OPEN

A Retrospective Cohort Study of Traumatic Brain Injury and Usage of Protective Headgear During Equestrian Activities

Donna S. Lemoine, BSN, RN, NR-P, TCRN ■ Bradley J. Tate, MSN, RN, CEN, TCRN ■ Jennifer A. Lacombe, LPN ■ Theresa C. Hood, MS, RNC

ABSTRACT

Some of the more popular sporting activities for those living in rural areas include equestrian activities such as rodeo events and horseback riding. The lack of helmet use poses a concern for those who participate in these activities due to the risk of sustaining a traumatic brain injury (TBI) and ultimately having a negative effect on their future. A retrospective cohort study was conducted at a trauma center comparing the data on animal-riding patients and their use or lack of use of headgear and incidence of TBI. Of the patients identified, 16.2% sustained a head injury, ranking TBI fourth among all injuries sustained by the animal-riding population. Males were predominantly affected; however, females of pediatric age 5–17 years (54.5%) ranked high among the TBI population. Among all the patients identified with TBI, none of the patients were wearing a helmet and all sustained a head injury. The average injury severity score was 11, with hospital length of stay averaging less than 2 days and the overall mortality was 3.6%. Findings from the study should be considered for the purpose of implementing an age-specific educational program focused on head injury prevention and utilization of protective headgear. Current literature supports the use of protective headgear to reduce the risk of head injuries. Animal riders should be educated on the importance of using headgear as a preventive measure. Future studies are needed to indicate the effectiveness of injury prevention in regard to head injury severity and the use of protective headgear.

Key Words

Concussion, Equestrian, Helmet, Injury prevention, Traumatic brain injury

The purpose of this study was to identify a correlation between head injuries and reduced use of protective headgear in animal-riding accidents to support the implementation of a head injury education prevention program. The concept of the study was developed from interviews with patients who sustained a traumatic brain injury (TBI) during their animal-riding accident. Within our study, the diagnosis of TBI included intracerebral hemorrhage, intracerebellar hemorrhage, and concussion. Statistics from the Brain Injury Association of America (BIAA, 2016) stated more than 3.5 million children and adults sustain a TBI annually and upward of 5.3 million people live with TBI-related disabilities. The Centers for Disease Control and Prevention (CDC, 2016) defined TBI as an injury ranging from mild to severe with the possibility of changes in the patient's mental status postinjury, including loss of consciousness and amnesia. Approximately 75% of TBIs were categorized as concussions, and mild TBIs occurring repeatedly within a short period of time can be tragic or fatal in nature; therefore, wearing protective headgear during periods of horseback riding is recommended (CDC, 2016).

REVIEW OF THE LITERATURE

Literature pertaining to TBI was searched in various databases, including MEDLINE, Cochrane Database of Systematic Reviews, and PubMed, using the terms "traumatic brain injury," "injury prevention," "equestrian," "helmet," and "concussion." Limitations included dates between years 2010 and 2016, and abstracts were reviewed in identifying articles relevant to the research question.

Author Affiliation: Trauma Services, Rapides Regional Medical Center, Alexandria, Louisiana.

Author Contributions: Donna S. Lemoine participated in conceiving and designing the work, analyzing and interpreting the data, writing part of the manuscript, and approving the final version of the manuscript; Bradley J. Tate participated in collecting, analyzing, and interpreting the data, writing the manuscript, and approving the final version of the manuscript; Jennifer A. Lacombe participated in conceiving and designing the work, writing and revising part of the manuscript, and approving the final version of the manuscript; and Theresa C. Hood participated in collecting other material, revising the manuscript to make important changes in content, and approving the final version of the manuscript.

The authors declare no conflicts of interest.

Correspondence: Bradley J. Tate, MSN, RN, CEN, TCRN, Trauma Services, Rapides Regional Medical Center, 211 Fourth St, Alexandria, LA 71301 (bradley.tate@hcahealthcare.com).

