MONROE CARELL JR. CHILDREN'S HOSPITAL AT VANDERBILT

PEDIATRIC TRAUMA SERVICE IEP

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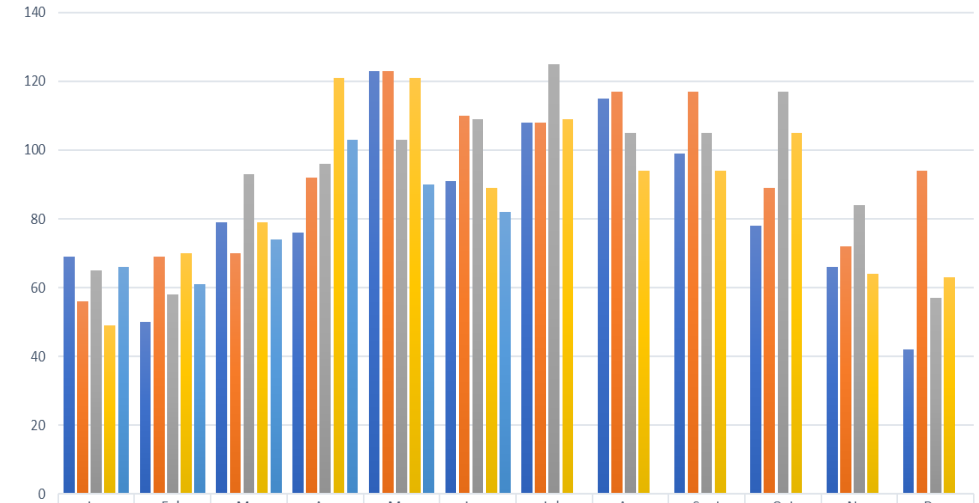
Inside this issue:

Trauma Registry Admissions by Month 2014 - 2018

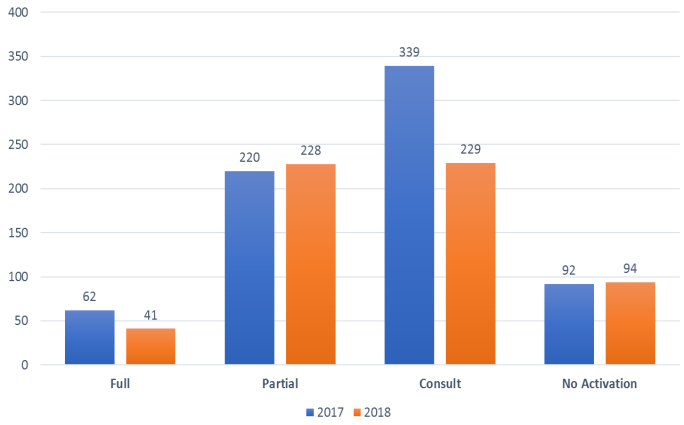


	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2014	69	50	79	76	123	91	108	115	99	78	66	42
2015	56	69	70	92	123	110	108	117	117	89	72	94
2016	65	58	93	96	103	109	125	105	105	117	84	57
2017	49	70	79	121	121	89	109	94	94	105	64	63
2018	66	61	74	103	90	82						

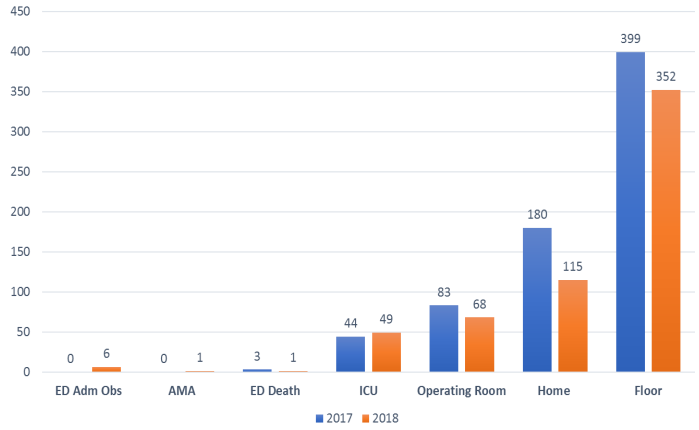
Elevating PI concerns

- For any patient quality concerns or systems issues related to our trauma population, please feel free to contact Amber Greeno.
- 615-936-7074
- amber.greeno@vumc.org

Activation Levels First Half of Year Comparisons



ED Disposition First Half of Year Comparison



EVALUATING THE "CUSHION EFFECT" AMONG CHILDREN IN FRONTAL MOTOR VEHICLE CRASHES

The "Cushion Effect" is the phenomenon in which obesity serves as a protective factor against abdominal injuries and a risk factor for lower extremity injuries following frontal motor vehicle crashes (MVC) among adults (1). It was first described by Arbabi et al. based on three key observations: (1) obese adult patients had higher mortality rates, not primarily attributable to overall injury severity, (2) extremity injuries were linearly associated with body weight, and (3) overweight individuals had the lowest rates of abdominal injury and best outcomes.

