

**TRIAGE OF TRAUMA PATIENTS INJURED BY LARGE ANIMALS:
DO URBAN DOCTORS UNDERTRIAGE?**

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ABSTRACT

In the United States the responsibility to develop criteria for trauma patient's triage status rests upon individual hospitals rather than the American College of Surgeons. Traumatic injuries from large animals represent a potential need for expanded hospital resources. Urban emergency departments are less likely to regularly see patients with large-animal related injuries and might be expected to underestimate the predicted injuries. There is scarce research on the topic of initial triage designation for large-animal related injuries. The aim of this study is to investigate the adequacy of the initial triage designation given to patients presenting with injuries from animals larger than themselves at an urban, safety net, academic Emergency Department and Trauma Center (ACS Level 1 Adult, Level 2 Pediatric). A retrospective chart review was performed on patients presenting to the emergency department (ED) from Jan 2006 until September 2015 with injuries resulting from animals larger than the patient. A total of 213 patients met the inclusion criteria. Our study found that trauma patients injured by large animals who are triaged as low priority have dispositions that are not statistically different from those with higher initial prioritization.

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INTRODUCTION

Interacting with large animals carries an inherent risk for potentially serious traumatic injuries. Injuries that result from animals larger than the patient are less common in the urban setting likely given the low prevalence of farm and ranch related activities. Nevertheless, an estimated 30 million Americans take part in horseback riding activities each year which represents a common source for injuries related to large animals that is not solely limited to ranch and farm related activities.¹

Although less common in urban emergency departments, large animal injuries are not insignificant in any setting. Retrospective reviews of equine injuries have shown admission rates as high as 60-95% of those patients who were evaluated by the trauma surgery service.^{2,3} Moreover, these types of admissions have a significant impact on the healthcare system with an estimated annual healthcare cost of 60 million dollars for patients admitted for large animal injuries not including their significant outpatient and rehabilitation costs.⁴

There is a paucity of research in regards to the initial trauma triage designation given to patients presenting to an emergency department after having sustained an injury from a large animal. Prior studies in the area of large animal injuries have primarily been focused on equine related injuries, specifically the characteristics and patterns of injuries rather than the triage protocols. There is clinical value in the appropriate level of initial trauma response for these patients based on their potential need for expanded hospital resources.

Trauma triage levels and their designated responses are inconsistent amongst hospitals in the United States. The American College of Surgeons (ACS) does not have predetermined trauma triage criteria. The responsibility therefore lands on the individual hospitals to establish appropriate criteria for their trauma patients' triage status. We hypothesize that the severity of injuries is underestimated in patients who are injured by animals larger than themselves. The aim of this study is to retrospectively investigate the adequacy of the initial triage designation given to these patients who presented to at an urban, safety net, academic Emergency Department and Trauma Center (ACS Level 1 Adult, Level 2 Pediatric).

METHODS

This retrospective study extracted its patient population from the hospital's trauma registry. Patient population was initially selected from the trauma registry based upon the International Classification of Disease (ICD) code that indicated involvement of an animal in a traumatic injury. The diagnosis codes were in the following range: ICD-9-CM800–959.9 or ICD-10-CM S00-S99, T07, T14, T20-T28, T30-T32 and T79.A1-T79.A9. This cohort was then further evaluated to verify having been traumatically injured by an animal larger than the patient via confirmation with documentation in Epic, MIHS's electronic medical record software. Both adult and pediatric patients from January 2006 until September 2015 who were injured by a large animal were included in the study population. Exclusion criteria included patients that left against medical advice prior to completing ED assessment as well as patients injured by animals smaller than the patient (including venomous animals). Four patients were excluded due to inability to correlate the trauma registry patient to an electronic health record chart; one patient was excluded as the ICD code was inappropriately assigned to their record; finally, a pediatric patient was excluded as the relative size of the animal could not be determined (dog).

Variables were gathered and recorded in Microsoft excel spreadsheet format. All variables were prospectively determined and included (1) demographics: age, gender; (2) triage/injury information: initial activation level, final activation level, time of injury, time of arrival, method of arrival; (3) utilization of resources: ED advanced imaging obtained, admissions, LOS in ED, overall length of stay (LOS) in hospital; (4) injury characteristics: nature of injury, anticoagulation status; (5) outcome: disposition, in-hospital deaths. These variables were collected in an attempt to control for confounding variables such as age, gender and anticoagulation status. Additionally, these data were used to assess the extent of resource utilization and as endpoints for patient outcomes.

