Tricycle Injuries Presenting to US Emergency Departments, 2012–2013

Sean Bandzar, BS[a], Atul Vats, MD[b,c], Shabnam Gupta, BS[d], Hany Atallah, MD[d], Stephen R. Pitts, MD, MPH[d]

abstract

OBJECTIVE: To investigate the characteristics of tricycle-related injuries in children presenting to US emergency departments (EDs).

METHODS: Data regarding tricycle injuries in children younger than 18 years of age were obtained from the National Electronic Injury Surveillance System for calendar years 2012 and 2013. Data included body regions injured, ED disposition, and demographics.

RESULTS: There were an estimated 9340 tricycle-related injuries treated in US EDs from 2012 to 2013. The average age was 3 years. Children 2 years of age had the highest frequency of injuries. Boys accounted for 63.6% of all injuries. Children 1 to 2 years of age represented 51.9% of all injuries. Lacerations were the most common type of injury. Internal organ damage was the most common type of injury in 3- and 5-year-olds. Contusions were the most common type of injury in 1- and 7-year-olds. The head was the most commonly injured region of the body and the most common region to endure internal damage. The elbows were the most commonly fractured body part. The upper extremity was more frequently fractured than the lower extremity. Approximately 2.4% of all injured children were admitted to the hospital.

CONCLUSIONS: The upper extremity of children, particularly the elbow, was more frequently fractured than the lower extremity. The head was the most common body part to endure internal damage. By elucidating the characteristics of tricycle-related injuries, preventive measures can be implemented to decrease the incidence of tricycle-related injuries and ED visits.

FREE

WHAT'S KNOWN ON THIS SUBJECT: Tricycle riding is a common activity in children. In calendar year 2012, tricycle accidents were the most common cause of reported toy-related deaths in children. Little research has been conducted regarding tricycle-related injuries and how to counsel parents appropriately.

WHAT THIS STUDY ADDS: This study uses nationally representative data to investigate various characteristics of tricycle-related injuries in children to better counsel parents. This study highlights the importance of helmet and elbow pad use and parental supervision.

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Mr Bandzar and Ms Gupta conceptualized and designed the study, analyzed the data, and drafted and edited the initial manuscript; Drs Vats, Atallah, and Pitts coordinated and supervised the data collection and analyses, and critically reviewed and edited the initial manuscript; and all authors approved the final manuscript.

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Toys are an integral part of childhood, responsible for a stimulating environment and the development of spatial and interpersonal skills.[1] In the United States, ~3 billion toys are sold each year.[2] Concurrently, the annual toy-related injury rate in the pediatric population has increased by 39.9% from calendar year 1990 to 2011. Abraham et al[1] investigated these injuries and demonstrated that the most common mechanisms of toy-related injuries in children presenting to the emergency department (ED) were falls and collisions. The most common type of toy associated with these injuries was a ride-on toy.

Recent studies have investigated bicycle injuries in toddlers, and the American Academy of Pediatrics Committee on Injury, Violence, and Poison Prevention has suggested preventive measures to increase patient safety.[3,4] These measures have had a dramatic impact on bicycle safety.[5] However, little attention has been given to the characteristics of tricycle injuries. Tricycles have remained the second most common cause of reported toy-related deaths among children younger than 15 years in the United States from calendar years 2005 to 2009. In 2012, tricycle accidents were the most common cause of reported toy-related deaths in children.[6–10]

A better understanding of mechanisms and severity of tricycle-related injuries is warranted to help direct prevention efforts. By using the Consumer Product Safety Commission's (CPSC) National Electronic Injury Surveillance System (NEISS) database, this study aimed to investigate the characteristics and epidemiology of tricycle-related injuries in the pediatric population.

METHODS

Data Source

The CPSC monitors injuries in US EDs via the NEISS database, a stratified sample of 98 hospital EDs in the United States. The NEISS was established in calendar year 1972 and underwent various revisions in its sampling frame during 1978, 1990, and 1997. The data in the NEISS are selected from hospitals with at least 6 beds and that operate 24 hours a day in the United States and its territories. Participating hospitals submit data extracted from medical records in their ED, which are reviewed by professional NEISS coders who receive detailed training to decrease the variability in data collection. The data submitted to the NEISS database represent a probability sample of 6100 hospitals. Furthermore, the data uploaded to the database are related to a consumer product. A NEISS coordinator assigns a product code based on the consumer product. Other aspects of a patient's injury also are recorded, including a narrative of the injury by the attending physician in the ED. Participating hospitals are required to submit ~400 000 records per year under contract. Previous studies have demonstrated the NEISS's accuracy in identifying injuries.[3,4,11]