DOI: 10.1097/JTN.0000000000000300

Several literature reviews were identified related to TBI and protective headgear. Havlik (2010) sought to evaluate recent literature and draw conclusions related to mechanism of injury, demographics, incidence severity, and prevention methods. That study's findings showed that riders were predominantly female, falling from the horse was the most common mechanism of injury, and injuries to the head and neck were the second most common regions affected. Furthermore, a high incidence of injury was reported during recreational riding, which showed the need for increased use of protective gear during all types of equestrian events. Increased use of head protection was related to an increased awareness among riders and parents. Limitations identified included limited availability of equestrian-related literature compared with other contact sports. Worley (2010) also indicated that helmets can have a significant positive effect on riders' health and quality of life. Findings showed that young females were the most common cohort, head and facial injuries were the most common, and TBIs resulted from impacting the ground. It was also suggested that there was a reduction in the severity with the use of approved helmets, and emergency nurses should help promote safe practices through injury prevention. Literature by Goldberg (1992) provided recommendations by the American Academy of Pediatrics Committee on Sports Medicine and Fitness related to injury prevention by lessening the severity of injury during riding. Findings from the committee suggested that education programs presented to parents aided in reduced risk for injury. Parents should be urged to verify the horses their children ride were matched with their capabilities along with supervised riding activities. Riders should also wear helmets that meet industry standards when mounted on the animal. Zuckerman et al. (2015) sought to address the epidemiology of concussion and TBI in equestrian-related sports and summarized the existing literature. Findings from their study found that among all modern sporting activities, equestrian events have some of the highest rates of total body injury, brain injury, and mortality. Helmet rates remained low despite the evidence that helmet use was a major opportunity for improvement for rider safety. Limitations from the study included the need for more data from equestrian governing bodies regarding mechanism of injury, protective gear, and patient outcomes. The authors felt the sample size was small and risk reduction was difficult to calculate and noted in their limitations.

Retrospective studies with supportive data were also identified related to equestrian events and helmet use. The retrospective and prospective study by Butterwick, Lafave, Lau, and Freeman (2011) classified debilitating injuries as well as injury prevention methods to help reduce the severity of injury and have a positive effect on riders' quality of life. Their research identified that helmet use in rodeo events did have a protective effect in reducing injury and fatality as evidenced by no fatalities identified because of head injury when helmets were worn during the rodeo event. Limitations for the study included underreported catastrophic injuries and fatalities as well as limited data collection. Davidson, Blostein, Schrotenboer, Sloffer, and VandenBerg (2015) identified the frequency with which injuries occurred, mechanism of injury, types of injury and surgical interventions, use of safety equipment, and patient mortality outcomes. Their findings showed that females were predominantly affected by injury, falling from the horse was the most common mechanism of injury, and chest injuries were the most common, followed by head injuries. Patients identified in the study who wore helmets did not need a neurological intervention during their admission; however, those patients who did not utilize helmets during their accident did sustain a TBI and required neurological intervention. A retrospective data analysis and case–control survey by Hasler et al. (2011) sought to identify injury patterns, protective factors, and risk factors related to horse riding and identified safe riders and those at increased risk. The findings from their study showed that education was seen as a protective factor as well as the wearing of helmets. The authors concluded that knowledge of risk factors and protective measures was important in the prevention of injuries and injury prevention initiatives should focus on safe riding practices. Limitations of their study included that the patients under review and controls were not interviewed sequentially. Those who were interviewed postriding may have over- or underestimated their riding readiness, and opportunity for bias could not be estimated.

Finally, a cross-sectional survey and exploratory descriptive study by Ross, Ferguson, Bosha, and Cassas (2010) sought to determine the usage rates and barriers in protective equipment use by rough-stock rodeo riders. Their findings included barriers such as discomfort and rider persona, even though riders agreed that protective equipment prevents injury. Riders who wore helmets had a lower concussion and loss-of-consciousness rate than riders without helmets. Three fourths of the respondents agreed that helmets prevented head injury; however, the riders reported helmets as being visually restrictive, heavy, and affected performance. Even though the barriers were reported by the respondents, the authors supported the concept that athletes should be educated about the risk of not wearing helmets and encouraged to use them appropriately. Limitations in their study included a low number of participants, data based on participant recall, possibility of repeat responders, and possible researcher bias due to interpretation of open-ended responses.

METHODS

Setting and Sample

The study was conducted utilizing data from our own American College of Surgeons verified Level II trauma

facility and included patients who were designated as trauma activation per the facility's trauma criteria. These patients were identified as activated trauma patients due to the mechanism of injury sustained as an ejected animal rider and then further narrowed specifically to patients sustaining one of our three diagnoses of TBI.