Pediatric crash victims often suffer more frequent and severe multi-system organ injuries as compared to their adult counterparts due to lack of compliance with restraint use. One study hypothesized that subcutaneous abdominal adiposity would have a significant negative association with abdominal injuries and positive association with extremity injuries based on the Maximum Abbreviated Injury Scale (MAIS), even after correction for patient demographics and vehicle factors.

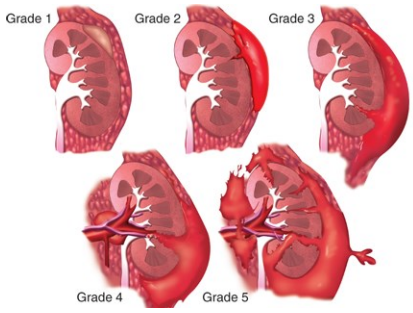
The study found that subcutaneous fat cross-sectional area was not significantly associated with unadjusted or adjusted rates of MAIS 2+ abdominal injuries or extremity injuries, thus indicating that the Cushion Effect was not present among children and adolescents in contrast to adults.

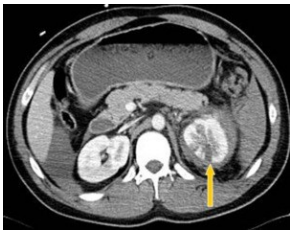
EVALUATION OF THE MANAGEMENT OF SEVERE TRAUMA KIDNEY INJURY AND LONG-TERM RENAL FUNCTION IN CHILDREN

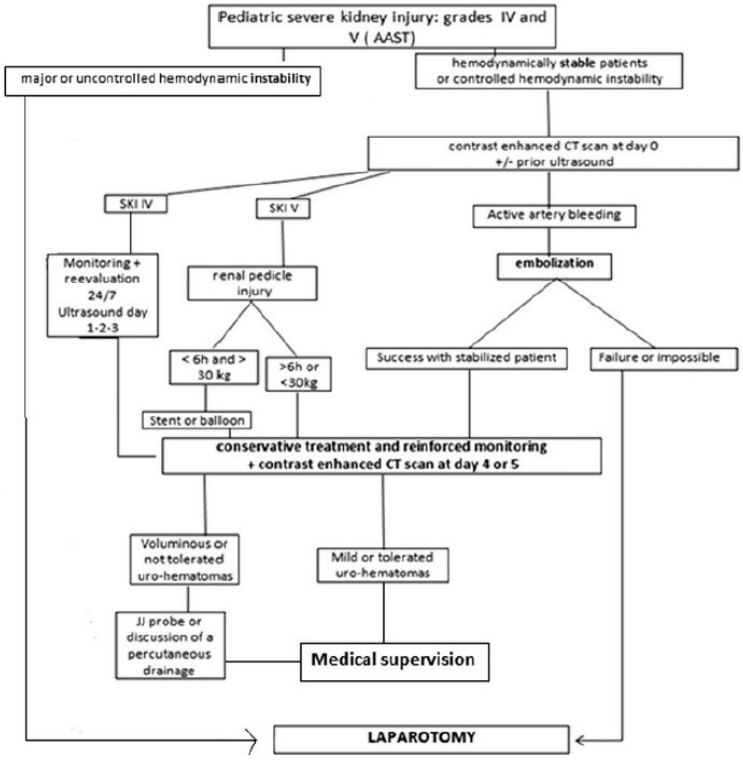
Pediatric severe renal traumatic injuries are commonly found in abdominal trauma and are even more frequent than in adults because the kidneys are more superficial and less protected (3). Like their adult counterparts, conservative management is the usual treatment of choice and a nephrectomy is only performed when there is hemodynamic instability with active bleeding.

Overs et al. sought to confirm the possibility of a conservative management for severe renal traumatic injury (grade IV and V) in children, and that the injured kidney can recover and be functional at long term. Their study found that among the 21 severe traumatic renal injury, 11 (52.4%) children required a therapeutic procedure in which a secondary nephrectomy at day 6, three embolizations, four double J stent poses, one percutaneous nephrostomy, one laparoscopic peritoneal lavage for a splenic hemoperitoneum, and four pleural drainages. These results highlight the importance of embolization and endo urologic approach, with the aim of a conservative renal management, as much as possible.

The first symptoms or complications appeared after 48 hours to 72 hours in grade IV injury, for this reason, they now perform a systematic radiologic reassessment with a CT scan on day 4 or 5. Regarding the injured renal function, it was assessed after at least 6 months from the trauma, and was at 39.4% for the 11 (47.3%) of 16 grade IV injuries analyzed, against 17% for the 4 (80%) of 5 grade V injury analyzed. These results give an argument in favor of the currently conservative management of severe renal traumatic injury in children. Compared with adults, the renal pediatric recovery seems discreetly better.







