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Brief Report

Characterization of pediatric golf cart injuries to guide injury prevention efforts

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ABSTRACT

Background: Golf cart injuries represent an increasing source of morbidity and mortality in the United States. Characterization of the circumstances of these injuries can inform injury prevention efforts.
Methods: This study retrospectively reviews a prospective trauma registry at a level-one pediatric trauma center for golf cart-related injuries in patients under 18 years of age admitted to the hospital between 2008 and 2016.
Results: The 40 identified crashes were associated with 82 hospital days, 17 ICU days, and more than $1 million in hospital charges over the study period. The median hospital stay was 1.5 days, and the median hospital charge was $20,489. Severe injuries with an Injury Severity Score of >15 were identified in 25% of patients, and moderate injuries with scores between nine and 15 were identified in an additional 30%. The most common injures were head and neck (60%) and external injuries to the body surface (52.5%). Only a single child was wearing a seatbelt, and the vast majority was not using any safety equipment. Children as young as nine years old were driving golf carts, and child drivers were associated with the cart overturning ($p = 0.007$).
Conclusions: Golf cart crashes were a source of substantial morbidity at a level-one trauma center. Increased safety measures, such as higher hip restraints, seatbelts, and front-wheel breaks could substantially increase the safety of golf carts. Increased regulation of driving age as well as driver education may also reduce these injuries.

1. Introduction

Golf cart injuries represent a significant and increasing source of morbidity and mortality in the United States. There were an estimated 147,696 injuries treated in the United States between 1990 and 2006 with a >100% rate increase over this period [1]. Injuries are more common among children and the elderly [2] with an estimated 31.2% of injuries involving children under 16 years of age [1]. Golf cart injuries are a common cause of neurologic injury in children [3,4] and are a known cause of craniofacial trauma [5,6]. Additionally, golf cart injuries are generally more severe among children than adults [6].

Most public health measures have targeted all-terrain vehicles (ATVs), but the risk of other non-automobile vehicles is evident [7]. At one tertiary medical center, central neurologic injuries were the most common injury type observed in pediatric golf cart injuries, and the median hospital charge was $23,677 [8]. This same study found that more than half of patients spent time in the intensive care unit. Consensus guidelines from professional organizations—including the American Academy of Pediatrics (AAP) [9] and the American Pediatric Surgical Association [10]—recommend that children under 16 not operate ATVs or similar unlicensed vehicles and that children wear seatbelts while riding as passengers. The AAP has informally extended these recommendations to golf carts specifically [11]. Despite these recommendations, use of seatbelts and other safety measures is rare [4,8].

In response to increasing on-road use and higher top-speeds, a federal regulation was created that requires seat belts in golf carts with top speeds between 20 and 25 miles per hour [12]. However, many golf carts do not meet this speed requirement and are only subject to state and local laws that vary widely [12]. For example, in Tennessee, slower carts are not allowed on city streets but also do not require seat belts or a valid license [13]. Because laws vary by state, it is likely that types of crashes and injuries vary by state as well.

This study aims to expand the geographic reach of existing local studies [8] and add insights into additional variables not available in

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national studies [1,2], such as use of safety equipment and location of children in the cart at the time of the crash. These analyses will inform injury prevention efforts. We reviewed the trauma registry records at a level-one pediatric trauma center to characterize golf cart-related injuries between 2008 and 2016 and identify potential injury prevention interventions.

2. Methods

The Institutional Review Board at the authors' home institution approved this study.

2.1. Data collection

A retrospective review of a prospective trauma registry at a level-one pediatric trauma center was conducted to identify patients under 18 years of age admitted to the hospital for golf cart-related injuries between 2008 and 2016. Patient demographics, injury locations, Injury Severity Score (ISS), Abbreviated Injury Scale (AIS), referral status, hospital stay, and hospital charge data were reviewed from the registry. Location in the golf cart, direct cause of injury, and use of safety measures were collected by chart review. Prior to May 2015, there was no golf cart field available in the database. Golf cart crashes prior to this date were identified by manual review of all traumas in the database. County and state median incomes were taken from the Small Area Income and Poverty Estimates program of the US Census Bureau [14].

2.2. Data analysis

Descriptive statistics were used to describe the results. Chi-squared tests were used for categorical variables where the expected values exceeded five in each cell, and Fisher's exact test was used otherwise. Logistic regressions were used to examine associations between some variables. All statistical analyses were conducted using Stata version 14.2 (StataCorp LP, College Station, TX).