Data Collection

To obtain quantifiable information, the study was intended to retrospectively analyze demographic and clinical data. Descriptive statistics included variables of age, sex, regions of injury, injury severity score (ISS), Glasgow Coma Scale (GCS) score, hospital and intensive care unit (ICU) length of stay (LOS), mortality, and whether protective headgear were used. All patients admitted for inpatient care were identified from a query of the trauma registry (TraumaBase; Clinical Data Management, Conifer, CO) from January 1, 2012, through December 31, 2016, with International Classification of Diseases and Related Health Problems, Ninth Revision (ICD-9) cause codes E828.2 and E825.5 and 10th revision (ICD-10) cause codes V80.010A and V80.018A.

Ethical Considerations

The Midwest Health System Institutional Review Board (IRB) application was submitted, and it was determined the study was exempt from IRB review and no further action was requested. Should any of the study procedures change that could affect the exempt status of the study, the IRB office would be contacted for review.

RESULTS

Patient Demographics

There were 15,379 records retrieved for this time period, and among these records, 173 patients sustained injuries related to animal-riding accidents and 28 (16.2%) patients sustained a TBI. Within the sample population of 173 patients, 83.8% did not sustain a head injury and were excluded from the study. In the TBI population, 16 (57.1%) patients were male between 5 and 71 years of age (M = 30.8, SD = 21.66) and 12 (42.9%) patients were female between 9 and 59 years of age (M = 31.3, SD = 21.36) (Table 1). The average age of the TBI population was 30.8 years; however, a high incidence of injury was identified in the female pediatric population (n = 11; 54.5%; Table 2).

Subject Demographics

Cumulatively, TBI ranked fourth (16.2%) among all major injuries identified following thoracic injuries (29.9%), long bone fractures (25.4%) and spinal injuries (19.5%) (Table 3). Among those patients who sustained a TBI, concussion (n = 18; 60%) ranked highest, followed by intercerebral hemorrhage (n = 6; 20%) and intracerebellar hemorrhage (n = 3; 10%). Patients who sustained a TBI were injured by striking the ground (n = 27; 96.4%) or by striking other objects (n = 1; 3.6%). Minor injuries, including abrasions, contusion, lacerations, avulsions, are found in many patients within the sample and were excluded in calculating the number of major injuries. Small bone fractures in phalanges, metacarpals, carpals, metatarsals, tarsals, nasal bones, and isolated fractures of facial bones were also considered minor injuries in the calculation.

Basic Item Analysis

Patients with TBI demonstrated an ISS from 1 to 51 (M = 11), and six patients (21.4%) sustained an ISS of 15 or more. The mean GCS score was mild at 14. Total hospital LOS ranged from 0 to 9 days (M = 1.64, SD = 1.40), and ICU LOS ranged from 0 to 2 days (M = 0.32, SD = 0.39). Among the patients discharged from the emergency department, 39.2% (n = 11) were transferred to the nursing floor, 17.9% (n = 5) went to the ICU, and 7.1% (n = 2) went to the operating room. The overall mortality rate of TBI patients was 3.6% (n = 1), with no reports of usage of protective headgear during their accidents. Three of 172 patients (M = 1.7) within the larger animal-riding population did utilize protective headgear and did not sustain a head injury during their accident.

DISCUSSION

Patients who do not utilize protective head gear and are injured in animal-riding accidents risk sustaining injuries to the head among many other injuries; therefore, our initial hypothesis regarding a correlation between lack of helmet use and TBI was supported because of our findings. Patients in this study who sustained a TBI were not wearing protective headgear. Three patients identified in the general animal-riding population were wearing a helmet and did not sustain a TBI. Many other studies suggest that helmet use in rodeo events can reduce incidents of head injury and fatality (Butterwick et al., 2011; Havlik, 2010; Ross et al., 2010; Worley, 2010). This study supported our hypothesis of outcomes correlated to the nonuse of protective headgear during animal-riding accidents. Further research is warranted to identify a correlation between lower head injury severity and use of proper head protection in all age groups of the animal-riding population postinjury prevention implementation.

