or III).

This study was exempted from review by the Institutional Review Board of the Nationwide Children's Hospital, because it used publicly available and de-identified data.

Study Population

Eligible patients were children with major trauma aged 0 to 16 years. We extracted ED encounters with diagnosis codes for trauma [International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) 800–959]. We excluded superficial injuries

(910–924.9), injuries from late effects (905–909.9), and injuries due to foreign bodies (930–939.9) (1, 3). Beginning in 2009, the NEDS provides injury severity scores (ISS) assigned by the STATA ICD Programs for Injury Categorization (ICDPIC). We used ISS>15 and age 0–16 to identify pediatric major trauma patients.

Definition of undertriage

We used the definition of undertriage recommended by the American College of Surgeons Committee on Trauma, that is, patients with major trauma were undertriaged if they received definitive care at non-trauma centers or level III trauma centers (2). In this study, undertriaged patients were those with a major trauma who were (1) treated and released from the ED of a non-trauma center or a level III trauma center (e.g. discharges to home or self-care, discharges to skilled nursing home, left against medical advice, and home health care), (2) admitted as an inpatient to a non-trauma center or a level III trauma center, or (3) died in the ED of a non-trauma center or a level III trauma center. Patients who were brought in dead or dying were not included in the NEDS. The NEDS specified that only patients who received medical treatments at the ED were included. We excluded patients who were transferred to another hospital to avoid double counting, because transferred patients could be counted at both the transferring hospital and the receiving hospital. We also excluded patients with unknown ED dispositions and those with an unspecified level of care (Figure 1).

Statistical analysis

We performed data analyses using SAS 9.3 software (SAS Institute, Cary, NC). We assessed the total number of ED encounters of pediatric major trauma in the 2009–2013 NEDS. We produced a national undertriage rate of pediatric major trauma patients. The undertriage rate was defined as the proportion of pediatric major trauma patients who received definitive care at non-trauma centers or level III trauma centers. We also produced undertriage rates by patient characteristics, including age, sex, presence of life-threatening injuries, presence of chronic conditions, insurance status, median household income, patient's residential location, external cause of injuries, and admission timing. We defined life-threatening injuries as those defined by the ACS-COT as life-threatening (Appendix). Patients with those injuries in particular benefit from early transfer to level I or II trauma centers. We identified factors associated with undertriage of pediatric major trauma using univariate and multivariate logistic regression models.

Results

The 2009–2013 NEDS contained 15,494 ED encounters of pediatric major trauma patients (Figure 1). Of these patients, 9,244 were seen at level I or II trauma centers, 5,064 were seen at non-trauma centers or level III trauma centers, and 1,186 were seen at hospitals with unspecified level of care. There were 117 ED deaths at level I or II trauma centers, compared to 104 ED deaths at non-trauma centers or level III trauma centers. To avoid double counting patients, we excluded patients transferred from the ED (3,308). We also excluded ED patients with unspecified level of care (1,186), and those with unknown ED dispositions

(49). Our final study sample included 10,951 ED encounters of pediatric major trauma patients, representing 52,116 ED patient encounters on the national level.

Nationally, the undertriage rate among children with major trauma was 21.7% [95% confidence interval (CI): 17.8% – 25.6%] (Table 1). Children with life-threatening injuries had a lower rate of undertriage (12.8%, 95% CI: 9.7% – 15.9%) than children without life-threatening injuries (28.4%, 95% CI: 23.6% – 33.3%). Similarly, children with chronic conditions had a lower rate of undertriage (11.6%, 95% CI: 8.5% – 14.7%) than children without chronic conditions (29.3%, 95% CI: 24.6% – 34.0%). Children living in rural areas had a higher rate of undertriage (31.9%, 95% CI: 24.3% – 39.5%) when compared with those living in large fringe metropolitan areas (18.7%, 95% CI: 13.7% – 23.8%). Children with injuries caused by falls had a higher rate of undertriage (30.0%, 95% CI: 24.9% – 35.1%) than children with motor vehicle traffic injuries (11.9%, 95% CI: 8.6% – 15.1%).

