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Injuries and outcomes associated with recreational vehicle accidents in pediatric trauma☆

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ABSTRACT

Purpose: To identify injuries and outcomes from Recreational/Off-Highway Vehicles (RV/OHV) accidents at a pediatric trauma center.
Methods: A retrospective review of a prospective pediatric trauma registry was performed to identify patients sustaining injuries from an RV/OHV between January 2007 and July 2015. Vehicles included: all-terrain vehicles (ATV), dirt bikes, utility-terrain vehicles (UTV), golf carts, go-karts, and dune buggies.
Results: Five hundred twenty-eight patients were injured while on an RV/OHV: 269 ATV, 135 dirt bike, 42 UTV, 38 golf cart, 34 go-kart, and 10 dune buggy. The majority ($n = 381$, 72%) had at least one injury with an Abbreviated Injury Scale ≥2; 39% ($n = 204$) had orthopedic injuries and 22% ($n = 116$) had central neurologic injuries. Over three-fourths ($n = 412$, 78%) were admitted. For the 48% ($n = 253$) of patients requiring surgery, 654 surgical procedures were performed. Median hospital charge was $27,565 (IQR: $15,553–$44,935). Excluding golf carts, helmet use was 49% ($n = 231$); 16% ($n = 76$) wore protective clothing. Only 22% ($n = 26$) wore a restraining belt.
Conclusion: Severe injuries occur in children who ride RV/OHV often warranting admission and surgical intervention. Improved understanding of RV/OHV injuries may guide caregivers in decision-making about pediatric RV/OHV use and encourage use of protective gear.
Level of Evidence: Level II, Prognosis Study.

Accidents from recreational vehicles (RV) and off-highway vehicles (OHV) such as all-terrain vehicles (ATV) and dirt bikes are an increasing source of preventable morbidity and mortality in the United States, particularly in the pediatric population. Twenty-three percent of ATV-related fatalities are under the age of 16 years [1] and over 20,000 pediatric patients are treated annually in United States emergency departments (ED) for injuries sustained while participating in motocross or off-road motorcycling. Of those injured, almost 70% are under the age of 15 years [2]. Despite the known dangers, RV/OHV use continues to have a significant appeal. This may be because, in many states, a license is not required to operate these vehicles, there are no rider age restrictions [3], and children as young as 4 years may compete in organized competition [4].

The state of Arizona is a favorable location for RV/OHV use given the predictable climate, lack of extreme winter weather, and varying terrain. These ideal conditions have led to RV/OHV use contributing four billion dollars to the Arizona economy each year [5]. Since the laws governing RV/OHV use in Arizona are controlled at the state level [6], there are currently no age restrictions on children riding or driving an RV/OHV as long as the vehicle is off the road. However, Arizona law does mandate that children younger than 18 years wear helmets [5,6]. The combination of the popularity of RV/OHV use and limited regulations makes Arizona an ideal setting to examine injuries and outcomes of RV/OHV use in the pediatric population.

Numerous studies have highlighted the dangers of ATV and dirt bike use. However, the impact of other RV/OHV types, such as utility-terrain vehicles (UTV), golf carts, go karts and dune buggies remains underreported [1]. The purpose of this study was to identify injuries and outcomes from all RV/OHV types use at a single pediatric trauma center in the state of Arizona.

Abbreviations: RV, recreational vehicle; OHV, off-highway vehicle; ATV, all-terrain vehicle; ED, emergency department; UTV, utility-terrain vehicle; AIS, Abbreviated Injury Scale; *ICD-9, International Classification of Diseases, 9th Revision*; NEISS, National Electronic Injury Surveillance System; ICU, intensive care unit; AAP, American Academy of Pediatrics; AAOS, American Academy of Orthopedic Surgeons; APSA, American Pediatric Surgical Association; ROHVA, Recreational Off-Highway Vehicle Association.

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1. Materials and methods

1.1. Patient population

After institutional review board approval (IRB #15-104), a retrospective review of a prospective American College of Surgeons verified level-1 pediatric trauma center registry was performed. All RV/OHV-injured patients younger than18 years who presented through the ED or as a trauma between January 2007 and July 2015 were identified for evaluation. Patients were excluded if: they were in a non-RV/OHV vehicle involved in an accident with an RV/OHV ($n = 1$), the mechanism of injury did not involve one of the six specified RV/OHV types ($n = 4$, e.g., sprint car or toy car), the patient was injured as a pedestrian in a pedestrian versus vehicle accident ($n = 3$), or they were indirectly involved in an accident with the RV/OHV (e.g., pulled on skateboard behind the RV/OHV) ($n = 3$).

1.2. Data collection

Data obtained from the trauma registry included: patient demographics (gender, age, race/ethnicity), injury location (place for recreation and sport, home, street, other), protective device use (helmet, protective clothing, restraining belt), Abbreviated Injury Scale (AIS) scores, *International Classification of Diseases, 9th Revision* (*ICD-9*) codes, and resource utilization (trauma team activation, admission, hospital charges). Additionally, the specific type of RV/OHV used at the time of injury was collected, including ATV, dirt bike, UTV, golf cart, go kart, and dune buggy, as described below.