Continued lack of helmet utilization by animal riders in rodeo events is a problem due to these riders sustaining TBIs. Havlik (2010) and Zuckerman et al. (2015) describe equestrian activities as having a higher risk of injury than with football, motorcycle riding, automobile racing, track and field, wrestling, skiing, and rugby. One study found respondents agreeing that protective equipment prevents head injuries and the reason for not wearing protective

TABLE 1 TBI Patient Demographics and Variables

Variables[a]	*f*	%	*M* (*SD*)
Sex			
Male	16	57.1	31.3 (21.36)
Female	12	42.9	30.1 (21.66)
Age, years			30.8 (21.09)
0–10	7	25.0	
11–17	4	14.3	
18–29	4	14.3	
30–40	3	10.7	
40–60	7	25.0	
>60	3	10.7	
Ranking of TBI			
Concussion	18	60.0	
Intracerebral hemorrhage	6	20.0	
Intracerebellar hemorrhage	3	10.0	
Other head injuries	3	10.0	
Mechanism of Injury			
Striking the ground	27	96.4	
Striking the animal/equipment	1	3.6	
ISS of TBI patients			11
0–9	15	53.6	
10–14	7	25.0	
15–24	3	10.7	
≥25	3	10.7	
Initial GCS score of TBI patients			14
<9	1	3.6	
≤14	7	25.0	
15	20	71.4	
Hospital LOS in days			1.64 (1.40)
0	10	35.7	
1–2	10	35.7	
3–4	7	25.0	
>5	1	3.6	
ICU LOS in days			0.32 (0.39)
0	21	75.0	
1	5	17.9	
2	2	7.1	
ED disposition			
Floor	11	39.2	
Home	9	32.1	
ICU	5	17.9	
OR	2	7.1	
Other	1	3.6	
Mortality			
Alive	27	96.4	
Expired	1	3.6	

Note. ED = emergency department; GCS = Glasgow Coma Scale; ICU = intensive care unit; ISS = injury severity score; LOS = length of stay; OR = operating room; TBI = traumatic brain injury.

[a]N = 28, The variables provide supportive data in developing an effective injury prevention program. One patient within our TBI sample did not wear a helmet and died of injury, and this incident could have potentially been prevented, or risk reduced, with the use of protective headgear. Davidson et al. (2015) encountered similar findings, where 91.9% of patients did not use protective headgear, falls from the animal were the most common, and sustained a TBI.

TABLE 2 Pediatric Population With TBI

	f	%	*M* (*SD*)
Pediatric population <18 years of age (n = 11)			10.6 (3.69)
Male	5	45.5	
Female	6	54.5	

Note. TBI = traumatic brain injury. Those in the pediatric patient population who sustained a TBI ranged in age from 5 to 17 years, where females were the majority and the average age was 10 years. Pediatric females were identified as having a high number of injuries, and education focused on this group may reduce incidents of TBI in this age group population. Other literature by Davidson et al. (2015), Worley (2010), Hasler et al. (2011), and Havlik, (2010) supports the findings seen in our study where females of pediatric age were prevalent among the TBI sample population, leading us to further conclude that our findings were consistent among other geographical locations.

headgear was specifically related to how the rider perceives his or her performance, describing the headgear as a visual restriction, heavy, uncomfortable, "not cowboy," and some just do not like wearing the headgear (Ross et al., 2010).

The BIAA (2016) listed trauma as a typical cause of brain injury due to an external force where the head was struck against the ground (40.5%) or against an object (15.5%). Findings in our study showed that more patients were injured when falling from the animal and striking the ground, similar to findings by Worley (2010), where 90% of equestrian-related TBIs were the result of an impact with the ground or other objects when ejected from the animal. Patients with TBI in our study averaged a GCS score of 14 and ISS of 11, allowing us to identify TBI as a moderate to severe injury when a helmet is not utilized. Findings from our study were also congruent with findings in other literature in that head injuries ranked as one of the most common cause of equestrian-related injuries, between 20% and 48% of cases (Worley, 2010), and concussions are the most common form of TBI (Ross et al., 2010).

Several resources reported that helmet use was linked to a 50% risk reduction in sustaining a head injury (Hasler et al., 2011; Havlik, 2010; Zuckerman et al., 2015); therefore, helmet use is a significant factor in injury prevention, and safe riding practices should include its proper usage. Various literature also supported the use of an educational injury prevention program that includes head protection to decrease the incidences of TBI and lead to a better quality of life (Butterwick et al., 2011; Davidson et al., 2015; Hasler et al., 2011; Ross et al., 2010). One of the most interesting findings in our study was related to the high number of incidents found in the female pediatric population and these occurrences were also found in other studies (Davidson et al., 2015; Hasler et al., 2011; Havlik, 2010; Worley, 2010), leading us to conclude that our findings were consistent among similar cohorts and locations.