These same factors, along with insurance status and day of admission, were associated with undertriage in the multivariate model (Table 2). Specifically, children with life-threatening injuries were less likely to be undertriaged [adjusted odds ratio (AOR) =0.62; 95% CI, 0.53 – 0.73; P-value <0.0001], as were children with chronic conditions (AOR =0.42; 95% CI, 0.33 – 0.52; P-value <0.0001). Children living in rural areas were more likely to be undertriaged than those living in large central metropolitan areas (AOR=1.63; 95% CI, 1.07–2.47; P-value=0.02). Children with injuries caused by falls were more likely to be undertriaged than those with motor vehicle traffic injuries (AOR=2.41; 95% CI, 1.86 – 3.14; P-value <0.0001). In addition, children without insurance were more likely to be undertriaged than those with private insurance (AOR =1.79; 95% CI, 1.21–2.64; P-value=0.00). Children admitted on weekends were less likely to be undertriaged than those admitted on weekdays (AOR=0.87; 95% CI, 0.78 – 0.99; P-value =0.03).

Discussion

Our study is the first to examine undertriage among children with major trauma in the United States. In the 2009–2013 NEDS, 21.7% of children with major trauma were undertriaged. Children living in rural areas and those without insurance were more likely to be undertriaged. Children with life-threatening injuries and those with chronic conditions were less likely to be undertriaged.

To improve outcomes of injured children, it is imperative to understand the causes behind the high rate of undertriage observed here (21.7%), which greatly exceeds the 5% rate recommended by the American College of Surgeons Committee on Trauma (ACS-COT) (2). One possible cause is that many injured children use private transport rather than Emergency Medical Services (EMS). EMS personnel are equipped with the knowledge of field triage guidelines to find the optimal destination hospital for an injured child (10). However, over one third of injured children used private transport in the US (11). Private transporters (e.g., parents or caregivers) often take injured children to the nearest or most familiar hospital (12). As a result, 16% to 34.9% of injured children are transferred to another hospital for more appropriate level of care (12, 13). To help parents quickly find the right hospital for their injured child, experts from the 2015 Childress Summit suggested developing a

smartphone app to help parents understand which hospitals best fit their child's needs (e.g., urgency level and specialties), where they are located, and what characteristics differentiate them (e.g. distance, waiting time) (14).

Our study showed that children living in rural areas were more likely to be undertriaged. This finding reflects that Level I or II trauma centers are generally located in urban areas (15); about 77% of children living in rural areas do not have access to pediatric trauma centers (16). Although our study was unable to distinguish between adult and pediatric trauma centers, prior studies indicated that pediatric trauma centers are scarce (15–17); most injured children were treated at adult hospitals (5, 7). Those adult hospitals often lack dedicated pediatric trauma experts and resources. To improve access to pediatric trauma services, experts from the 2015 Childress Summit proposed a virtual pediatric trauma center (14). The goal of a virtual pediatric trauma center is to quickly transfer existing pediatric trauma expertise to rural hospitals or adult hospitals using wireless technology and modern computer software.

Our study also found that children without insurance were more likely to be undertriaged. However, prior studies showed that trauma patients were more likely to be undertriaged if covered by insurance (18–21). This phenomenon was attributed to the potential financial gain of retaining patients with insurance (21). The effect of insurance status on undertriage of severely injured children warrants further research. We also found that children with life-threatening injuries and those with chronic conditions were less likely to be undertriaged. This finding is consistent with one prior study in which children with more severe injuries or pre-existing conditions were less likely to be undertriaged (5).

There are several limitations to this study. First, we attempted to include and describe differences in pediatric trauma centers and adult trauma centers, but found that pediatric trauma centers were under-sampled in the NEDS. In 2009– 2013, the NEDS included ED encounters from an average of only 4 pediatric trauma centers per year. Future studies should recognize this limitation of using the NEDS. Second, we used a single injury severity measure, the ISS, to identify major trauma patients. The ISS is a frequently used severity measure in trauma research (22–25). Third, the NEDS did not provide detailed information on clinical practice. We were only able to use the ICD-9-CM diagnosis codes to describe patients' clinical situations.

