Review of gunshot injuries in cats and dogs and utility of a triage scoring system to predict short-term outcome: 37 cases (2003–2008)

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Objective—To describe the signalment, wound characteristics, and treatment of gunshot injuries in cats and dogs in urban and rural environments, and to evaluate the utility of the animal trauma triage (ATT) score as an early predictor of survival to discharge from the hospital.

Design—Retrospective case series.

Animals—29 dogs and 8 cats.

Procedures—Medical records of cats and dogs evaluated for gunshot wounds from 2003 and 2008 at a private urban referral practice in Cedar Rapids, Iowa, and an urban veterinary teaching hospital in Ames, Iowa, were reviewed. Information collected included signalment, chief reason for evaluation, circumstance of the injury, general physical examination findings, wound characteristics, treatments provided, cost of care, survival to discharge from the hospital (yes vs no), and duration of hospital stay. For each animal, ATT scores were calculated and evaluated as a prognostic tool.

Results—37 animals met study inclusion criteria. Animals with higher ATT scores had a greater likelihood of poor outcome following gunshot injury. Animals with higher ATT scores, classified as low (< 4.5) or high (> 4.5), were found to have a longer duration of stay, classified as zero (0 days), short (1 to 3 days), or long (> 3 days). Young male dogs generally considered working breeds were overrepresented (29/37 [78.4%]). A preference for low-velocity, low-kinetic-energy firearms was identified (19/37 [52%]). The most numerous wounds were those inflicted to the limbs (12/37 [32.4%]), during low-visibility hours or hunting excursions. Calculated ATT scores on admission were higher in animals requiring blood products or surgical procedures and in nonsurvivors.

Conclusions and Clinical Relevance—Results of the present study suggested that regional preferences in breed ownership and firearm choice are responsible for variation in gunshot injury characteristics and management in animals sustaining injuries in rural and urban settings in Iowa. In cats and dogs, calculation of an ATT score may provide a useful predictor of the need for surgery or blood products, duration of stay, and likelihood of survival to discharge from the hospital. (*J Am Vet Med Assoc* 2014;245:923–929)

Gunshot injuries represent a small subset of traumatic injuries in veterinary patients, compared with other causes of trauma, and are potentially devastating.[1] Previous surveys of urban patient populations have demonstrated that most trauma is induced by motor vehicles and altercations with other animals, with the number of patients with trauma induced by firearms varying between studies, comprising up to 2.1% of trauma cases.[1–5] Descriptions of the patient demographics and characteristics of gunshot injuries were similar among previous studies.[1–5] Characteristics of the wound can provide a reasonable estimate of the firearm type, even if the injury went unwitnessed.[5–9] A large percentage of gunshot wounds are inflicted by handguns in urban environments, whereas rifles and shotguns are more common in rural populations, contributing to regional variability in wound characteristics and severity.[5–7] Recommendations for care vary on the basis of injury location and firearm type, with indication for surgery versus medical management well established and accepted on the basis of previously published surveys of outcome in gunshot injuries.[5,7,8,10,11] Hemothorax and pneumothorax are frequent sequelae to penetrating thoracic injuries that, when unsuccessfully managed with medical treatment, can warrant surgical intervention. Recommendations for managing penetrating abdominal wounds include surgical exploration because of the high risk of peritonitis secondary to disruption of hollow organs.[1,5,7,9–13] Limb wounds are rarely life threatening,

Abbreviation

ATT	Animal trauma triage

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with course of treatment dependent on the severity of soft tissue injury, need for stabilization of orthopedic trauma, and extent of contamination.[1,5,7,9–13]

To provide early prediction of survival to discharge from the hospital based on numeric characterization of disease severity as well as to establish guidelines for care, trauma scores such as the Acute Physiology and Chronic Health Evaluation II scoring system have long been used in human trauma centers.[3,14] Several trauma scores have been recently modified for use in veterinary medicine to provide uniform initial triage of trauma injuries. Previously developed scoring systems have included the small animal coma scale for head trauma[15] and the Kirby and Brasmer[16] categorization of trauma (mild, moderate, severe [non–life threatening], and catastrophic-severe [life threatening]). The small animal coma scale for head trauma described by Shores[15] has shown promise in predicting outcome based on the score assigned, although exclusively for head trauma, whereas other trauma scores have had limited predictive utility.[1,3,14] The ATT score developed by Rockar et al[3] in 1994 **(Appendix)** assigns a cumulative score based on evaluation of 6 body system categories (perfusion, cardiac, respiratory, eye-muscle-integument, neurologic, and skeletal), each graded on a scale of 0 (least severe) to 3 (most severe).[3,14] Previous evidence has suggested that this score is an accurate predictor of 7-day survival rate, with an increased score correlating with a worse outcome and each 1-point increase in ATT score corresponding with a 2.3 times decreased likelihood of survival to 7 days in a prospective cohort.[3,14] Sources of trauma in the study by Rockar et al[3] included motor vehicle trauma, altercations with other animals, and blunt force trauma of unknown etiology.[3,14] To our knowledge, this scoring system has not previously been used in predicting outcome for gunshot injuries in veterinary patients.