For comparative analysis patients were separated into different subsets including: low initial triage priority designation (lowest level activation or non-leveled trauma) versus higher initial triage priority designation. The emergency department where this study took place triages the trauma patients as green, yellow, or red (increasing severity respectively) based upon the suspected severity of injuries being reported. Yellow and red traumas are initially

managed jointly by emergency medicine and trauma surgery physicians. Green traumas are managed by emergency medicine physicians without trauma surgery as they are presumed to have a lower likelihood of not requiring emergent management based on the nature of their reported injuries.

Admission status was assessed using proportions and 95% CI for patients who were categorized as low priority versus those who were categorized as high priority. Chi-squared analysis was used to ascertain the relationships between specified admission statuses between the two groups. Odds ratios and 95% confidence intervals were reported using logistic regression to ascertain the associations between the different admission statuses and priority status. Furthermore, the estimated mean differences and 95% confidence intervals of ED length of stay and overall length of stay were ascertained via linear regression. All P-Values were 2-sided and $p < 0.05$ were considered statistically significant. All data analysis was conducted using STATA version 14 (College Station, TX).

RESULTS

In total, 213 patients were included in the study after screening 219 patients for inclusion and exclusion criteria. In total 119 patients were initially a low triage priority; 94 were of a higher triage priority; one patient succumbed to their injuries and one patient was transferred to another facility. There was no observed statistically significant difference between high and low initial triage priority patients in regards to any of the patients' potential dispositions from the ED. The overall dispositions of the patients in respect to their initial triage status are outlined in Table 1 (excluding the one patient transferred).

The large majority of patients (81.7%) had surgical services involved in their care either in the initial trauma assessment or the consultation or admission. 29/213 patients (13.6%, 95% CI [9.6, 18.9]) required operative care at some point during their admission. Of all the patients that underwent operative management 14/29 (48.3%) of them were initially in the lower triage priority subset of patients. The increased likelihood of the higher priority patients to require a higher level of care on disposition than the lower priority group was not found to be statistically significant in our analysis (Table 2).

Patients with initially high triage priority were found to spend a statistically significant 67% shorter LOS in the ED when compared to the initially low triage priority patients. For both high and low priority groups the mean overall ED LOS stay was 281.9 minutes (SD of 241.3) and average absolute difference showed the high triage priority patients on average spent 132 fewer minutes in the ED ($p < 0.001$). The overall hospital length of stay was not statistically significant between the two groups (Tables 3,4). For all patients in this study the mean LOS in the emergency department was 281.9 minutes and the mean hospital LOS was 2.63 days.

Table 1: Disposition of Patients (Percentages and 95 % CI of admission status)

Variables	Overall N=213	Low Priority N=119	High Priority N=94	P-Value ¹
	% (95 % CI)	% (95 % CI)	% (95 % CI)	
Admission Status				
Admitted	74.6 (68.3, 80.0)	70.56 (61.6, 78.2)	79.8 (70.3, 86.8)	0.12
ICU Admitted	33.3 (27.3, 39.9)	29.4 (21.8, 38.3)	38.2 (28.8, 48.6)	0.17
Non-ICU Admitted	27.6 (22.0, 34.1)	29.4 (21.8, 38.3)	25.5 (17.6, 35.5)	0.53
Operating Room	13.6 (9.6, 18.9)	11.7 (7.0, 19.0)	15.9 (9.7, 24.9)	0.37
Discharged Home	24.9 (19.4, 31.1)	28.5 (21.1, 37.5)	20.2 (13.1, 29.7)	0.16

¹P-Values calculated using Chi-squared analysis.

Table 2: Odds Ratios assessing the association between initial activation levels and admission outcome.

Outcomes	High vs Low Priority Odds Ratio (95 % CI)	P-Value ¹
Admitted	1.66 (0.87, 3.18)	0.12
ICU Admission	1.41 (0.78, 2.52)	0.24
Non-ICU Admission	0.87 (0.47, 1.61)	0.66
Operating Room	1.45 (0.65, 3.19)	0.35
Discharged Home	0.62 (0.32, 1.19)	0.15

¹P-value calculated using Logistic Regression adjusted by age and gender

Table 3: Beta-Coefficients to assess the estimated percent difference in specified outcomes between low and high initial activation levels

Outcomes*	High vs Low Priority Beta-Coefficient (95 % CI)	P-Value ¹
ED Length of Stay	-0.67 (-0.88, -0.46)	<0.001
Overall Length of Stay	0.36 (-0.01, 0.74)	0.057
CT Counts	0.25 (0.09, 0.41)	0.002
MRI Counts	-0.036 (0.27, 0.19)	0.29

¹P-value calculated using Linear Regression adjusted by age and gender

*Denotes a Log Transformation of the outcomes to approximate a normal distribution