TABLE 3 Top Five Major Injuries in Animal Riders

Top Five Major Injuries (*n* = 185; 51.2%)	*f*	%
Thoracic injury	48	25.9
Long bone fracture	47	25.4
Spinal injury	36	19.5
Traumatic brain injury	30	16.2
Pelvic fracture	24	13.0

Note. Patients reviewed in the study sustained an array of major and minor injuries, with head injury among the top five major injuries. Hasler et al. (2011) identified head injury as the second highest injury (n = 127/578; 24%) in a similar retrospective study, whereas it was identified as the fourth highest injury in our cohort analysis. This finding lead us to determine that the injuries seen at our facility were consistent with findings in other geographical areas.

IMPLICATIONS FOR TRAUMA NURSING

This particular study sheds light on an issue in which injury prevention can have a positive impact and the information gained provides a baseline assessment for the TBI population treated at our facility. Despite safety recommendations, some animal riders continue to participate in equestrian events without protective headgear and a retrospective study by Worley (2010) showed that 64% of injured riders believed their injuries were preventable. Most participants are aware of the safety equipment itself, but they also need the education and awareness of the potential health issues (Havlik, 2010). The American Academy of Pediatrics recommends the utilization of education programs through professional equestrian organizations to stress the risks of trauma regarding horseback riding, including preventive measures to avoid such injury (Goldberg, 1992). Being cognizant of the age groups with high numbers of incidents presents the need for age-specific education related to head injuries and the proper use of protective headgear. Another opportunity identified for nursing includes the political lobbying of professional and government organizations to require mandatory helmet use in these events (Zuckerman et al., 2015). The concept of utilizing nurses specialized in trauma and emergency nursing for advocating, promoting,

and developing head injury prevention is also supported in the literature (Worley, 2010). Trauma nurses can share their stories of related experience from patients suffering a TBI, including the required care needed and the journey through rehabilitation.

INJURY PREVENTION

With the use of our findings, injury prevention strategies can be implemented within the community and directed specifically toward the animal-riding population. Our facility frequently provides information regarding general health issues through segments on a local news network in an effort to communicate to a larger population. Through this process, the facility released an interview with one of our advanced practitioners discussing the importance of protective headgear in horseback riding and possible injuries that occur during accidents (Rapides Regional Medical Center, 2016). Gaining access to the animal-riding population could be possible through facility sponsorship of a rodeo event and education, through the development of a visual display of evidence-based research. Our findings as well can address the risk of TBI and the importance of protective headgear. For the prevention program to be successful, TBI information and community education should include nurses with trauma and emergency nursing experience to help educate the public and age-specific groups who ride animals, including parental attendance for those younger than 17 years.

LIMITATIONS

The study had certain limitations in that it was conducted at a single institution. The inclusion of additional trauma centers involvement could yield further results. The TBI population sample size was rather small for the time period under review and may yield additional results with a larger sample population. The study was not conducted under the randomization of a sample size; however, any future study should consider such research design to strengthen the foundation of evidence. Author bias toward the use of helmets was also identified in that one of the authors participates in horse-related events and has sustained injuries, including a concussion, and promotes the use of protective headgear. Literature supporting the need for protective headgear during riding events was sought during the literature review and could be portrayed as a form of author bias. A strength of our study was the accuracy of the trauma registry in collecting specific data points for review and analysis.