In summary, 21.7% of pediatric major trauma patients were undertriaged in the US. Children living in rural areas, those without life-threatening injuries or chronic conditions were more likely to be undertriaged. Improving access to specialized pediatric trauma care through innovative service delivery models may reduce undertriage and improve outcomes for severely injured children.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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References

1. MacKenzie EJ, Rivara FP, Jurkovich GJ, et al. A national evaluation of the effect of trauma-center care on mortality. N Engl J Med. 2006;354(4):366–378. [PubMed: 16436768]
2. American College of Surgeons Committee on Trauma (ACS-COT) Resources for optimal care of the injured patient 2014. Chicago (IL): The Committee; 2014.
3. Xiang H, Wheeler KK, Groner JI, et al. Undertriage of major trauma patients in the US emergency departments. Am J Emerg Med. 2014;32(9):997–1004. [PubMed: 24993680]
4. Nathens AB, Jurkovich GJ, MacKenzie EJ, et al. A resource-based assessment of trauma care in the United States. J Trauma. 2004;56(1):173–8. [PubMed: 14749585]
5. Segui-Gomez M, Chang DC, Paidas CN, et al. Pediatric trauma care: an overview of pediatric trauma systems and their practices in 18 US states. J Pediatr Surg. 2003;38(8):1162–9. [PubMed: 12891486]
6. Overview of the Kids' Inpatient Database (KID). https://www.hcup-us.ahrq.gov/kidoverview.jsp [accessed 2017.1.10]
7. Densmore JC, Lim HJ, Oldham KT, et al. Outcomes and delivery of care in pediatric injury. J Pediatr Surg. 2006;41(1):92–8. [PubMed: 16410115]
8. National Trauma Data Bank. https://www.facs.org/quality-programs/trauma/ntdb [accessed 2017.1.10].
9. Overview of the Nationwide Emergency Department Sample (NEDS). https://www.hcup-us.ahrq.gov/nedsoverview.jsp [accessed 2017.1.10].
10. Sasser SM, Hunt RC, Faul M, et al. Guidelines for field triage of injured patients: recommendations of the National Expert Panel on Field Triage, 2011. MMWR Recommendations and reports : Morbidity and mortality weekly report Recommendations and reports / Centers for Disease Control. 2012;61(RR-1):1–20.
11. Corrado MMSJ, Wheeler K, et al. Emergency Medical Services (EMS) versus non-EMS transport among injured children in the United States. Am J Emerg Med. 2016;Publication Pending.
12. Acosta CD, Kit Delgado M, Gisondi MA, et al. Characteristics of pediatric trauma transfers to a level i trauma center: implications for developing a regionalized pediatric trauma system in california. Acad Emerg Med. 2010;17(12):1364–73. [PubMed: 21122022]
13. Faul M, Xu L, Sasser SM. Hospitalized traumatic brain injury: low trauma center utilization and high interfacility transfers among older adults. Prehosp Emerg Care. 2016:1–10.
14. Fallat MEMG, Barbara A; Haley Kathy, et al. The Childress Summit II Work Groups. Proceedings of the second Childress Summit on pediatric trauma: Operationalizing the vision. J Trauma. 2016;81(4):795–801.
15. Tarima S, Ertl A, Groner JI, et al. Factors associated with patients transferred from undesignated trauma centers to trauma centers. J Trauma. 2015;79(3):378–85.
16. Nance ML, Carr BG, Branas CC. Access to pediatric trauma care in the United States. Arch Pediatr Adolesc Med. 2009;163(6):512–8. [PubMed: 19487606]
17. Petrosyan M, Guner YS, Emami CN, et al. Disparities in the Delivery of Pediatric Trauma Care. J Trauma. 2009;67(2):114–9.
18. Nathens AB, Maier RV, Copass MK, et al. Payer status: the unspoken triage criterion. J Trauma. 2001;50(5):776–83. [PubMed: 11371832]

19. Newgard CD, McConnell KJ, Hedges JR. Variability of trauma transfer practices among non-tertiary care hospital emergency departments. Acad Emerg Med. 2006;13(7):746–54. [PubMed: 16723727]

20. Parks J, Gentilello LM, Shafi S. Financial triage in transfer of trauma patients: a myth or a reality? Am J Surg. 2009;198(3):35–8.

21. Delgado MK, Yokell MA, Staudenmayer KL, et al. Factors associated with the disposition of severely injured patients initially seen at non-trauma center emergency departments: disparities by insurance status. JAMA surgery. 2014;149(5):422–30. [PubMed: 24554059]

22. Mohan D, Rosengart MR, Farris C, et al. Assessing the feasibility of the American College of Surgeons' benchmarks for the triage of trauma patients. Arch Surg. 2011;146(7):786–92. [PubMed: 21422329]

23. Nakamura Y, Daya M, Bulger EM, et al. Evaluating age in the field triage of injured persons. Ann Emerg Med. 2012;60(3):335–45. [PubMed: 22633339]

24. Mohan D, Barnato AE, Rosengart MR, et al. Trauma triage in the emergency departments of nontrauma centers: an analysis of individual physician caseload on triage patterns. J Trauma. 2013;74(6):1541–7.

