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Injuries from all-terrain vehicles: An opportunity for injury prevention

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ABSTRACT

Background: Patient demographics, behavior, and injury patterns were assessed to inform preventative efforts for reduced incidence of all-terrain vehicle (ATV) trauma.
Methods: ATV-related injuries treated at a Level I trauma center from 2008 to 2012 were retrospectively reviewed. Patient outcomes and incidence of traumatic brain injury (TBI) were compared by helmet use and alcohol intoxication.
Results: Helmet data were available for 304 patients of 404 patients included; of these, 75 (24.7%) wore a helmet. Incidence of TBI was lower in the helmeted (8.0%) versus the unhelmeted subgroup (26.6%) ($P < 0.001$). Helmeted patients had lower injury severity scores, lower intensive-care unit (ICU) admission rates, and shorter ICU and hospital length of stay (LOS) ($P < 0.05$). Intoxicated patients had higher rates of TBI and ICU admission as well as prolonged ICU LOS ($P < 0.05$).
Conclusions: These data support the requirement for a greater emphasis on injury prevention among ATV users.

1. Introduction

Popularity of the all-terrain vehicle (ATV) has continuously increased since its introduction in the United States in 1971. Estimates of ATVs currently in use nationwide exceed 10.2 million, which is more than triple the estimate from the previous decade.[1] ATVs being manufactured now are larger (over 800 pounds) and more powerful than previous models and are capable of speeds greater than 80 miles per hour.[2,3] Subsequently, ATV-related deaths and injuries are an increasing public health concern, with 13,043 ATV-related fatalities occurring between 1982 and 2013.[4] The Consumer Product Safety Commission (CPSC) received reports of 426 ATV-related fatalities occurring in 2013 alone. Also in 2013, US emergency departments (EDs) treated an estimated 99,600 ATV-related injuries, 25% of which involved children under the age of 16.[4] Many factors have been suggested to influence this increase in ATV-related injuries, including greater vehicle power and speed, children riding adult-sized ATVs, lack of helmet use, alcohol use, and limited law enforcement.[5] A substantial burden of injury results, as more than $6.5 billion is spent each year in the United States for the treatment of ATV-related injuries.[6]

In efforts to improve ATV safety, the CPSC negotiated a 10-year decree with leading ATV manufacturers in 1988 to (1) cease production of three-wheeled ATVs, (2) ban the sale of large-engine ATVs to children under 16 years of age, (3) implement safety warning labels on ATVs, (4) police ATV dealers for age recommendation compliance, and (5) launch a public-awareness campaign regarding ATV safety.[7] This decree expired in 1998 and was followed by a similar ATV Action Plan, in which ATV manufacturer participation is voluntary, self-regulated, and enforced internally by the ATV industry.[8] Currently, no federal regulations exist to govern ATV use, and state laws remain inconsistent: only 12 states mandate helmet use by all users.[9] In North Carolina, the location of our Level I trauma center, state law allows children as young as 8 years old to operate ATVs. Persons born after January 1990 must acquire a safety certificate, which is obtained after only a half-day ATV training course.[10] While, in general, eye protection and helmets are required, an exception exists for use on North Carolina beaches.

Despite North Carolina state law, helmet use remains low, and many ATV accidents are associated with alcohol and drug intoxication. This may be due to a lack of federal oversight and federal funding, which are often required for successful law enforcement

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and injury prevention programs.

The aim of this study was to assess the demographics, behavior, and injury patterns of patients presenting with ATV-related injuries to a Level I trauma center. Specifically, we hypothesized that both decreased helmet use and use of ATVs while under the influence of alcohol are associated with increased injury severity and higher rates of traumatic brain injury (TBI). Focusing future injury prevention efforts on relevant factors may help to decrease patient morbidity and mortality.

2. Materials and methods

2.1. Study population and design

A retrospective secondary data analysis was performed of all patients with ATV-related injuries who presented to Carolinas Medical Center (CMC), a Level I trauma center, from 2008 to 2012. CMC is the only American College of Surgeons (ACS)-certified Level I trauma center in Charlotte, North Carolina, and has a large catchment area of over 2.5 million people including residents of northeast South Carolina. All patients with ATV-related mechanisms of injury were identified through the Trauma Registry Database, and individual data not in the trauma registry was obtained with retrospective chart review of the patients' hospital records. No patients were excluded. The following variables were analysed: age, sex, helmet use, blood alcohol content (BAC), injury severity score (ISS), injury type, Glasgow Coma Score (GCS) upon emergency department (ED) admission, admission to intensive care unit (ICU), and admission to operating room (OR) for emergency surgery.