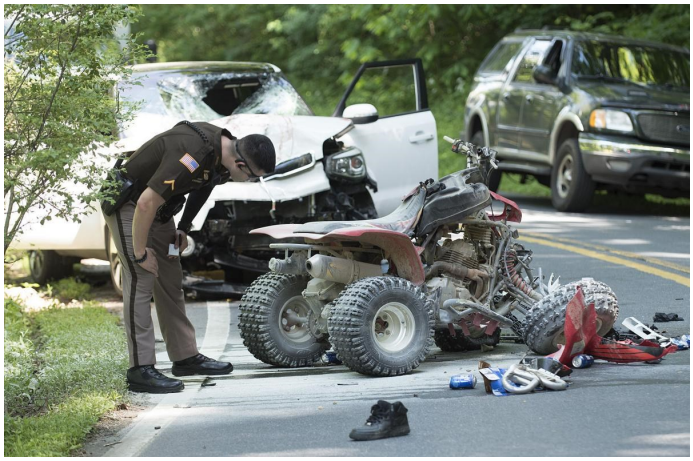
COMPARISON STUDY: ED VISITS BY CHILDREN AFTER ATV, MVC, AND SPORTS ACTIVITIES

It is well known that all-terrain vehicles (ATVs) are not designed with children in mind because children lack the strength, skills, and judgement required to operate these vehicles. Despite this, children <16 years comprise 14% of all ATV riders and those children account for 37% of all ATV-related injuries and 28% of ATV-related fatalities (2). Most of these incidences occur when children are operating the vehicles under parental supervision.

One study hypothesized that injuries from ATV crashes would be more severe than injuries sustained from MVCs because of the effective interventions (passive and active) that are now universal in the automobile industry and absent in the ATV industry. They also used sports injuries as the recreational comparison and hypothesized that ATV-related injuries would occur at higher rates and greater severity than sports injuries, despite the common perception that ATVs are toys designed for family recreation.

Results:

* Although most children visiting EDs in the United States have a low acuity, their study showed that visits after ATV crashes result in severe injuries similar to those sustained by children involved in MVC and more severe injuries and higher charges than those after sports.
* Older children aged 10 to 17 years were more likely to sustain severe trauma when compared with 5- to 9-year-olds, and there was no injury severity difference between under-fives and 5- to 9-year old children.
* Children visiting ED hospitals in rural residences were 1.2 times more likely to sustain a severe trauma than children living in urban areas.



Emergency department visits by children after ATV crashes result in significant injuries and charges. Public health interventions such as education, legislation, and engineering are needed to reduce injuries among children and the subsequent ED visits for care. The impact of proven interventions will be greatest for children living in rural areas and among older children, 10 to 17 years old.

TABLE 4. Proportions of Anatomical Region Injured by Age for ED Visits Due to ATV Crashes, 2006 to 2011

Body Region*	Head and Neck	Upper Extremity	Lower Extremity	Other†	Multiple/Crush Injury	Superficial
Age, y						
0–4	17.2	11.4	3.9	5.5	13.7	48.3
5–9	10.4	19.7	8.6	9.8	11.2	40.3
10–14	5.6	19.7	11.5	16.9	11.7	34.5
15–17	6.0	14.3	8.9	21.9	12.3	36.7

*Body regions injured are not mutually exclusive and do not necessarily add up to 100%.
†Other includes torso, spine, nerves and vessels, dislocations, burns, and not elsewhere classified.