The NEISS database is updated daily and allows estimation of the epidemiology of injury-related ED visits. Data regarding tricycle (product code: 1301) injuries among children <18 years of age were retrospectively analyzed from calendar years 2012 to 2013 using the NEISS database. Calendar years 2012 and 2013 were chosen as a convenience sample to include enough cases to broadly represent tricycle-related injuries presenting to the ED. The number of calendar years analyzed in the study was limited to 2 to eliminate confounding variables attributable to the fact that the same institution may not participate in the NEISS program every year and that new institutions may be included every year. The analyzed data from the NEISS included patient age, weight, gender, body part injured, type of injury, ED disposition, locale of injury, and a short narrative written by the attending physician in the ED regarding the injury.

Data Analysis

Data were analyzed by using SAS (University Edition) (SAS Institute, Inc, Cary, NC) software. Survey Procedures (PROC SURVEYFREQ) were used to account for the NEISS's complex statistical design. Sample weights from the NEISS database were used in all analyses to extrapolate national estimates and to adjust for the inverse probability of selection for each injury depending on several factors, including the volume of the ED. These factors are built into the statistical design of the NEISS database. Relationships were examined by using linear regression and χ^2 tests, and by calculating relative risk (RR) with 95% confidence intervals (CIs). A $P < .05$ was considered statistically significant.

Study Variables

Cases were categorized based on injury type, ED disposition, locale of injury, and injured body part. NEISS categories for injury types included internal organ damage, laceration, fracture, and contusion. Injury types that did not represent at least 5% of total injuries were assigned to the category "other." NEISS categories for the patient's disposition from the ED included treated and released, hospitalized (admitted, transferred to another hospital, or held for observation), and left the ED against medical advice or without being seen. NEISS categories for locale of injury included home, public street/highway, and place of recreation (ie, school). NEISS categories for injured body parts included head, elbow, lower arm, face, and mouth. Body parts that were injured that did not represent at least 5% of total injuries were assigned to the category "other."

Ethical Considerations

This study received institutional review board exemption from Emory University.

RESULTS

General Description

During the 2 years (January 2012 to January 2014), the NEISS database reported an estimated 9340 tricycle-related injuries in children presenting to US hospital EDs. This estimate is based on a total of 328 cases documented by the NEISS database from 2012 to 2013. In 2012, there were an estimated 4789 tricycle-related injuries (95% CI 3034–6067) and in 2013 there were an estimated 4551 tricycle-related injuries (95% CI 3474–6103) presenting to US hospital EDs, averaging an estimated 4670 injuries per year. The mean age of injury was 3 years (median 2 years; range 12 years). Patients between the ages of 1 and 2 years represented 51.9% of the entire study population (4847 of the estimated 9340). The estimated number of injuries per age group peaked at 2 years of age and then gradually declined, as seen in Fig 1.

During the study period, there was a higher percentage of male patients seen in US hospital EDs for tricycle-related injuries (63.6%; 5943 of estimated 9340). Among the patients for whom the location of injury was recorded (71.8% of total), most injuries occurred at home (Fig 2).

Type of Injury

Lacerations were the most common type of injury during the study period (28.2%; 2637 of estimated 9340), as seen in Fig 3. Lacerations also were the most common type of injury among 1-year-olds (27.9%; 555 of estimated 1990), 2-year-olds (10.1%; 846 of estimated 2857), 6-year-olds (42.8%; 82 of estimated 193), and patients >7 years of age (34.1%; 169 of estimated 496). Internal organ damage was the most common type of injury in 3-year-olds (29.9%; 604 of estimated 2022) and 5-year-olds (32.9%; 108 of estimated 331). Contusions were the most common type of injury in 7-year-olds (70%; 201 of estimated 287).

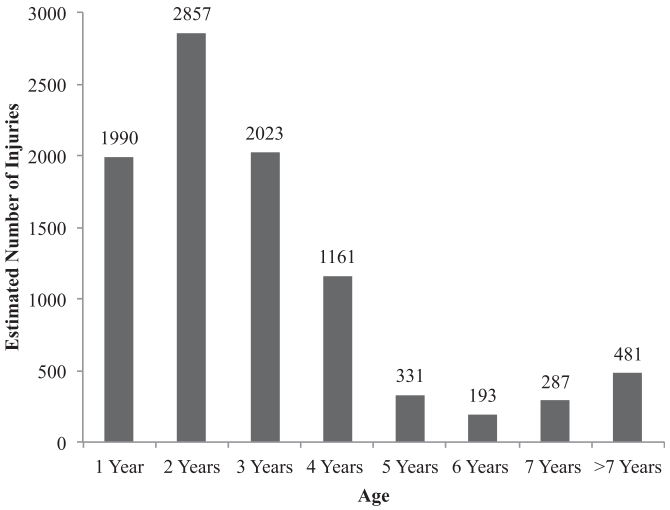

FIGURE 1
Estimated number of tricycle-related injuries seen in US hospital EDs during calendar years 2012 to 2013, stratified by age.