CONCLUSION

A quantitative retrospective analysis was conducted consisting of 28 patients identified as meeting trauma activation criteria where the animal rider was ejected from an animal and sustained a TBI. The data in this study concluded that patients who are animal riders sustain an array of injuries. When protective headgear is underutilized, TBIs occur ranging from mild to fatal. None of the patients in our cohort study were wearing protective headgear and therefore sustained varying levels of TBI. Males were found to be primarily affected; however, a high incidence among pediatric female patients was also identified and these findings were consistent in other literature reviews. Education regarding protective headgear through injury prevention programs can help increase riders' awareness of TBI and potential consequences of not wearing a helmet. Three patients identified in the larger animal-riding population wore protective headgear and did not sustain a TBI, leading us to conclude the riders' helmet aided in the prevention of a head injury. With the support of these research findings, the facility will be able to continue to utilize various methods of community education in addressing the issue of TBI and promoting helmet usage. Educating animal riders on the importance of safety equipment while riding equestrian animals continues to be key in the prevention of head injuries and fatalities. Further research by the facility will be needed to compare current and future findings to help determine the effectiveness of community education regarding incidents of TBI and the utilization of protective headgear.

Acknowledgment

The authors thank Lynn Randall, MSN, RN, for assistance in manuscript preparation.

KEY POINTS

- Traumatic brain injury ranked fourth among all major animal-riding injuries, following thoracic, long bone, and spinal fractures.
- Pediatric-age females were identified as a population with a high number of head injuries, and this finding was also consistent in other research, indicating injury prevention strategies should be directed toward this age group along with parental involvement.
- There were no reports of protective headgear usage in the patients identified with TBI; however, three patients in the larger population did wear protective headgear and did not sustain a head injury.
- Literature supports the concept in which animal riders who do not utilize protective headgear risk sustaining TBI among many other injuries and injury prevention programs can help reduce the incidence of injury.
- Nurses with experience in emergency and trauma care can have an impact through education within the community, advocating for healthy practices through injury prevention and participating in organizational and governmental lobbying for standards change regarding helmet use in equestrian events.

REFERENCES

Brain Injury Association of America (BIAA). (2016). *Brain injury facts and statistics*. Retrieved from http://www.biausa.org/brain-injury-awareness-month.htm

Butterwick, D., Lafave, M., Lau, B., & Freeman, T. (2011). Rodeo catastrophic injuries and registry: Initial retrospective and prospective report. *Clinical Journal of Sport Medicine*, *21*(3), 243–248. doi:10.1097/JSM.0b013e318218acdd

Centers for Disease Control and Prevention (CDC). (2016). *Basic information about traumatic brain injury and concussion*. Retrieved from http://www.cdc.gov/traumaticbraininjury/basics.html

Davidson, S., Blostein, P., Schrotenboer, A., Sloffer, C., & VandenBerg, S. (2015). Ten years of equine-related injuries: Severity and implications for emergency physicians. *The Journal of Emergency Medicine*, *49*(5), 605–612. doi:10.1016/j.jemermed.2015.03.025

Goldberg, B. (1992). Horseback riding and head injuries. *Pediatrics*, *89*, 512. Retrieved from http://emsaonline.net/wp-content/uploads/2013/07/Horseback-Riding-and-Head-Injuries.pdf

Hasler, R., Gyssler, L., Benneker, L., Martinolli, L., Schotzau, A., Zimmermann, H., & Exadaktylos, A. (2011). Protective and risk factors in amateur equestrians and description of injury patterns: A retrospective data analysis and a case-control survey. *Journal of Trauma Management & Outcomes*, *5*(4), 1. doi:10.1186/1752-2897-5-4

Havlik, H. (2010). Equestrian sport-related injuries: A review of current literature. *Current Sports Medicine Report*, *9*(5), 299–302. doi:10.1249/JSR.0b013e3181f32056

Rapides Regional Medical Center. (2016, November 10). *Rapides Regional Health Talk—Rodeo trauma* [video file]. Retrieved from http://www.youtube.com/watch?v=cd-DM1Lizol

Ross, D., Ferguson, A., Bosha, P., & Cassas, K. (2010). Factors that prevent roughstock rodeo athletes from wearing protective equipment. *Current Sports Medicine Reports*, *9*(6), 342–346. doi:10.1249/JSR.0b013e3181fc7357

Worley, G. (2010). Promoting the use of equestrian helmets: Another opportunity for injury prevention. *Journal of Emergency Nursing*, *36*(3), 263–264. doi:10.1016/j.jen.2010.01.007

Zuckerman, S., Morgan, C., Burks, S., Forbes, J., Chambless, L., Solomon, G., & Sills, G. (2015). Functional and structural traumatic brain injury in equestrian sports: A review of the literature. *World Neurosurgery*, *83*(6), 1098–1113. doi:10.1016/j.wneu.2014.12.030