25. Staudenmayer KL, Hsia RY, Mann NC, et al. Triage of elderly trauma patients: a population-based perspective. J Am Coll Surg. 2013;217(4):569–76. [PubMed: 24054408]

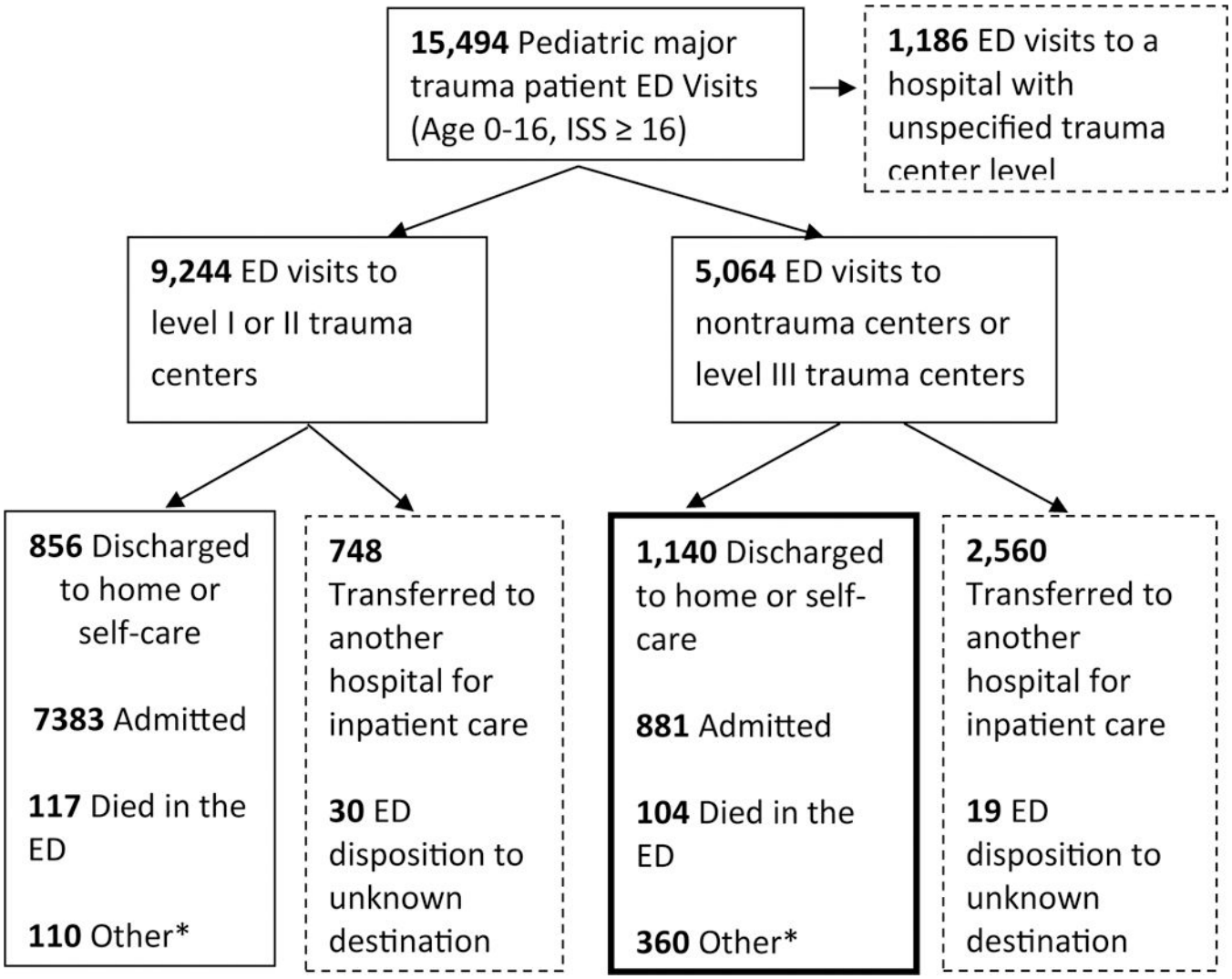

Figure 1.

