

Equestrian injuries: incidence, injury patterns, and risk factors for 10 years of major traumatic injuries

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Abstract

Background: Horseback riding is more dangerous than motorcycle riding, skiing, football, and rugby. The purpose of this study was to identify the incidence and injury patterns, as well as risk factors associated with severe equestrian trauma.

Methods: All patients with major equestrian injuries (injury severity score ≥ 12) admitted between 1995 and 2005 were reviewed. A 46-question survey outlining potential rider, animal, and environmental risk factors was administered.

Results: Among 7941 trauma patients, 151 (2%) were injured on horseback (mean injury severity score, 20; mortality rate, 7%). Injuries included the chest (54%), head (48%), abdomen (22%), and extremities (17%). Forty-five percent required surgery. Survey results (55%) indicated that riders and horses were well trained, with a 47% recidivism rate. Only 9% of patients wore helmets, however, 64% believed the accident was preventable.

Conclusions: Chest trauma previously has been underappreciated. This injury pattern may be a result of significant rider experience. Helmet and vest use will be targeted in future injury prevention strategies. © 2007 Excerpta Medica Inc. All rights reserved.

Keywords: Equestrian; Injury; Trauma; Risk factors

Equestrian activities, both recreational and work related, are a fundamental component of life in Alberta. Although the precise number of Canadian riders is unclear, more than 470,000 people are employed exclusively within the equestrian industry [1]. Furthermore, Alberta possesses more than 50% of the 854,032 horses in the country [1] and holds the largest rodeo in the world.

Unfortunately, horseback riding is also a significant contributor to major injury. The hospital admission rate associated with equestrian activity is .49/1000 hours of riding [2]. The rate when motorcycle riding is merely .14/1000

hours [3]. As a result of this potential for injury, horseback riding has been identified as a higher-risk activity than automobile racing, motorcycle riding, football, and skiing, and at least as dangerous as rugby [2,4–6]. Equestrian riding also is considered to have the highest mortality of all sports, with an annual death rate of 1 per 1 million population [7,8]. This reality is not surprising because a horse weighs up to 500 kg, moves at a speed of 65 km/h, elevates the rider 3 meters above the ground, and kicks with a force of nearly 1 ton. A horse also is more unpredictable than either a motorcycle or a racecar.

Although numerous studies have outlined the frequency of neurologic trauma and the patterns of injury among horseback riders [2,9–19], we defined injuries among victims of major trauma with a mean injury severity score (ISS) greater than 12.

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As a result of these poorly described risk factors, and hence possible targets for injury prevention, the primary objective of this study was to identify common rider, animal, and environmental characteristics among those with major equestrian injuries. The secondary objective was to define the incidence and patterns of injury among these patients.

Material and Methods

All patients admitted to our institution between January 1, 1995, and July 1, 2005, as a direct result of an equestrian injury, were identified via our trauma registry. The Foothills Medical Centre is an adult tertiary care trauma referral center that is responsible for all major injuries in southern Alberta. This is also the area of the province where equine activities are most common. The trauma registry is a prospective database, updated daily with all aspects of a patient's status and treatment.

Inclusion criteria for the survey component incorporated any patient who was injured as a direct result of an equestrian activity, and who was discharged from the hospital alive. A 46-question telephone survey was used to identify rider, animal, and environmental characteristics common to the riders on a daily basis, as well as at the time of the accident. The survey itself was created by a group of clinicians that included trauma surgeons, recreational riders, professional horsemen, and an occupation therapist. Questions were derived from previously published literature, as well as from the authors' experience within the equestrian community.

Independent variables included patient and injury characteristics (sex, age, ISS, presenting systolic blood pressure and heart rate, injury, hospital and intensive care unit [ICU] length of stay in days, type of transport to the hospital, surgical procedures, and mortality), rider demographics (years of riding experience, animal ownership, saddle and tack handling, helmet use, protective gear use [chaps and vests], footwear, spurs, alcohol use, number of previous falls from a horse, previous horse-related injuries, purpose of riding, and style of riding [Western, English, bareback]), animal details (age, breed, amount of training [months], riding frequency, and cause of injury), and environmental factors (location [indoor vs outdoor], type of terrain, type of surface, time of year [season], time of day, and weather conditions). Questions outlining rider opinion regarding preventability, postinjury riding patterns, and changes in riding behaviors also were included.