https://safetennesseeproject.org/tennessee-firearm-death-data/

https://webappa.cdc.gov/sasweb/ncipc/leadcause.html

MONROE CARELL JR. CHILDREN'S HOSPITAL AT VANDERBILT

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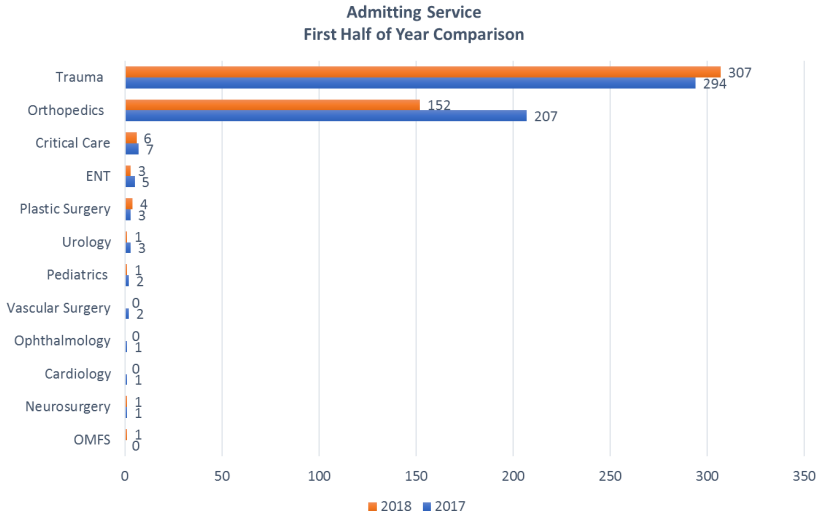
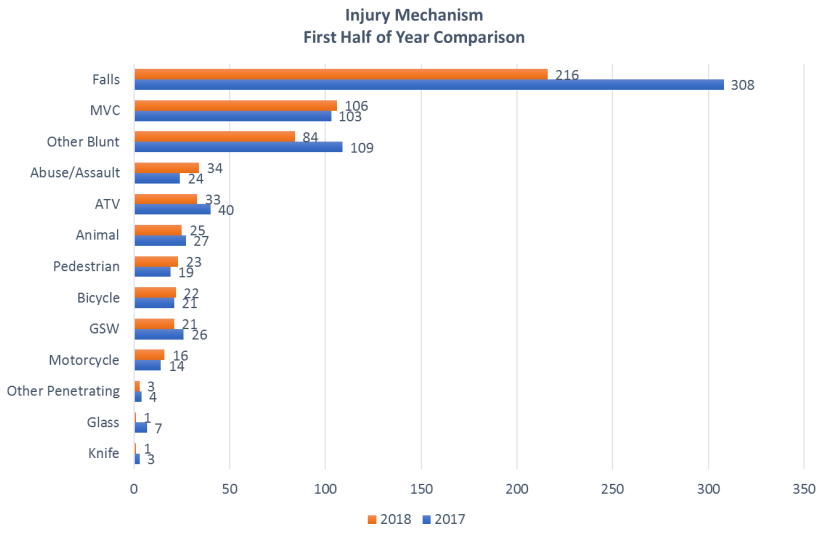
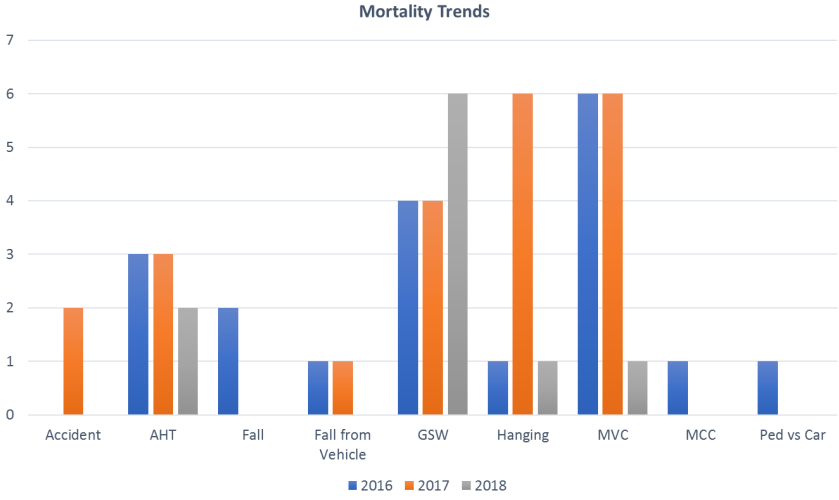
REGISTRY DATA CONTINUED...







TRAUMA PM&I DISCUSSION POINTS

* A patient with suspected abdominal trauma/ bowel injury was having episodes of repeated emesis. The patient was given 8mg of Zofran total and a NGT was not placed. Upon further discussion, Dr. Chung felt strongly that this is not best practice. Zofran should not be administered in the trauma bay for blunt trauma without having a gastric tube placed to decompress the gastric space.
* Worsening abdominal exams should be elevated to the trauma attending/fellow if the patient is at risk for peritonitis following a possible bowel injury.
* Wounds and surgical incisions should be thoroughly assessed prior to discharge to ensure the integrity of the closure and avoid readmissions due to fascial dehiscence.
* Dr. Pruthi and Dr. Bonfield were in agreement that if a cortical vein is found to be thrombosis, anti-coagulation is not necessarily needed because there are multiple other cortical veins that can take over and blood supply is never compromised. There also is not a need for further images with these.
* All of those in attendance felt like there should NOT be any set policy on radiographical exams for trauma patients and that imaging should be individualized to the patient.

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3. Overs, C., Teklali, Y., Boillot, B., Poncet, D., Rabattu, P.-Y., Robert, Y., & Piolat, C. (2018). Evaluation of the management of severe trauma kidney injury and long-term renal function in children. J Trauma Acute Care Surg, 84(6), 951-955.

A Cross-Sectional Study of Emergency Department Visits by Children After All-Terrain Vehicle Crashes, Motor Vehicle Crashes, and Sports Activities

Rosemary Nabaweesi, DrPH, James M. Robbins, PhD,* Anthony Goudie, PhD,* Jennifer I. Onukwube, MPH,* Stephen M. Bowman, PhD,† and Mary E. Aitken, MD**

Objectives: All-terrain vehicle (ATV) crashes have been responsible for significant injuries among children, despite public education efforts. Our study examined pediatric ATV injury patterns in US emergency departments (EDs) compared with injuries after motor vehicle crash (MVC) and sports activities.

Methods: We studied 2006 to 2011 data from the Nationwide Emergency Department Sample. Children younger than 18 years and involved in ATV crashes, MVC, or sports activities were included. The primary outcome analyzed was a constructed binary measure identifying severe trauma, defined as injury severity score greater than 15. Logistic regression models were fit to determine the association between mechanism of injury and severe trauma.

Results: A total of 6,004,953 ED visits were identified. Of these, ATV crashes accounted for 3.4%, MVC accounted for 44.7%, and sports activities accounted for 51.9%. Emergency department visits after ATV crashes were more likely to result in admission (8%) and incur higher median charges ($1263) compared with visits after sports activities (1%, $1013). Visits after sports activities were 90% less likely to result in severe trauma when compared with ATV crash visits. Emergency department visits after ATV crashes result in severe injuries similar to those sustained in MVC (odds ratio, 1.03; $P = 0.626$).