ED disposition of pediatric major trauma patients by level of care, NEDS 2009–2013

Patients in the bolded box were undertriaged. Patients in the dashed boxes were excluded from our study sample.

* Other: left against medical advice or transferred to other facilities (e.g. Skilled Nursing Facility, Intermediate Care Facility, and another type of facility).

Table 1.

Undertriage rates by patient characteristics for pediatric major trauma patients, NEDS 2009–2013[1]

Patient Characteristics	Sample		National			
	Total patients	Undertriaged patients[2]	Total patients	Undertriaged patients[2]	Undertriaged %	95% CI
Total	10951	2485	52116	11299	21.7%	(17.8 - 25.6)
Sex *						
Male	7189	1644	34299	7533	22.0%	(18.1 - 25.9)
Female	3760	840	17809	3764	21.1%	(17.0 - 25.3)
Age (years)						
0–5	4021	1038	19199	4616	24.0%	(18.8 - 29.3)
6–11	2218	528	10579	2416	22.8%	(17.8 - 27.9)
12–16	4267	919	22338	4267	19.1%	(16.1 - 22.1)
Life-threatening injuries[3]						
Life-threatening	4696	614	22525	2882	12.8%	(9.7 - 15.9)
Not life-threatening	6255	1871	29591	8417	28.4%	(23.6 - 33.3)
Chronic condition						
Without chronic conditions	6286	1906	29694	8698	29.3%	(24.6 - 34.0)
With chronic conditions	4665	579	22422	2601	11.6%	(8.5 - 14.7)
Primary expected payer *						
Medicare/Medicaid	4463	977	21366	4296	20.1%	(15.7 - 24.6)
Private including HMO	5362	1239	25443	5761	22.6%	(18.5 - 26.8)
Self-pay	497	157	2322	713.04653	30.7%	(24.1 - 37.3)
Other	586	105	2791	498.61951	17.9%	(11.2 - 24.5)
Median household income by zip code *						
$1-$40,999	3300	725	15749	3238	20.6%	(14.9 - 26.3)
$41,000-$50,999	3045	663	14477	3046	21.0%	(16.4 - 25.6)
$51,000-$66,999	2499	590	11972	2754	23.0%	(18.6 - 27.4)
$67,000 or more	1891	458	8892	2023	22.8%	(18.4 - 27.1)
Patient Location *						
Large central metropolitan>=1 million	2109	564	9643	2383	24.7%	(18.2 - 31.2)
Large fringe metropolitan >=1 million	1791	394	8641	1618	18.7%	(13.7 - 23.8)
Medium metropolitan 250,000–999,999	2033	350	9431	1626	17.2%	(11.8 - 22.7)
Small metropolitan 50,000–249,999	862	281	4238	1464	34.5%	(25.5 - 43.6)
Micropolitan <50,000	1118	285	5337	1357	25.4%	(18.1 - 32.8)
Rural area	786	253	3778	1205	31.9%	(24.3 - 39.5)
External cause of injury						
Fall	2510	798	11811	3546	30.0%	(24.9 - 35.1)
Motor vehicle traffic	3645	449	17440	2069	11.9%	(8.6 - 15.1)
Struck	1061	403	4967	1839	37.0%	(30.5 - 43.5)

Patient Characteristics	Sample		National			
	Total patients	Undertriaged patients[2]	Total patients	Undertriaged patients[2]	Undertriaged %	95% CI
Firearm	399	53	1894	239.97937	12.7%	(8.6 - 16.8)
Cutting or piercing	91	23	433.407	121.41799	28.0%	(17.6 - 38.5)
Nature	138	33	623.739	131.82695	21.1%	(12.8 - 29.5)
Other causes of injury[4]	3107	726	14947	3352	22.4%	(17.0 - 27.0)
Admission timing						
Admission on Mon-Fri	7353	1689	34987	7682	22.0%	(17.9 - 26.0)
Admission on Sat-Sun	3597	796	17125	3618	21.1%	(17.1 - 25.1)

[*] Missing <210%

Abbreviation: HMO, health maintenance orgnization.