Analysis was performed using Stata version 8.0 (Stata Corp, College Station, TX). The mean, median, and range were calculated using standard methodology. Data were reported as means when normally distributed, and medians when nonnormally distributed. Means were compared using the Student *t* test and medians were compared using the Mann-Whitney U test. Differences in proportions among categorical data were assessed using the Fisher exact test. A *P* value of less than .05 was considered to represent statistical significance for all comparisons.

Results

During the 10-year study period, 7941 injured adult patients were treated at the Foothills Medical Centre. A total

of 151 (2%) patients were admitted with equestrian injuries. Ten (7%) patients died. Of the 141 potential respondents, 78 (55%) completed the survey. No patient refused to complete the questionnaire. We were unable to engage the remaining patients because of outdated contact information.

The average respondent was male (60%) and 47 years of age (range, 20–78 y). These patient demographics are consistent with the remaining injured patients in the trauma registry over the same time period ($P > .05$). The study patients had a mean ISS of 20 (range, 12–75 d), a mean hospital length of stay of 13 days (range, 1–137 d), a 13% ICU admission rate, and a median ICU length of stay of 9 days (range, 1–137 d). Five (6%) patients also presented with hemodynamic instability (systolic blood pressure <90 mm Hg).

The most common injuries were located in the upper body (Table 1), with 54% and 48% of all patients experiencing chest and head injuries, respectively. The injury distribution was statistically equivalent to the surveyed group ($P > .05$). Overall, 68 of 151 (45%) patients injured by a horse underwent a surgical procedure. The percentage of patients undergoing various procedures included the following: 18% open extremity reductions and fixations, 9% laparotomies, 8% craniotomies, 6% spinal fixations, and 4% open facial repairs. These values are consistent with the surveyed cohort as well ($P > .05$).

The mechanism of injury included the following: 47 (60%) patients were thrown from or fell off a horse, 12 (16%) were crushed by a falling horse, 6 (8%) were kicked, 3 (4%) were stepped on, and 10 (13%) were injured by a variety of other mechanisms. The respondents believed the horse was "spooked" in 27 (35%) cases, not fully trained for the rider's input demands in 21 (27%) cases, had a bad temperament in 12 (15%) scenarios, or simply fell in 9 (12%) instances. Equipment failure occurred in 6% of all injuries. Rider inexperience was offered as a cause in only 5% of cases.

Rider characteristics outlined a very experienced study cohort (Table 2). Patients typically were recreational or working riders who owned horses, rode Western style, and had a mean of 27 years of experience when injured (Table 2). Only 6% of surveyed riders had been riding for less than 1 year at the time of their accident. Half of these (3%) were first time riders. Forty-seven percent of all riders had been injured previously before their index accident, and the minority reported the use of helmets or safety equipment, other than cowboy riding boots (Table 2). Most riders inspected

Table 1
Injury distribution

Injury	Number (%)
Chest	81 (54)
Head	72 (48)
Abdomen	33 (22)
Skull fractures	27 (18)
Extremity fractures	25 (17)
Spinal fractures	25 (17)
Pelvic fractures	23 (15)
Spinal cord	10 (6)
Neck	2 (1)

Table 2
Rider characteristics

Mean riding experience, y (range)	27 (0–70)
Number of previous riding-related injuries (%)	37 (47)
Mean number of previous falls	7
Riding purpose (%)	
Recreation	36 (46)
Work	30 (38)
Rodeo/sport	12 (15)
Western riding style (%)	57 (92)
Owned horse (%)	57 (73)
Ingested alcohol before riding (%)	5 (6)
Wore helmet (%)	7 (9)
Wore other protective gear (%)	24 (31)
Saddled own horse (%)	61 (78)
Inspected own tack (%)	51 (65)
Wore spurs (%)	15 (19)
Footwear (%)	
Cowboy boots	62 (79)
English boots	3 (4)
Other (shoes)	13 (17)

and applied their own saddle and tack (Table 2). All rider characteristics at the time of injury were consistent with their reported “typical” riding and preparation patterns. The exception was the 44 (56%) patients who admitted typically using protective gear in normal riding circumstances, however, only 24 (31%) reported use of protective riding gear during the accident itself ($P < .05$).