Body Part Affected by Injury

The head was the most commonly injured body part (29.6%; 2767 of estimated 9340), as seen in Fig 4, and the most common body part to endure internal organ damage (99.6%; RR 6.93; 95% CI 6.70–7.18). Bladder injuries accounted for the rest of the internal organ injuries (0.4%; 6 of estimated 1576). The elbows were the most commonly fractured body part (47.4%; 475 of estimated 1003). In addition, the upper extremity was more likely to be fractured than the lower extremity (RR 1.91; 95% CI 1.41–2.60). The face was the most commonly lacerated body part (49.0%; 1292 of estimated 2637). The face and head were the most common locations for a contusion, representing 42.6% of all contusions (858 of estimated 1959). The lower arm and toe were the next most common locations for a contusion, representing 9% (188 of estimated 1959) and 8% (151 of estimated 1959) of all contusions.

ED Disposition

Among the estimated 9340 cases nationally, only 224 (2.4%) were admitted to the hospital. The main

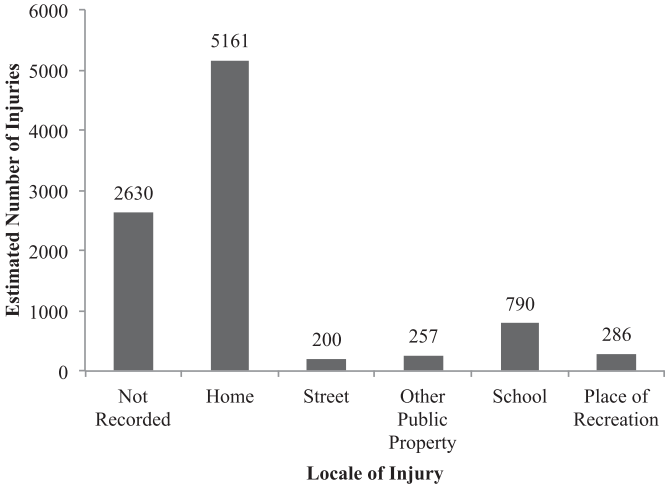

FIGURE 2
Estimated number of tricycle-related injuries seen in US hospital EDs during calendar years 2012 to 2013, stratified by setting of injury.

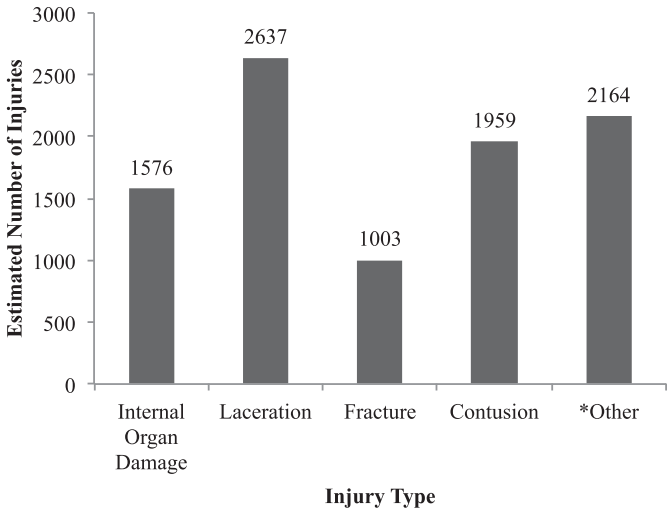

FIGURE 3

Estimated number of tricycle-related injuries seen in US hospital EDs during calendar years 2012 to 2013, stratified by injury type. *Injury types representing <5% of total injuries were assigned to the category "other." The 3 most common types included sprains or strains, dental injuries, and dislocations.

reasons for admission included amputation, fracture, and internal organ damage, which included all 6 bladder injuries and 11 head injuries. In a small minority of cases (0.5%; 48 of estimated 9340), patients left against medical advice or without being seen. The vast majority of cases (97.0%; 8977 of estimated 9340) were treated and released from the ED.