Conclusions: Pediatric ED visits after ATV crashes result in significant injuries and charges. Public health interventions such as education, legislation, and engineering are needed to reduce injuries among children and the subsequent ED visits for care. The impact of proven interventions may be greatest for children living in rural areas and among older children, 10 to 17 years old.

Key Words: all-terrain vehicle crashes, emergency department visits, sports activities, injuries, motor vehicle crashes

(*Pediatr Emer Care* 2018;34: 479–483)

Injuries resulting from all-terrain vehicle (ATV) crashes have been studied extensively using local hospital trauma registries[1–3] and Consumer Product Safety Commission's National Electronic Injury Surveillance System (NEISS), a nationally representative database focusing on injuries related to consumer products.[4–6] Other mechanisms of injury compared with ATV crashes vary widely including scooters, bicycles, snow mobiles, sports activities, and motor vehicle crashes (MVCs).[7–9] Most of these studies were conducted using local hospital administrative data and state level data to present trends over time or to study the potential benefits of state policy changes such as the mandatory helmet use.[7,9–11] In 2012, a brief report on national trends in emergency department (ED) use after ATV crashes appeared using the Nationwide Emergency Department Sample (NEDS), a nationally representative sample of ED visits for all reasons.[12] Our study was designed to extend this report and examine pediatric ATV injuries in more depth. The NEDS affords the opportunity to make national level comparisons of ATV crashes with other mechanisms of injury that are common (motor vehicle related) or represent other forms of recreation for children (sports related).

It is well documented that ATVs are not built for children.[6,13,14] Children younger than 16 years do not have the strength, skills, or judgment needed to operate an ATV.[6,15,16] Children younger than 16 years comprise 14% of all ATV riders yet account for 37% of ATV-related injuries and 28% of ATV-related fatalities.[17,18] Despite the recommendations of the American Academy of Pediatrics against use of ATVs by children younger than 16 years,[19–21] parents purchase ATVs for their children younger than 16 years or allow their use, and most ATV crashes occur when children are operating the vehicles under parental supervision.[19] Despite overwhelming evidence that children sustain a higher proportion of ATV-related injuries when compared with adults, manufacturers continue to market to children, and both industry and off-highway sporting groups have continued to promote ATVs as a recreational activity for families with children.[18,19]

Most children presenting to, and discharged from, hospital EDs after ATV incidents have less severe injuries than children admitted to a hospital with similar mechanisms of injury.[8,22,23] However, evidence from state level analyses indicates that ED visits related to ATV incidents tend to involve more severe injuries and higher charges when compared with ED visits resulting from sports activity and MVCs.[17] To our knowledge, a national level comparison of the severity of ATV crash, MVC, and sports injuries in children presenting to EDs has not been conducted. Our study compared the incidence and severity of ATV injuries among children who presented to EDs in the United States with injuries sustained from MVCs and sports activities in the same population. We used MVC as a benchmark to compare with injuries sustained from ATV crashes because MVCs have been well studied and their morbidity and mortality is well established and understood.

We hypothesized that injuries from ATV crashes would be more severe than injuries sustained from MVC because of the effective interventions (passive and active) that are now ubiquitous in the automobile industry. Conversely, this is not the case with the ATV industry. We used sports injuries as the recreational comparison and hypothesized that ATV-related injuries would occur at higher rates and greater severity than sports injuries, despite the common perception that ATVs are toys designed for family recreation.[9,18,24]

METHODS

Database

We conducted a retrospective cross-sectional study using the NEDS from the Healthcare Cost and Utilization Project. The study

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period was between January 1, 2006, and December 31, 2011. The NEDS represents approximately 130 million discharges annually, resulting in the largest all-payer ED database in the United States. The database allows for the study of relatively uncommon events and trends over time. Data for ED visits come from approximately 1000 hospitals annually from a 20% stratified sample of US hospital-based EDs in 30 states reporting data to Healthcare Cost and Utilization Project. The NEDS incorporates discharge-level weights that can be used to create regional and national estimates of ED care.

Patient and Variable Selection

Discharges from children younger than 18 years who presented to the ED with *International Classification of Diseases, Ninth Revision* external cause of injury codes (E-code) involving the following events were included in our analysis: ATV (E821.0, E821.1, E821.8, and E821.9), MVC (E810, E811, E812, E813, E815, E816, E818, E819, and E825 with the fourth digit of 0 and 1 for occupants), or sports activity (E866.0, E917.0, E917.2, and E917.5). Emergency department discharges with indications of both ATV and MVC mechanisms of injury were assigned to the ATV mechanism of injury. Only records with a valid injury *International Classification of Diseases, Ninth Revision* code were kept for analysis, ranging from 800 to 960. Emergency department patients subsequently transferred to another hospital were excluded to avoid double counting multiple hospitalizations for the same episode of care.

Independent patient-level factors studied included mechanism of injury (ATV, MVC, and sports activities), age categories (0–4, 5–9, 10–14, and 15–17 y), sex, urban/rural status, health insurance, household income category, and anatomical region injured. Independent hospital-level factors included region and teaching status. The primary outcome variable analyzed was a constructed binary measure identifying severe trauma, which indicated an injury severity score (ISS) greater than 15. Secondary dependent variables studied were ED charges and disposition including death, discharge home, and admissions. To account for inflation, charges were adjusted to 2011 dollars using the medical consumer pricing index. There are no cost-to-charge ratio adjustments available for the NEDS database. We analyzed ISS as an ordinal variable (mild, moderate, severe, and critical) categorized by ISS: 1–8, 9–15, 16–25, and 26–75, respectively. Healthcare Cost and Utilization Project began collecting ISS data in 2009; therefore, we had 3 years with ISS data to include in this study.