Animal characteristics displayed an experienced and well-trained horse cohort (Table 3). The horses were ridden often and had a median age of 7 years. Environmental factors identified the average injured rider as having ridden outdoors, in an open field, on dirt or uncultivated land, and on a summer afternoon with good weather (Table 4).

Two thirds (51) of all injured riders believed their accident, and therefore injury, was preventable. The majority (87%) were still riding at the time of the survey, although 43 (55%) had ongoing physical difficulties as a result of the trauma. Forty-seven percent also admitted changing their riding practices as a result of the injury.

Comments

Although the true frequency of equestrian injuries in Alberta is unclear, as many as 96% of patients are treated for minor injuries without hospitalization [20]. This relatively low admission rate (.49/1000 hours of riding) con-

Table 3
Horse characteristics

Median age, y (range)	7 (1–18)
Breed (%)	
Quarter horse	52 (67)
Arabian	13 (17)
Other	13 (17)
Mean training time, mo (range)	7.2 (0–60)
Riding frequency (%)	
Daily	28 (36)
Weekly	28 (36)
Rarely	22 (28)

Table 4
Environment characteristics

Environment	Number (%)
Outdoors	69 (88)
Surface	
Dry dirt	30 (38)
Uncultivated land	29 (37)
Rocky	10 (13)
Other	9 (12)
Location	
Open field	35 (45)
Enclosed pen	24 (31)
Trail/road	19 (24)
Season	
Summer	43 (55)
Spring	15 (19)
Fall	14 (18)
Winter	6 (8)
Time of day	
Afternoon	41 (53)
Evening	19 (24)
Morning	19 (24)
Sunny weather	68 (87)

firm the benign nature of many of these injuries. The incidence of severe (ISS ≥ 12) equestrian trauma in this study cohort, however, was 2% (151 of 7941) of all patients treated at our center. This is consistent with the less than 2% rate reported in other studies from level 1 trauma referral centers in predominantly Western riding communities [5,10,21]. The reality that 64% of all patients with equestrian injuries were transported by ground ambulance, as opposed to air, confirms the close proximity of many of the horseback riders to our center.

Although many studies adequately have identified head and extremity traumas as the most common injuries among riders, with a maximum mean ISS of 12 [3–19], it was our goal to define the pattern of injury in a more severely injured cohort (ISS ≥ 12). The severity of injury in our study population was confirmed not only by a mean ISS of 20 and a mortality rate of 7%, but also by the long hospital and ICU lengths of stay (13 and 9 days, respectively), as well as the high surgical rate (45%). In fact, 9% of our cohort underwent a laparotomy and 8% underwent a craniotomy. Unlike previous literature, chest trauma was the most frequent injury in our study group. Chest injuries were present in 54% of all patients, and included rib and clavicle fractures, as well as pneumothoraces and hemothoraces. We propose that chest trauma is a frequent event in patients presenting to a level 1 trauma center and is much more common than the 8% to 25% rate previously reported in less-injured patients [5–12]. As a result, chest injuries must be ruled out with appropriate clinical and radiologic examinations [22,23] in all severely injured patients. The rate of head injuries in the study cohort also was substantial at 48%. This approximates the published range of 12% to 44% [5–12] and is not surprising given the standard riding position and the reality that most falling riders are projected head forward and downward [6]. All deaths in the study were also a result of head injuries, supporting the notion that the prevention of equestrian death equates to preventing

head trauma. Furthermore, only 17% of all patients had extremity fractures. Although fractures are common in 29% to 67% of all injured patients with a lower ISS [5–12], they appear to be less common in the severely injured populace.