DISCUSSION

Injuries related to tricycle accidents are not well described in the literature. Although there are fewer tricycle-related accidents that require visits to the ED in comparison with bicycle accidents, deaths attributable to tricycles are an important concern.[6–10] Understanding the characteristics of tricycle-related accidents and the associated morbidity and mortality will help direct pediatricians on how to better educate parents regarding tricycle safety and improve on current preventive measures.

A study conducted at Children's Hospital of Philadelphia demonstrated that most tricycle-related injuries observed at a local ED were due to falls.[12] Injuries observed in this study may have occurred when the rider fell due to sudden turns of the front wheel, causing the tricycle to tip over. Younger children have proportionally larger heads that can increase the torque applied to the tricycle during sudden turns. This increase in torque can cause the tricycle to tip over. Children also lack the cognitive ability, coordination, physical strength, and size to anticipate and protect themselves from a crash, increasing the risk of injury after an accident.

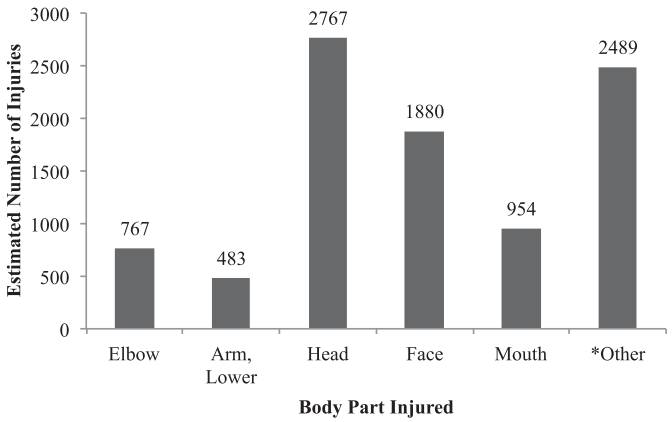

FIGURE 4

Estimated number of tricycle-related injuries seen in US hospital EDs during calendar years 2012 to 2013, stratified by injured body part. *Injured body parts representing <5% of total injuries were assigned to the category "other." The 3 most common body parts included pubic region, arm, and finger.

The setting for most injuries in this cohort was at home, in contrast to bicycle users where most injuries occur on public streets.[3] In this cohort, there were no patients who collided with a motor vehicle, in contrast to studies on bicycle users. Children <4 years primarily use tricycles before advancing to bicycles. This user population generally does not travel far from home in comparison with older children who ride bicycles. Older children are able to travel on public roads to ride their bicycles, putting them at risk for colliding with motor vehicles. In this study, there were no reported deaths. However, a previous study demonstrated that collisions between motor vehicles and tricycles play a role in pediatric deaths.[12] The actual incidence of collisions between tricycles and motor vehicles in this study may be underreported. Emergency physicians at participating hospitals are not required to include details, such as collisions, in the data submitted to NEISS unless they are listed in the narrative.

Tricycle-related deaths also are reported to the CPSC every year. In recent years (since 2009), the annual number of reported deaths associated with tricycle accidents has increased, but not at a statistically significant rate (P = .5; B = 0.8). The mechanism of death in each of these cases was

related to drowning or falling (Table 1). Further studies incorporating the time of day and weather conditions at the time accident are warranted.

Recommendations to help decrease the incidence of tricycle-related injuries include changes to the tricycle, rider, and environment. Injuries commonly occur after a fall when a sudden turn of the tricycle's front wheel causes the user to lose balance and tip over. A design alteration that decreases the maximal turning radius of the tricycle's handlebars may decrease the frequency of tipping over and related injuries. In addition, tricycles can gain significant speeds going down graded, paved areas. Many tricycles do not have brakes, putting children at risk for losing control. An implantable device in the wheels of a tricycle that attenuates the tricycle's maximum speed may help decrease the frequency of injuries. Finally, a mechanism to prevent injury to the feet, such as the dual-purpose step described in US Patent 6089587, also may decrease the frequency of contusions to the lower extremities. The dual-purpose step acts as a footrest to protect the feet of a child learning to ride the tricycle. The step prevents 1 or both feet of the child from being hurt by the tricycle's front wheel in motion or pedals in operation.[13]

Other recommendations include changes to the rider and environment. This study illustrates the importance of elbow pads and helmets. In this cohort, the head was the most likely body part to sustain internal organ damage. The upper extremity was the most likely body part to sustain a fracture, specifically the elbows. Thus, helmets are strongly recommended and elbow pads are encouraged to prevent upper extremity injuries. In an effort to form habits that will result in improved helmet use rates as young cyclists grow older, policy makers may wish to consider mandating tricycle users to wear a helmet. As of July 2007, New Mexico has taken initiative and passed a law requiring tricycle users to wear a helmet. Further studies are warranted to investigate the change in frequency of head injuries in states passing laws that mandate helmet use by tricycle users.