3. Results

During the nine-year study period (2008–2016) there were 40 golf cart-related crashes found in the database. Children between 5 and 14 years of age accounted for 85% of crashes with relatively few cases among those younger than 5. The majority of children were white and male. Basic demographics and crash information are presented in Table 1.

3.1. Injury severity

Injury Severity Score (ISS) was used as a measure of injury severity. About 25% of children had severe injuries (ISS >15), and an additional 30% had moderate injuries (ISS 9–15). Major trauma is generally defined as an ISS >15. ISS generally increased with age (median ISS [0–4 years], 5; [5–9 years], 10; [10–14 years], 10; [15–18 years], 13), but this difference was not statistically significant. More than a quarter (27.5%) of children spent time in the intensive care unit (ICU). Children with higher ISS were more likely to go to the ICU when adjusted for age and gender (OR 1.23 per point; 95% CI [1.06–1.43]; p = 0.007).

Table 1
Characteristics of golf cart crashes

Age	10.855 (7.68, 13.06)
Gender	
Female	37.5%
Male	62.5%
Race	
African American	2.5%
White	95.0%
Other/unknown	2.5%
ISS score	10 (5, 13)
Hospital days	1.5 (1, 2)

Continuous variables are presented as median (IQR), and categorical variables are presented as percentages. N = 40 for all variables.

Fig. 1 shows Abbreviated Injury Score (AIS) by body region. More than half of children (52.5%) had a serious injury to at least one body region (AIS ≥ 3). An AIS score of two is considered moderate while a score of 3 is considered serious. The most overall injuries were seen in the head and neck followed by external injuries to the body surface. The highest proportions of serious injuries (AIS ≥ 3) were seen in head and neck and extremity injuries.

3.2. Injury mechanism

Being thrown off the cart was the most common cause of injury in both age categories. The cart overturning was more common in older children (29%) than younger children (11%) while being thrown off was more common in younger children (63%) than older children (43%). These differences were not statistically significant (Table 2).

The most common sites of injury were home (22.5%) and recreational areas, including golf courses (17.5%). Just one child (2.5%) was injured while the cart was being driven on the street. Injury locations for other children were listed as “other” or “unspecified” and could not be determined from manual chart review.

3.3. Safety measures

Only one child (2.5%) was using a seatbelt at the time of the crash. Nearly all (90%) of children did not use any safety equipment, including seatbelts or helmets. Use of safety equipment in the remaining cases could not be determined from chart review.

Children were most commonly seated passengers (58%) or drivers (22%) during the crash (Table 3). Driving was relatively rare among children under nine years of age but was the most common location in the cart for children aged 10–14. The youngest drivers were 9 years old, and only one child driver was over 16 years of age. When the child was driving, the most common cause of the crash was the cart overturning (55.6%). When the child was a passenger, the most common cause was falling or jumping from the cart (69.6%). Being the driver was associated with the cart overturning compared to other injury mechanisms (OR 11.67; 95% CI [1.98–68.75]; p = 0.007).

3.4. Hospital course

The median hospital stay was 1.5 days, and 97.5% of children spent at least one day in the hospital. 27.5% of children spent at least one day in the ICU. The median hospital charge was $20,489, and a total of $1,225,393.60 charges were generated across all children. Nearly all

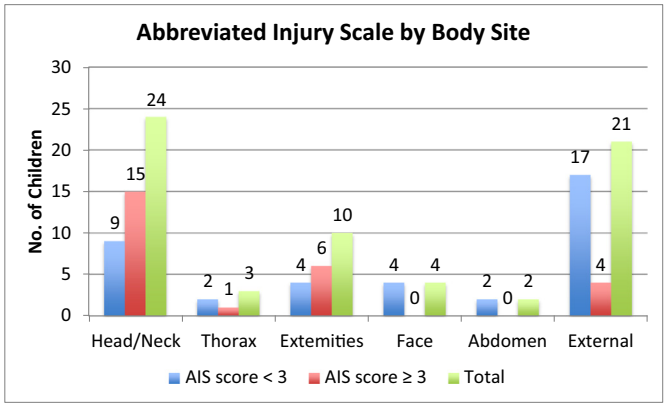

Fig. 1. Abbreviated Injury Scale (AIS) by body region. Injuries to the head and neck (60%) and external injuries (52.5%) were the most common. Severe injuries with an AIS of greater than or equal to three were most common in the head and neck and extremities.