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Pediatric all-terrain vehicle (ATV) injuries: An epidemic of cost and grief

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ABSTRACT

Objective: Evaluate cost of care of all-terrain vehicle (ATV) related injuries sustained by riders 16 years and younger in Pennsylvania.
Methods: Population-based retrospective cohort design reviewing costs of care of 78 patients (≤16 years), admitted (01/01/2007–12/31/2009) to our institution for injuries sustained during an ATV accident.
Results: Cost of care varied from $322 to $310,435. Mean and median costs for all patients were $25,760 and $8,066, respectively. Average costs increased with increasing age. Patients wearing helmets or driving the ATV had lower mean costs, but these trends were not statistically significant. Crashes with stationary objects not involving rollover or ejection had significantly lower mean costs than other crash types ($p = 0.01$). Patients involved in rollover accidents were significantly more likely to require an overnight hospital stay (OR = 3.45, $p = 0.02$). Patients wearing helmets were marginally less likely to require an overnight admission (OR = 0.34, $p = 0.07$).
Conclusion: ATV crashes involving unhelmeted riders and rollover accidents result in significant medical costs. Interventions to increase helmet use and measures to improve stability are likely to reduce these costs and shorten hospital stays.
Level of evidence: Level III, Therapeutic study.

Introduction

Designed for single riders, all-terrain vehicles (ATVs) are three- or four-wheeled motorized vehicles with large, soft tires that have been dubbed the "nearly unbreakable toy" since their introduction in the 1970's.[1–3] ATVs are used in all climates, various terrains, and are considered by some to be the most versatile vehicle in operation. In recent decades, the popularity of ATVs has increased for use in hunting, farming, and recreation, by people of all ages. In 2010 there were an estimated 10.6 million 4-wheel ATVs in operation in the United States.[4]

With their increased popularity, ATVs have been involved in an alarming number of injuries and deaths.[5–7] ATVs in general are difficult machines to operate, as the high center of gravity requires a high degree of coordination, muscle strength, mature judgment and experience for safe operation.[8] Like their three-wheel predecessors, four-wheel ATVs have some of the same design features: a high center of gravity, short wheel base, short turning radius, weight in excess of 1000 pounds, and high-powered engines capable of speeds up to 70 mph.[1,2,5] By design, four-wheel ATVs are somewhat less likely to rollover than the three-wheeled versions.

Waiver of patient consent granted by IRB for Retrospective chart review.

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However, uneven surfaces can cause them to turn over, largely due to the high center of gravity. When used on hills, they are capable of flipping over from front to back, as the rear wheels can lift the front wheels off the ground when excessive power is applied. Studies have shown that almost 60% of accidents involving four-wheeled ATVs result from tipping and overturning. Drivers and passengers can be thrown from these ATVs or can be crushed beneath them. As such, ATVs are known to be associated with significant injuries. Spine, neurologic, and orthopaedic injuries have been documented.

Pediatric trauma constitutes 30–40% of all ATV-related deaths and approximately 11% of injured ATV operators seen in the emergency department require admission to the hospital.[3,5,9,10] Despite statements from government agencies and medical societies including the American Academy of Orthopaedic Surgeons (AAOS) and the American Academy of Pediatrics against the use of ATVs by children, one third of all ATV-related fatalities and emergency department visits involve patients younger than 16 years.[3,5,11] The Consumer Product Safety Commission (CPSC) Annual Report of ATV-Related Deaths and Injuries recorded 2865 fatalities (25% of total) in children younger than 16 years of age between 1982 and 2011, with 1226 fatalities (43%) of those among children 12 years and younger.[4]

In 1998, the CPSC reached an agreement with ATV manufacturers that they would not market adult-sized ATVs for use by children younger than 16, would not market three-wheeled ATVs, and would provide information and safety and education.[1]

The number of ATV accidents has risen in recent years across all states.[1] As of December 2011, the CPSC received reports of 327 ATV-related fatalities occurring in 2011, 590 in 2010, 684 in 2009 and 741 in 2008.[4] In the CPSC 2011 Annual Report of ATV-Related Deaths and Injuries, Pennsylvania is ranked third with 459 reported deaths related to ATVs from 1982 to 2007, and from 1989 to 2002 children accounted for 32% of the total deaths in PA.[2,5] There is a significant economic cost associated with these injuries: hospital admitted ATV-related injuries to youth under 17 years cost over $5.2 million annually.