TABLE 1. ED Visits by Children Aged 0 to 17 Years: Demographic Characteristics, 2006 to 2011 (N = 6,004,953)

	MVC (n = 2,325,501)	Sports Activities (n = 3,389,409)	ATV Crash (n = 290,043)	
	% (95% CI)	% (95% CI)	% (95% CI)	*P*
ED visit rate per 100,000 population	522.2	76.1	65.1	
Age, y				0.0001
0–4	18.5 (18.1–18.8)	1.0 (1.0–1.0)	4.9 (4.7–5.1)	
5–9	18.0 (17.7–18.3)	10.6 (10.5–10.8)	18.0 (17.6–18.4)	
10–14	21.8 (21.6–22.0)	50.1 (49.9–50.4)	42.9 (42.5-43.4)	
15–17				
Sex	41.7 (41.1–42.3)	38.2 (37.9–38.6)	34.2 (33.6–34.8)	0.0001
Female	55.4 (55.2–55.6)	24.4 (24.2–24.7)	28.9 (28.3–29.4)	
Male	44.5 (44.3–44.7)	75.5 (75.3–75.8)	71.1 (70.5–71.6)	
Residence*				0.0001
Urban	77.6 (75.6–79.1)	79.6 (78.5–80.8)	61.1 (59.4–62.8)	
Rural	21.9 (20.3–23.5)	19.8 (18.7–21.0)	38.5 (36.7–40.2)	
Region				0.0001
Northeast	15.5 (13.9–17.1)	25.8 (23.7–28.0)	13.4 (11.8–15.0)	
Midwest	21.7 (20.0–23.4)	25.2 (23.4–27.0)	24.4 (22.5–26.3)	
South	48.0 (45.6–50.4)	31.2 (29.3–33.1)	42.7 (40.2–45.1)	
West	14.8 (13.6–16.0)	17.8 (16.4–19.2)	19.5 (17.2–21.7)	
Income†				0.0001
Low	31.3 (29.7–32.9)	21.2 (20.1–22.4)	29.0 (27.4–30.5)	
Medium	49.8 (48.4–51.3)	47.3 (45.9–48.8)	52.5 (51.0–53.9)	
High	16.9 (15.7–18.1)	29.7 (27.4–31.5)	16.2 (15.1–17.4)	
Health insurance				0.0001
Private	55.7 (55.6–55.9)	65.0 (64.8–65.0)	59.2 (58.8–59.5)	
Public	28.4 (28.3–28.5)	28.7 (28.6–28.8)	32.1 (31.7–32.5)	
None	15.9 (15.7–16.0)	6.3 (6.2–6.4)	8.7 (8.4–8.9)	
Hospital teaching status				0.0001
Urban nonteaching	39.9 (37.8–42.1)	44.3 (42.2–46.3)	38.0 (35.7–40.3)	
Urban teaching	37.3 (34.8–39.8)	34.5 (32.1–36.9)	22.0 (19.6–24.5)	
Rural nonteaching	20.3 (18.4–22.2)	19.2 (18.0–20.3)	38.0 (35.8–40.3)	

*0.5% unknown residence.

†2% unknown income.

CI indicates confidence interval.

We decided not to impute missing ISS data for previous years to maintain data consistency. We empirically tested the hypothesis that children involved in ATV crashes sustain more severe injuries compared with those involved in MVCs and sporting activities.

Statistical Analysis

Rates of ED visits for each mechanism of injury were calculated using US population estimates for years 2006 to 2011. Continuous and categorical outcomes were presented as medians and proportions with 95% confidence intervals. Differences between continuous or categorical variables and mechanism of injury were determined using ANOVA tests and Pearson χ^2 tests, respectively. Logistic regression models were fit to determine the association between the mechanism of injury, the main predictor, and the severe trauma. Models were adjusted for age, sex, urban/rural residential status, region, and health insurance status. Income, anatomical body region affected, and hospital teaching status were left out of the model because of potential problems with multicollinearity.

We restricted the multivariable modeling to the 3 years of data (2009–2011) containing the ISS values. To account for the NEDS complex sample design, we accounted for hospital strata and population weights. Analytical data sets were compiled using SAS version 9.4 software (SAS Institute Inc, Cary, NC), and statistical analysis was performed using Stata 13 software (StataCorp LP, College Station, Tex). Statistical significance was determined at *P* values less than 0.05. Scatter plots were used to identify outliers.