Intoxication was defined as a BAC >80 mg/dL, and although a urine drug screen is routinely obtained for trauma activation, only alcohol was used to defined intoxication as other drugs could be metabolized previously but still show positive on a drug screen. Alcohol serum testing is part of the labs obtained with a level 1 or 2 trauma activation at our facility. This requires placing the order and obtaining blood before going to the floor, ICU, CT scanner, or the operating room. The initial blood draw is kept for every trauma patient in case the sample is not sent in the ED, both for blood typing and need for alcohol and drug testing; when a serum alcohol is accidently not sent, this sample is run for the alcohol level. Lower acuity, trauma alerts and pediatric traumas do not have this requirement. Primary outcomes of interest were injury severity (as measured by ISS) and TBI, and secondary outcomes of interest were hospital disposition, ventilator days, hospital length of stay (LOS), and ICU LOS. Outcomes were compared between helmeted and unhelmeted ATV users and between alcohol intoxicated and non-intoxicated ATV users.

2.2. Statistical analysis

Descriptive statistics including means, standard deviations, counts, and percentages were calculated. For purposes of this analysis, a blood alcohol content (BAC) $\geq$ 80 mg/dL indicated intoxication. Bivariate analysis was performed for helmet use and intoxication status; for categorical data, the chi-square test or Fisher's exact test was used. For ordinal data or interval data (which were not normally distributed), the Wilcoxon rank-sum test was used. Multivariate analysis was performed for categorical outcomes using logistic regression and for continuous outcomes using Poisson regression controlling for the following confounding variables: age, sex, ISS, helmet use, and intoxication status. SAS® Enterprise Guide 5.1 (SAS Institute, Cary, NC) was used for all data analyses, and a two-tailed P value < 0.05 was considered statistically significant.

3. Results

Overall, 404 patients incurred ATV-related injuries during the study period. Descriptive statistics of the entire study population are reported in Table 1. These 404 patients were predominantly male ($n = 308$; 76.2%) with a mean (±SD) age of 29.0 ± 16.6 years and a mean (±SD) ISS of 11.1 ± 9.1. Helmet use data were available for 304 patients; of these, only 75 patients (24.7%) wore a helmet. 208 patients had serum alcohol testing sent, and 73 of 404 patients (18.1%) were legally intoxicated on presentation to the ED. Mean (±SD) presenting GCS was 13.6 ± 3.5, and TBI was diagnosed in 19.1% of patients. The most common injury type was long bone fracture in 111 (27.5%) of patients. Mean (±SD) ICU and hospital LOS was 1.1 ± 3.8 and 4.4 ± 6.7 days, respectively. Patients were discharged home primarily (n = 359; 88.9%), to a skilled nursing facility (n = 32; 7.9%), or to inpatient rehabilitation (n = 27; 6.7%). Inpatient death occurred in 9 patients (2.2%). All of these deaths were related to TBI, and 7 of these deaths occurred in patients who were not helmeted.

3.1. Helmet status

Helmet use data were available for 304 patients (75.2%) (Table 2). Similar sex distribution and revised trauma scores were found between the helmeted and unhelmeted subgroups. Compared with unhelmeted patients, helmeted patients were younger and much less likely to be intoxicated ($P < 0.01$ for both) and presented with significantly higher GCS and lower ISS ($P = 0.001$ for both). Rates of TBI and ICU admission for helmeted patients were less than one-third and one-half, respectively, those for unhelmeted patients. Spine, thoracic, abdominal, and pelvic injuries occurred at similar rates ($P > 0.05$) among the subgroups;

Table 1
Characteristics of patients after all-terrain vehicle (ATV)-related traumatic injuries.

Characteristic	Result ($n = 404$)
Age, mean, years ± SD	29.0 ± 16.6
Men, No. (%)	308 (76.2)
Helmeted, No. (%)[a]	75 (24.7)
Blood alcohol concentration (BAC)	
≥80 mg/dL[b], No. (SD)	73 (18.1)
Mean, mg/dL (SD)	73.5 (107.6)
GCS on ED presentation, mean (SD)	13.6 (3.5)
Revised trauma score, mean (SD)	7.4 (1.3)
Injury severity score, mean (SD)	11.1 (9.1)
Injury type, No. (%)	
Traumatic brain injury	77 (19.06)
Cervical spine injury	37 (9.2)
Thoracic or lumbar spine injury	54 (13.4)
Thoracic cavity injury	94 (23.3)
Intra-abdominal injury	34 (9.4)
Pelvic fracture	18 (4.5)
Long bone fracture	111 (27.5)
Intubation required, No. (%)	22 (5.5)
ICU admission, No. (%)	98 (24.3)
OR admission, No. (%)	37 (9.2)
ICU length of stay, mean, days (SD)	1.1 (3.8)
Ventilator days, mean (SD)	0.6 (3.7)
Hospital length of stay, mean, days (SD)	4.4 (6.7)
Discharge disposition	
Home	359 (88.9)
Inpatient rehabilitation	27 (6.7)
Skilled nursing facility	32 (7.9)
Inpatient mortality, No. (SD)	9 (2.2)

Abbreviation: ATV, all-terrain vehicle; SD, standard deviation; BAC, blood alcohol content; GCS, Glasgow Coma Score; ED, emergency department; ICU, intensive care unit; OR, operating room.

[a] Helmet use data were available for 304 patients only.

[b] For this study, BAC ≥80 mg/dL indicated alcohol intoxication.