The environment in which children ride their tricycles should be free of hazards, including paths that lead to public streets and sources of water. From calendar years 2005 to 2009 and in 2011, drowning accounted for a significant number of reported tricycle-related deaths. Adults should supervise all children riding tricycles and ensure that paths do not lead to sources of water (ie, pools).

This study has several limitations. This study does not consider the type of tricycles used in each case. More detailed information regarding the products used can shed light on the safety profile of each consumer product. Second, this study lacks details regarding how the injury occurred (eg, losing control of the tricycle, hitting stationary object). A more descriptive narrative could help determine what features of the tricycle could be redesigned to reduce the risk of accidents. Other details that would help the study include whether an adult was present during the time of injury, if the child was wearing a helmet, and if the tricycle was stationary or moving at the time of the injury. Third, the NEISS database does not include data on patient follow-up or severity of injury, which could help distinguish major injuries from minor injuries. Fourth, data from the NEISS database do not include what time of day the injury occurred, which could shed light on other variables, such as poor visibility at night contributing to injuries.

TABLE 1 Number of Reported Tricycle-Related Deaths in Children Younger Than 15, Stratified by Mechanism According to the US CPSC From Calendar Years 2005 to 2012

	2005	2006	2007	2008	2009	2010	2011	2012
Toy-related Deaths	26	22	18	19	3	17	10	11
Tricycle-related Deaths	3	2	5	4	3	0	2	5
Drown	1	2	3	2	3	0	2	0
Collision With Motor Vehicle	2	0	1	2	0	0	0	0
Fall	0	0	1	0	0	0	0	5

CONCLUSIONS

This study demonstrates that the most common type of tricycle-related injury was a laceration, specifically on the face. Children 2 years of age are more likely to be injured than other age groups. The upper extremity is more likely to be fractured than the lower extremity. Specifically, the elbows are the most likely body part to fracture in a tricycle accident, underscoring the importance of elbow pads. Finally, the head is the most frequently injured body part and most likely body part to endure internal organ damage. By elucidating the characteristics of tricycle-related injuries, preventive measures can be implemented to decrease the incidence of tricycle-related injuries and the frequency of ED visits.

ABBREVIATIONS

CI: confidence interval
CPSC: Consumer Product Safety Commission
ED: Emergency Department
NEISS: National Electronic Injury Surveillance System
RR: relative risk

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THE LAND OF GIANTS: *My wife and I love to hike. We have hiked all over the world but perhaps our favorite place to hike is in the southwestern United States. We have hiked in most of the National Parks and Monuments in New Mexico, Arizona, central and southern Utah, and southern Colorado. Generally, the terrain is fascinating and almost every step is rewarded with a great view. While we have seen many wonderful sights during our hikes in the southwest, we have never seen a dinosaur skeleton. Evidently, Grand Staircase-Escalante National Monument in southern Utah contains thousands of dinosaur fossils.*

As reported in The New York Times *(Science: July 20, 2015), tens of thousands of fossils have been excavated from the Kaiparowits Plateau, a 50-mile-long, high-elevation ridge in the Monument. Most fossils have been excavated from bands of sandstone and mudstone dating to the Late Cretaceous Period- about ten million years before the great dinosaur extinction. The fossils are in pristine condition and have shed light not only on the dinosaurs, but on the environment as well. While the area is now very dry, 75 million years ago the region was a steamy, swampy, coastal forest and home to dozens of unique species of dinosaurs. Scientists have unearthed several species of horned-face and duck-billed dinosaurs, two new species of tyrannosaurs, six crocodile species and 17 turtle species.*

One of the enduring questions is how such a small landmass supported so many very large animals. After all, the entire African continent currently only supports a few large land animals. The answer may lie in the fossil presence of a fantastic number of moonseed leaves which suggests an incredibly dense vine system. The intense vine vegetation may have provided the nutrients necessary to support the large herbivores. While I do not see vines when hiking in Southern Utah, I love the current vegetation and the fact that I am treading in the same territory as the giant herbivores and even the Tyrannosaurus Rex.

Noted by WVR, MD

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