RESULTS

During the study period, an estimated 6,004,953 US children were discharged from an ED as a result of an incident involving ATV, MVC, or sports activity. Emergency department visits due to sports activities had the highest discharge rate per 100,000 population at 761.1, followed by MVC (522.2) and ATV (65.1). Most children had private insurance (60%), one quarter had public insurance, and 10% were not insured. Age categories of 10 to 14 and 15 to 17 years accounted for 40% each of the age categories. Children younger than 5 years accounted for 8% (data not shown) (Table 1). The highest proportion of MVC ED visits occurred in older teens compared with ATV and sports-related ED visits peaking in early teens. Male children accounted for more than 71% of ED visits for ATV and sports injuries but only 44% of MVC-related visits.

TABLE 3. Proportions of Anatomical Region Injured Among ED Visits Due to ATV Crashes, 2006 to 2011

Body Region*	Proportion, %	95% Confidence Interval
Head and neck	6.8	6.5–7.1
Upper extremity	16.4	16.0–16.9
Lower extremity	9.2	8.9–9.6
Superficial	35.0	34.4–35.5
Multiple/crush injury	11.3	10.9–11.7
Other†	15.8	15.4–16.3
None	5.5	5.2–5.8

*Body regions injured are not mutually exclusive and do not necessarily add up to 100%.

†Other includes torso, spine, nerves and vessels, dislocations, burns, and not elsewhere classified.

Although ED visits for all 3 mechanisms of injury were more likely to occur in urban areas, the proportion of ATV injuries (38.5%) occurring in rural areas was nearly twice that of MVC (22%) and sports-related (20%) injuries (Table 1). Emergency department visits were higher in the south for all injury mechanisms but less common in the northeast for ATV and MVC and the west for sports. More than half of the ED visits were made by children with private insurance; the proportion was greater among visits due to sports activities. The proportion of children visiting national EDs in rural hospitals due to ATV incidents was approximately twice that of children visiting due to sports activities or MVCs. The rural nonteaching hospitals had twice as many ED visits due to ATV crashes compared with sports activities or MVC.

More than 90% of children visiting the ED were treated and released, and less than a tenth of a percent died in the ED (Table 2). Emergency department visits due to ATV crashes (8%) were more likely to result in an admission compared with visits due to MVC (4%) and sports activities (1%). The median ED charge per visit was highest among ATV crashes at $1263, followed by sports activities at $1013 and MVC incidents at $866. Approximately 11.8% of the ED visits had no ISS (Table 2). Among the injured, most of the ED visits were made by children (93%) who sustained minor injuries (ISS 1-8) regardless of the mechanism.

Among children visiting national EDs after ATV crashes, more than 35% sustained superficial injuries (Table 3). Whereas

TABLE 2. ED Visits by Children Aged 0 to 17 Years: Clinical Characteristics, 2006 to 2011 (N = 6,004,953)

	MVC (n = 2,325,501)	Sports Activities (n = 3,389,409)	ATVs (n = 290,043)	
	% (95% CI)	% (95% CI)	% (95% CI)	*P*
ED disposition				0.0001
Discharged	96.0 (95.5–96.4)	98.8 (98.7–98.9)	91.8 (90.9–92.7)	
Admitted	3.9 (3.5–4.4)	1.2 (1.1–1.3)	8.1 (7.3–9.0)	
Died	0.1 (0.1–0.1)	0.0 (0.0–0.0)	0.1 (0.1–0.1)	
ED charges,* median (IQR)	$866 (408–1869)	$1013 (637–1630)	$1263 (725–2515)	0.0001
Injury severity score†				0.0001
1–8	96.6 (96.5–96.7)	99.1 (99.1–99.2)	93.7 (93.4–94.0)	
9–15	2.1 (2.0–2.2)	0.7 (0.7–0.8)	5.1 (4.8–5.4)	
16–25	0.9 (0.8–0.9)	0.1 (0.0–0.1)	0.8 (0.7–1.0)	
26–75	0.3 (0.3–0.3)	0.00 (0.0–0.0)	0.2 (0.2–0.3)	

*ED charges adjusted for $2011.

†Injury severity score available for 2009 to 2011; 11.8% had no ISS.

5% sustained no anatomical injuries, 6.8% had injuries to the head and neck, 16.4% had injuries to the upper extremities, 9.2% had injuries to the lower extremities, 11.3% had injuries to multiple regions including crush injuries, and 15.8% had injuries to other regions. The latter includes torso, spine, nerves and vessels, dislocations, burns, and not elsewhere classified. Children younger than 5 years visiting EDs after ATV crashes sustained the highest proportion of head and neck injuries at 17% compared with 10% among 5- to 9-year-olds and half of that proportion in the remaining age groups (Table 4). Upper extremity injuries accounted for the highest proportion of anatomical regions, at 20% in the 5- to 9- and 10- to 14-year-olds.

Bivariate analysis indicated weak associations between the independent variables and severe trauma. The multivariate analysis indicated several associations between the independent variables and severe trauma. Emergency department visits by made 10- to 14-year-olds were 1.2 times more likely to result in severe trauma (odds ratio [OR], 1.23; $P \leq 0.0001$) compared with visits made by children aged 5 to 9 years (Table 5). Similarly, ED visits made by children aged 15 to 17 years were 2.2 times more likely to result in severe trauma than visits made by children aged 5 to 9 years (OR, 2.17; $P < 0.0001$). Compared with ED visits by female children, male children were 1.7 times more likely to experience severe trauma (OR, 1.68; $P \leq 0.0001$). Emergency department visits after sports activities were significantly less likely to result in severe trauma when compared with visits after ATV crashes (OR, 0.08; $P < 0.0001$). Compared with children on public insurance, children with private insurance were 1.2 times more likely to make ED visits that resulted in severe trauma (OR, 1.16; $P < 0.0001$). On the other hand, uninsured children were 65% less likely to have ED visits that resulted in severe trauma (OR, 0.35; $P < 0.0001$). Emergency department visits made from rural residences were 1.2 times more likely to result in severe trauma compared with those made from urban residencies.