1. Pediatric major trauma patients are patients who aged 0 to 16 years and had an injury severity score (ISS)≥16.

2. Undertriaged patients are major trauma patients (ISS≥16) receiving care at nontrauma centers or level III trauma centers.

3. Defined by the American College of Surgeon Committee on Trauma. Source: Rotondo, M. F., Cribari, C., & Smith, R. S. (2014). Resources for optimal care of the injured patient 2014.

4. Includes machinary, suffocation, drowning and etc.

Table 2.

Odds of undertriage by patient characteristics for pediatric major trauma patients, NEDS 2009–2013[1]

	Univariate			Multivariate		
Patient Characteristics	**UOR**	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Sex						
Male (ref.)						
Female	0.95	(0.86 1.05)	0.33	1.05	(0.94 1.17)	0.42
Age (years)						
0–5 (ref.)						
6–11	0.94	(0.81 1.07)	0.34	1.03	(0.87 1.21)	0.77
12–16	0.75	(0.62 0.90)	0.00	0.93	(0.75 1.15)	0.51
Life-threatening injuries[2]						
Not life-threatening (ref.)						
Life-threatening	0.37	(0.31 0.44)	<.0001	0.62	(0.53 0.73)	<.0001
Chronic condition						
Without chronic condition (ref.)						
With chronic conditions	0.32	(0.26 0.39)	<.0001	0.42	(0.33 0.52)	<.0001
Primary expected payer						
Private including HMO (ref.)						
Medicare/Medicaid	0.86	(0.72 1.03)	0.10	0.81	(0.67 0.98)	0.03
Self-pay	1.52	(1.14 2.02)	0.00	1.79	(1.21 2.64)	0.00
Other	0.74	(0.47 1.16)	0.19	0.80	(0.48 1.33)	0.39
Median household income by zip code						
$1-$40,999 (ref.)						
$41,000-$50,999	1.03	(0.79 1.35)	0.83	0.94	(0.68 1.31)	0.73
$51,000-$66,999	1.15	(0.84 1.59)	0.38	1.17	(0.81 1.71)	0.40
$67,000 or more	1.14	(0.79 1.64)	0.49	1.06	(0.70 1.63)	0.77
Patient Location						
Large central metropolitan>=1 million (ref.)						
Large fringe metropolitan >=1 million	0.70	(0.46 1.07)	0.10	0.60	(0.40 0.91)	0.02
Medium metropolitan 250,000–999,999	0.64	(0.38 1.06)	0.08	0.61	(0.36 1.03)	0.06
Small metropolitan 50,000–249,999	1.61	(1.01 2.55)	0.04	1.82	(1.10 3.01)	0.02
Micropolitan <50,000	1.04	(0.69 1.58)	0.86	1.23	(0.80 1.91)	0.34
Rural area	1.43	(0.96 2.13)	0.08	1.63	(1.07 2.47)	0.02
External cause						
Motor vehicle traffic (ref.)						
Fall	3.20	(2.46 4.16)	<.0001	2.41	(1.86 3.14)	<.0001
Struck	4.50	(3.36 6.03)	<.0001	3.71	(2.81 4.91)	<.0001
Firearm	1.07	(0.71 1.61)	0.76	1.06	(0.68 1.65)	0.81
Cutting or piercing	3.02	(1.68 5.42)	0.00	2.80	(1.50 5.25)	0.00
Nature	2.13	(1.31 3.47)	0.00	1.81	(1.00 3.27)	0.05

	Univariate			Multivariate		
Patient Characteristics	**UOR**	**95% CI**	**P-value**	**AOR**	**95% CI**	**P-value**
Other causes of injury[3]	2.12	(1.70 2.65)	<.0001	2.03	(1.62 2.55)	<.0001
Admission timing						
Admission on Mon-Fri (ref.)						
Admission on Sat-Sun	0.95	(0.86 1.05)	0.34	0.87	(0.78 0.99)	0.03

Abbreviation: HMO, health maintenance orgnization; UOR, unadjusted odds ratio; AOR, adjusted odds ratio.

1. Undertriaged patients are major trauma patients (ISS≥16) receiving care at nontrauma centers or level III trauma centers.

2. Defined by the American College of Surgeon Committee on Trauma. Source: Rotondo, M. F., Cribari, C., & Smith, R. S. (2014). Resources for optimal care of the injured patient 2014.

3. Includes machinary, suffocation, drowning and etc.