1.3. Vehicle type

An ATV was defined as an off-road, open, motorized vehicle with three or four low-pressure tires and one or two seats without restraints [1]. A dirt bike was defined as an off-road, two-wheeled motorcycle-like vehicle, including motocross and mini-bikes. An UTV was defined as a four-wheeled vehicle with side-by-side seating that often includes roll bars and restraining belts. A golf cart was defined as a low-speed, four-wheeled, roofed vehicle with side-by-side seating often with restraining belts; most frequently utilized for golf course transportation. A go kart was defined as a low-speed, four-wheeled vehicle set low to the ground with one or two seats with restraining belts. Finally, a dune buggy was defined as a four-wheeled widely set vehicle with roll bars intended for riding in sand dunes (includes sand rails). Fig. 1 displays images of the different RV/OHV types.

Confirmation of vehicle type was performed by chart review. Vehicles that were unable to be confirmed by chart review secondary to a lack of information in the electronic medical record remained the original vehicle type recorded in the trauma registry. Vehicle type was changed from what was recorded in the trauma registry if specification of the vehicle type was documented in a provider or social work note (e.g., ATV was changed to UTV if specified), or if several notes documented a different vehicle than the vehicle type reported in the registry.

1.4. Data analysis

Descriptive statistics were calculated for each variable. Categorical variables are displayed as frequency and percent. Continuous variables are displayed as median and interquartile range. Demographic, injury location, protective device use, injury categories, surgical procedures, and resource utilization data are displayed by vehicle type. Injuries and surgical procedures were categorized using *ICD-9*. Injuries with an AIS severity score less than one were excluded. Protective device use by age was also assessed. All analyses were performed using STATA® 13.1 (StataCorp LP, College Station, TX).

2. Results

2.1. Total cohort

From January 2007 to July 2015, 539 patients involved in RV/OHV incidents were included in the trauma registry. Eleven patients were excluded for reasons described above, for a total of 528 patients. Vehicle type was changed for 21 patients from what was originally recorded in the trauma registry (ATV to UTV, $n = 9$; ATV to dirt bike, $n = 4$; ATV to golf cart, $n = 2$; ATV to dune buggy, $n = 1$; golf cart to go kart, $n = 1$; go kart to dune buggy, $n = 1$; and other unspecified vehicle to dirt bike, $n = 2$ and UTV, $n = 1$). The final study population included 269 (50.9%) patients that were injured while on an ATV, 135 (25.7%) on a dirt bike, 42 (8.0%) on a UTV, 38 (7.2%) on a golf cart, 34 (6.4%) on a go kart, and 10 (1.9%) on a dune buggy.

Table 1 displays the demographic and injury location details by vehicle type. Of the 528 patients, 373 (71%) were male and 321 (61%) were white. Patient ages at the time of injury ranged from 8 months to 17 years. There were no mortalities.

2.2. Injury

Injury data were missing for one go kart patient. Three hundred eighty-one (72%) patients had at least one injury with an AIS severity ≥2. No patient had an AIS of 6. Table 2 displays injuries by vehicle type.

2.3. Resource utilization and surgical procedures

Resource utilization and surgical procedure data across vehicle types are displayed in Table 3. Collectively, the 253 (48%) patients that required surgical intervention had a total of 654 surgical procedures, for an average of 2.6 surgical procedures per child. The number of surgical procedures per patient ranged from 1 ($n = 131$) to 32 ($n = 1$). Hospital charge data were missing for three ATV patients and one golf cart patient. The median hospital charge was $27,565 (IQR: $15,553–$44,935).

2.4. Protective device use

Figs. 2 and 3 display protective device use by vehicle type and age. Protective device use was not documented for 20 patients. Excluding golf carts, at the time of injury 231 (49%) patients were wearing a helmet and 76 (16%) were wearing protective clothing. Twenty-six (22%) patients wore a restraining belt when one was present.

3. Discussion

Severe injuries can occur in all RV/OHVs regardless of type, presence of safety mechanisms (e.g., roll bars), or slower maximum speeds (e.g., golf cart). Patients sustaining injuries from these vehicles frequently require surgical intervention. In general, these preventable injuries necessitate the use of significant resources including high rates of admission and even ICU management. Finally, the majority of these patients were not using recommended protective devices at the time of injury.

Overall, orthopedic injuries were the most frequent among all the vehicle types with the exception of golf carts. This is consistent with other reports that have mainly focused on ATV, dirt bike and go kart injuries [7–14]. Interestingly, almost half of the patients presenting from a golf cart incident had a central neurologic injury, such as a subdural, epidural or intracerebral hematoma, skull fracture or significant concussion. This is higher than a review of the National Electronic Injury Surveillance System (NEISS) which noted over 35% of golf cart injured patients aged 10 to 19 years sustained an intracranial injury [15]. It may be because passengers are not wearing seatbelts and are usually distracted while driving or riding in the golf cart and may easily get ejected and hit their head on the hard golf cart path. However, the