Methods

This study was a population-based retrospective cohort design. Approval was obtained from the Institutional Review Board. Using the External Cause of Injury and Poisoning codes (E-codes) for off-road motor vehicle accidents, we identified children ages 2–16 years injured during a four-wheeled ATV accident admitted or transferred to our Level I and Level II trauma centers from January 1, 2007 to December 31, 2009. Data was obtained using our institutional trauma registry (Geisinger Medical Center, Danville, PA) which includes all orthopaedic trauma patients aged ≥1 year treated at one level I trauma center (Geisinger Medical Center, Danville, PA) and one level II trauma center (Geisinger Wyoming Valley, Wilkes-Barre, PA) associated with the system.

The E-codes used in this study for case selection included E821.0 through E821.9, which are specific for ATV accidents. Then, via manual chart review, accident-related data including age, gender, BMI, environment descriptors (i.e. rural highway, wooded area, personal property), length of hospital stay, whether the patient was a driver or passenger, and helmet use where noted was collected. Where possible, each crash was categorized into one of four categories, in decreasing order of severity: ejection, rollover, crash with a moving object, or crash with a stationary object. If more than one category applied, the most severe category was chosen. Total hospital costs related to the initial hospital stay for ATV-related trauma patients were determined for patients, including both direct and indirect costs of nursing, laboratory, diagnostic, surgical, surgical supplies, medications, and support staff. Costs associated with subsequent hospital readmissions or clinic visits after hospital discharge were not assessed.

The two main outcomes of interest were the total cost of care, and whether or not the injury required an overnight hospital stay (length of stay >1 day). Because cost data follow a log-normal distribution rather than a normal distribution, generalized linear regression (GLM) with a log-link function was used to test for significant risk factors associated with higher costs, and logistic regression was used to test for risk factors associated with overnight hospital stays. Finally, to examine whether there was a time trend, we compared both outcomes among the 3 years of the study using ANOVA or chi-square testing. All statistical analyses were performed using SAS statistical software (SAS 9.3, Cary, NC), with a p-value of <0.05 considered statistically significant.

Results

A total of 78 patients met inclusion criteria for the study. Sixty-one of the patients (78%) were male, and the mean age was 12.2 years (median 13 years, range 2–16 years). Table 1 describes the details of the crash circumstances. Rollovers (41%) were the primary mechanism of injury followed by ejections, collisions with stationary objects, and collisions with a moving object. Over half of the patients (54%) were reported as wearing a helmet at the time of the accident, 23% were not wearing a helmet, and helmet status was undocumented for 23% of patients. The majority (74%) were reported to be the driver with 15% reported as being passengers, and the remaining 10% did not have their role recorded. Only one fatality was reported.

Total cost of care ranged from $322 to $310,435 with a mean cost of $25,760 (median $8066). Length of stay ranged from 0 to 19 days with a mean value of 1.8 days, and 37 of 78 patients (47%) required an overnight stay. Table 2 shows the results of the cost analysis where each potential risk factor was assessed. Results are expressed as a Cost Ratio (CR), which is a multiplication factor by which the risk factor affected the log-cost of care, with ratios greater than 1.0 indicating higher cost and less than 1.0 indicating lower costs. Crashing into a stationary object (as opposed to the other three crash types of rollovers, ejections, or crashes with moving objects) had a cost ratio of 0.40 ($p = 0.01$), indicating it had significantly lower costs than other crash types. Age and rollover crashes were associated with cost ratios slightly greater than 1.0, but did not reach statistical significance. Likewise, helmet use was associated with a favorable cost ratio of 0.64, but this was not statistically significant ($p = 0.69$).

Because fewer than half of the patients were admitted overnight, we tested for associations between risk factors and an

Table 1
Crash circumstances.

Types of crash, N (%)	
Rollover	32 (41%)
Ejection	23 (29%)
Collision with stationary object	18 (23%)
Collision with moving object	1 (1%)
Other	1 (1%)
Not documented	3 (4%)
Helmet use, N (%)	
Helmet	42 (54%)
No Helmet	18 (23%)
Not documented	18 (23%)
Patient's role in crash, N (%)	
Driver	58 (74%)
Passenger	12 (15%)
Not documented	8 (10%)
Fatalities, N (%)	1 (1%)

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