TABLE 5. Multivariate Analysis for Severe Trauma* Among Children (0–17 y) Visiting US EDs, 2006 to 2011

Independent Variable	Odds Ratio	95% Confidence Interval	*P*
Mechanism of injury			
ATV (reference)			
Sports activity	0.08	0.062–0.095	<0.0001
MVC	1.03	0.909–1.171	0.626
Age, y			
5–9 (reference)			
0–4	0.95	0.813–1.111	0.526
10–14	1.23	1.078–1.140	0.002
15–17	2.17	1.934–2.451	<0.0001
Sex			
Female (reference)			
Male	1.68	1.555–1.817	<0.0001
Payer			
Public (reference)			
Private	1.16	1.070–1.262	<0.0001
Uninsured	0.35	0.291–0.426	<0.0001
Residence			
Urban (reference)			
Rural	1.22	1.123–1.332	<0.0001
Hospital region			
Midwest (reference)			
Northeast	0.78	0.691–0.896	<0.0001
South	0.92	0.843–1.021	0.126
West	1.10	0.894–1.251	0.089

*Injury severity score greater than 15.

DISCUSSION

We conducted this study to understand how ATV-related ED visits compare with visits due to MVC and sports activities in children using a nationally representative database. The NEDS is the largest all-payer ED database in the United States.[25] Unlike the NEISS database,[26] which collects demographic data and body part injured, the NEDS includes demographic data and body part injured in addition to hospital characteristics, charge data, and trauma center levels. All-terrain vehicle crash identification is possible in both databases; however, sports activities are limited in the NEISS, and automobiles are not covered consistently by the NEISS across the years.

We conclude that, nationally, ATV crashes, although occurring less frequently, are only as important as MVC in injury severity sustained by children. When they occurred, ATV crashes resulted in more severe injuries and higher ED charges for children when compared with sports activities. There was no difference in occurrence of severe trauma between ED visits due to MVC or ATVs.

In 2012, Blecker and colleagues found that the mean hospital charges resulting from ATV injuries were higher than those incurred as a result of MVC ($21,805 vs $17,480) using a level I urban trauma center registry. Blecker et al's study also demonstrated that the mean ISS for ATV injuries was higher than that of injuries resulting from MVC (8.7 and 6.2, respectively). In addition to showing ATV/MVC ED charges' comparisons similar to Blecker et al's findings, our study included body region of injury by age group for the ATV crash mechanism in the ED population that has not been studied before. Unlike Blecker et al's work, our study found no difference in severe injuries between ATV and MVC. Older children aged 10 to 17 years were more likely to sustain severe trauma when compared with 5- to 9-year-olds, and there was

TABLE 4. Proportions of Anatomical Region Injured by Age for ED Visits Due to ATV Crashes, 2006 to 2011

Body Region*	Head and Neck	Upper Extremity	Lower Extremity	Other†	Multiple/Crush Injury	Superficial
Age, y						
0–4	17.2	11.4	3.9	5.5	13.7	48.3
5–9	10.4	19.7	8.6	9.8	11.2	40.3
10–14	5.6	19.7	11.5	16.9	11.7	34.5
15–17	6.0	14.3	8.9	21.9	12.3	36.7

*Body regions injured are not mutually exclusive and do not necessarily add up to 100%.

†Other includes torso, spine, nerves and vessels, dislocations, burns, and not elsewhere classified.

no injury severity difference between under-fives and 5- to 9-year-old children.

Children visiting ED hospitals in rural residences were 1.2 times more likely to sustain a severe trauma than children living in urban areas. Our study showed that teaching hospitals are more likely to have visits from more severely injured children. Although most children visiting EDs in the United States have a low acuity, our study showed that visits after ATV crashes result in severe injuries similar to those sustained by children involved in MVC and more severe injuries and higher charges than those after sports.

Limitations

This was a secondary data analysis, and therefore, we were limited to the available variables collected in the NEDS database. In our case, ISS was collected in the last 3 years of our study period, and those 3 years had considerable missing data. Coding errors may exist with any large database that is compiled across states, regions, and institutions. We could not study the effect of race or protective gear (helmets and seat belts) use because the NEDS does not collect these data. The decision to compare ATV and MVC with all sports activities might have resulted in the ATV effects regressing to the mean as compared with the option of limiting our comparisons to sports activities similar to ATVs, such as motorcycles or snowmobiles.

CONCLUSIONS

Emergency department visits by children after ATV crashes result in significant injuries and charges. Public health interventions such as education, legislation, and engineering are needed to reduce injuries among children and the subsequent ED visits for care. The impact of proven interventions will be greatest for children living in rural areas and among older children, 10 to 17 years old.

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