Table 4: Absolutes for ED and overall LOS

Outcomes*	High vs Low Priority Beta-Coefficient (95 % CI)	P-Value ¹
ED Length of Stay (min)	-132.9 (-196.2, -69.8)	<0.001
Overall Length of Stay (days)	0.98 (0.17, 1.80)	0.017

¹P-value calculated using Linear Regression adjusted by age and gender

DISCUSSION

This study took place in an urban, safety net, academic Emergency Department and Trauma Center (ACS Level 1 Adult, Level 2 Pediatric). Although less common in the urban setting, large animal injuries do present to our emergency department from various locations in the surrounding suburban and rural areas. Our admission rate (74.6%) and ICU admission rate (33.3%) are slightly higher than prior retrospective studies admission rates.^{2,3} Additional literature to assess the adequacy of the initial triage of these patients is lacking for comparison to our outcomes.

Our data revealed that the the initial triage status (high vs. low) was a poor predictor of the disposition needs of the patient as evidenced by only small variations between these two groups in the percentages of patients who were: discharged home from the ED; required operative management; or admitted to the ICU. These represent dispositions that should be seen more often in those patients who were higher initial triage status if accurately assigning initial triage statuses to these patients. However, the triaging provider was not capturing enough of those patients who will need these additional resources. This is consistent with our hypothesis that the severity of these patients' injuries are being underestimated.

The overall hospital length of stay and ED length of stay illustrate both the importance of adequate triage as well as the amount of hospital resources these patients can require. The initially higher triage priority patient had a shorter LOS in the ED but an increased LOS in the hospital. This may be attributed to an adequate and efficient mobilization of resources for those patients early on resulting in expediting their management and disposition out of the ED. As a whole these patients injured by large animals necessitated a great deal of hospital resources in terms of mean hospital LOS as well as high total numbers of advanced imaging that were deemed necessary to assess the patients.

The mechanism of injury and the age of the patient are both variables that have been described as important factors in avoiding the underestimation of the severity of the injury in equine and other large animal studies.^{2,5} Our data set analysis controlled for age, gender and anticoagulation status for this reason and found no correlation between mechanism of injury and likelihood of initially being a higher or lower triage status. The inconsistent or somewhat

subjective nature of triaging patients as well as determining their disposition both represent a potential threat to the generalizability of our results.

An appropriate triage designation for patients who are injured by large animals may be something that is overlooked in urban emergency departments such as the one in this study. Equine related injuries specifically can be rare even in hospitals that service regions that have equine populations.⁶ A lack of familiarity with these patients from infrequent encounter represents a potential explanation for the discordance in initial triage status and the final disposition of these patients as a whole.

FUTURE DIRECTIONS

Significant data exists to support that patients injured by large animals represent a modest impact in the emergency healthcare system. Due to the overall paucity of research on the topic of adequacy of triage with regards to this future research should be structured to further evaluate the accuracy and efficacy of the triage physician or other healthcare provider in recognizing the severity of injuries resulting from large animals related injuries.

CONCLUSIONS

Patients injured by large animals can require a substantial amount of hospital resources and may be undertriaged in the setting of an urban inner-city emergency department. Despite their somewhat infrequent presentation in the urban setting; these patients stand to benefit from healthcare providers more accurately recognizing their initial triage status. The clinical value of accurately triaging these patients lies in the ability to expedite an appropriate response for their management; a responsibility that largely belongs to an individual hospital.

REFERENCES

1. Carrillo, EH, Varnagy, D, Bragg, SM, Levy, J, Riordan, K. Traumatic Injuries associated with Horseback Riding. *The Scandinavian Journal of Surgery*. 2007;96:79-82.
2. Craven, JA. Paediatric and adolescent horse-related injuries: Does the mechanism of injury justify a trauma response? *Emergency Medicine Australasia*. 2008;20:357–362.
3. Clarke, CN, Tsuei, BJ, Butler, KL. Equine-related injury: a retrospective analysis of outcomes over a 10-year period. *The American Journal of Surgery*. 2008;195:702–704.
4. Shahan, CP, Emmett, K, Zarzaur, BL. Large animal-related injury requiring hospital admission: Injury pattern disparities. *Injury*. 2012;43:1898–1902.
5. Ghosh, A, Di Scala, C, Drew, C. Horse-Related Injuries in Pediatric Patients. *Journal of Pediatric Surgery*. 2000;35:1766-1770
6. Griffin, M, Boulanger, B, Kearney, P. Injury During Contact with Horses: Recent Experience with 75 Patients at a Level I Trauma Center. *Southern Medical Journal*. 2002;95:441-444