In addition to defining injury incidence and patterns among this novel patient population (ISS \geq 12), we also aimed to identify common rider, animal, and environmental factors involved in the accident itself. Although many equestrian injury studies outside of North America provide excellent data on English-style riding, the vast majority of riders in Alberta are Western. The typical injured rider in our surveyed population was male, 47 years of age, and had 27 years of riding experience. This is similar to the rest of Canada where the mean rider age is 44 years and 83% possess 10 or more years of riding experience. The study respondents also usually owned the horse, were facile with saddling and tack, and rode for either recreation or work purposes. This extremely well trained and educated cohort was very different from the young and inexperienced female cohorts many publications have reported [11,12,14–17,24–27]. The experience level of our riders also may have had a direct impact on their injury pattern, with fewer sustaining extremity fractures. Our study group also was familiar with being thrown from a horse and with equestrian trauma because almost half (47%) had been injured previously. Although most riders wore appropriate footwear (83%) and other protective gear (56%) such as chaps and protective vests, the minority (9%) reported helmet use. This lack of head protection has been outlined in numerous other studies [2–27] and is not surprising given the resistance of the Western riding culture to wear a helmet when compared with pony clubs, racetracks, and Olympic jumping events [28,29]. It is particularly unfortunate on consideration of the 48% of patients with head injuries in the study population, as well as the 40% absolute risk reduction in head injuries observed in the United Kingdom after the increase in helmet use and improved helmet design [16,30]. Interestingly, there was a 25% absolute reduction in the number of respondents who were wearing their protective gear on the day of the accident in our study. This indirectly supports the use of protective equipment such as chaps and vests, as does the significant rate of chest injury (54%). It also has prompted us to include both vest and helmet use in our injury prevention work.

Horses ridden by the injured patients in the study also were well trained. Most were quarter horses (67%), with a mean training volume of 7.2 months and a daily (36%), or weekly (36%), riding frequency. Their median age also was 7 years, minimizing their risk for injury [21]. This level of experience and training indicates that the most severely injured patients who presented to a level 1 trauma center were not amateurs in either a rider or animal sense. The accident environment was unremarkable. Most injuries occurred outdoors (88%), in wide open spaces (45%), and on relatively good footing surfaces (38% dry dirt and 37% uncultivated land). Weather also was not an issue because most injuries occurred on sunny (87%), summer (55%) afternoons (53%).

The cause and mechanism of injuries in these severely injured patients was most commonly a fall from the horse

(60%) as a result of either the animal being “spooked” (35%), or simply not being “trained well enough” for the demands the rider was placing on it (27%) (ie, asking the horse to perform a maneuver outside of its skill set). These findings were similar to observations made among injured patients from a rural Alberta community who were primarily discharged home (85%) from the emergency room [9]. Although Thompson and Von Hollen [9] attributed two thirds of patient injuries to the horse itself, half of all patients in our study believed the injuries were preventable and were the fault of the rider. As expected, with a mere 3% of all study riders being new to horseback riding, only 5% of accidents were judged to be secondary to inexperience.

Although injuries among the study patients were severe, 87% of respondents resumed riding after the accident. However, 55% still had ongoing physical difficulties as a direct result of the trauma. Furthermore, nearly half (47%) of patients altered their riding habits and/or demands on the animal as a result of the injury. Anecdotally, some people now use protective gear in all riding circumstances.

This study had several potential limitations. First, because patient behaviors were reported and not observed, some responses may be biased. Second, our study had a moderate response rate of 55%. Although this is comparable with other telephone surveys using similar time frames, the possibility of excluding a unique subgroup of patients exists. The similarity of our survey group to the equestrian injury cohort, as well as to the trauma registry as a whole, however, is reassuring. Finally, our institution is an adult-only trauma center that does not treat the 25% of injured Canadian riders younger than 16 years of age [1,2]. It is important that these results, specific to the severely injured Western-style, horseback-riding patient be confirmed in other trauma centers.

In summary, this study outlined the incidence and pattern of injury, as well as possible rider, animal, and environmental risk factors in patients with severe equestrian trauma (ISS \geq 12). The incidence is significant at 2% of all injured patients. Furthermore, chest trauma has been underappreciated by studies outlining less-severe injuries. This unique pattern of injury, as well as the severity of trauma, may be a result of a more experienced rider population. Prevention strategies will now target not only helmet use among Western-style riders, but also the use of vests. We also will focus our attention on the seasoned riders and their well-trained horses found in southern Alberta, as opposed to the young, inexperienced, female riders previously identified in other communities.

References

- [1] 1998 National horse industry study. Agriculture and Agri-food Canada. Available from: <http://www.equinecanada.ca/EC/ECHICIR1998Study2.shtml>.
- [2] Sorli JM. Equestrian injuries: a five year review of hospital admissions in British Columbia, Canada. *Inj Prev* 2005;6:59–61.
- [3] Bixby-Hammett DM, Brooks WH. Neurologic Injuries in Equestrian Sports. *Sports Neurology*. Aspen: Aspen Publications; 1989:229–34.
- [4] Macnab AJ, Cadman R. Demographics of alpine skiing and snowboarding injury: lessons for prevention programs. *Inj Prev* 1996;2:286–9.
- [5] Norwood S, McAuley C, Vallina VL, et al. Mechanisms and patterns of injuries related to large animals. *J Trauma* 2000;48:740–4.

- [6] Buckley SM, Chalmers DJ, Langley JD. Injuries due to falls from horses. *Aust J Public Health* 1993;17:269–71.
- [7] Pounder DJ. The grave yawns for the horseman. Equestrian deaths in South Australia 1973–1983. *Med J Aust* 1984;141:632–5.
- [8] Paix BR. Rider injury rates and emergency medical services at equestrian events. *Br J Sports Med* 1999;33:46–8.
- [9] Thompson JM, Von Hollen B. Causes of horse related injuries in a rural western community. *Can Fam Physician* 1996;42:1103–9.
- [10] Griffen M, Boulanger BR, Kearney PA, et al. Injury during contact with horses: recent experience with 75 patients at a level 1 trauma center. *South Med J* 2002;95:441–5.
- [11] Northey G. Equestrian injuries in New Zealand, 1993–2001: knowledge and experience. *N Z Med J* 2003;116:601–9.
- [12] Lim J, Puttaswamy V, Gizzi M, et al. Pattern of equestrian injuries presenting to a Sydney teaching hospital. *Aust N Z J Surg* 2003;73:567–71.
- [13] Criddle LM. Livestock trauma in central Texas: cowboys, ranchers and dudes. *J Emerg Nurs* 2001;27:132–40.
- [14] Newton AM, Nielsen AM. A review of horse-related injuries in a rural Colorado hospital: implications for outreach education. *J Emerg Nurs* 2005;31:442–6.
- [15] Johns E, Farrant G, Civil I. Animal-related injury in an urban New Zealand population. *Injury* 2004;35:1234–8.
- [16] Abu-Zidian FM, Rao S. Factors affecting the severity of horse-related injuries. *Injury* 2003;34:897–900.
- [17] Moss PS, Wan A, Whitlock MR. A changing pattern of injuries to horse riders. *Emerg Med J* 2002;19:412–4.
- [18] Ketai LH, Temes RT, Deis JL, et al. Rodeo related large animal injury: is protective head-gear warranted? *Injury* 2000;31:757–9.
- [19] Ok E, Kucuk C, Deneme A, et al. Large animal-related abdominal injuries. *J Trauma* 2004;57:877–80.
- [20] Bixby-Hammett D, Brooks WH. Common injuries in horseback riding: a review. *Sports Med* 1990;9:36–47.
- [21] Ingemarson H, Grevsten S. Lethal horse-riding injuries. *J Trauma* 1989;29:25–30.
- [22] Ball CG, Kirkpatrick AW, Laupland KB, et al. Incidence, risk factors and outcomes for occult pneumothoraces in victims of major trauma. *J Trauma* 2005;59:917–24.
- [23] Ball CG, Kirkpatrick AW, Laupland KB, et al. Factors related to the failure of radiographic recognition of occult posttraumatic pneumothoraces. *Am J Surg* 2005;189:541–6.
- [24] Hobbs GD, Yealy DM, Rivas J. Equestrian injuries: a five year review. *J Emerg Med* 1994;12:143–5.
- [25] Lloyd RG. Riding and other equestrian injuries: considerable severity. *Br J Sports Med* 1987;21:22–4.
- [26] Grossman GA, Kulund DN, Miller CW, et al. Equestrian injuries: results of a prospective study. *JAMA* 1978;240:279–82.
- [27] Bixby-Hammett DM. Paediatric equestrian injuries. *Paediatrics* 1992;89:1173–6.
- [28] Press J, Davis P, Wiesner S, et al. The national jockey injury study: an analysis of injuries to professional horse-racing jockeys. *Clin J Sport Med* 1995;5:236–40.
- [29] Temes R, White J, Ketai L, et al. Head, face, and neck trauma from large animal injury in New Mexico. *J Trauma* 1997;43:492–5.
- [30] Chitnavis JP, Gibbons C, Hirigoyen M, et al. Accidents with horses: what has changed in 20 years? *Injury* 1996;27:103–5.