The goals of the study reported here were to review the signalment of cats and dogs with gunshot injuries, define the characteristics of gunshot wounds, compare management of gunshot injuries in rural settings with that previously described for studies performed in urban environments, and evaluate the utility of the ATT scoring system as an early predictor of outcome in animals with gunshot injuries.

Materials and Methods

All cats and dogs treated for gunshot injuries over a 5-year period between 2003 and 2008 at a private urban referral practice in Cedar Rapids, Iowa, and an urban veterinary teaching hospital in Ames, Iowa, were eligible for inclusion. Medical records were reviewed, and a standardized data sheet was used to record the following information for each animal: signalment, chief reason for evaluation, environment in which the injury took place (urban [defined by the US Census Bureau as a population > 50,000 residents] versus rural [populations < 50,000 residents)], historical data regarding the context in which the injury occurred (hunting, defense, etc.), vital parameters at initial examination, physical examination findings, injury location, specifics of the firearm and gunshot injury (if available), treatments provided, cost of care, survival to discharge from the hospital (yes vs no), and duration of hospital stay. On the basis of the guidelines provided by Rockar et al,[3,14] an ATT score was assigned for each patient. Animals were listed as survivors (survived to discharge from the hospital) or nonsurvivors (euthanized or died in the hospital). No distinction was made between animals that were euthanized because of financial reasons and those euthanized because of severity of illness.

Descriptive statistics were calculated; continuous data were reported as median and range, and categorical data were reported as frequencies. A simple logistic regression model comparing the marginal relationship between survival outcome and ATT score was fitted to the data. Asymptotic Wald and exact test *P* values were both calculated to assess the strength of this relationship. Leave-one-out cross-validation was used to investigate utility of the model (ie, ATT score) in predicting outcome. The cross-validation–predicted probability for each observation was used to classify observations as either survival or nonsurvival (dichotomizing threshold, 0.5), and the cross-validation classification was compared with the observed outcome to establish a misclassification rate. A receiver operating characteristic curve and associated area under the curve were also used to investigate the sensitivity and specificity of the classification tool. Simple logistic regression modeling was also used to investigate the relationship between outcome and duration of stay and between outcome and cost of care.

To assess bivariate relationships with type of firearm, the original firearm style categories were collapsed into 3 categories: bullet, pellet, unknown, or other (ie, air gun). A nonparametric Kruskal-Wallis 1-way ANOVA model was used to test for a difference in the stochastic ordering of ATT scores, cost of care, and duration of stay among the firearm types, with each response modeled separately. A Kruskal-Wallis test was again used to test for a difference in ATT scores based on the need for transfusion or surgical intervention. A Freeman-Halton test was used to evaluate the relationship between type of firearm and outcome and between location of injury and outcome. Because the ATT score and duration of stay were not bivariate normal, both continuous variables were transformed into ordinal variables (low and high for ATT score and zero, low, and high for duration of stay) prior to assessment with a Freeman-Halton test. The same procedure was used to compare ATT score and cost of care (low, medium, and high). Univariate histograms were used to evaluate signalment, wound characteristics, and trends in management of gunshot wounds among the study population.

Results

Over a 5-year period between 2003 and 2008, 37 animals were included in this study: 18 patients with injuries consistent with gunshot wounds were examined at a private referral center in Cedar Rapids, Iowa, and 19 patients at a veterinary teaching hospital in Ames, Iowa. Animals with projectiles found incidentally on radiographs during evaluation for other illness were not included in the study. Approximately 3.6 gunshot cases per year were reported, representing an overall incidence of 0.8% of all animals evaluated at the referral center during the study period. Of the 37 animals, 29 (78.4%) were dogs and 8 (21.6%) were cats. Of the 29 dogs, there were 5 (17%) Labrador Retrievers, 3 (10%) German Shorthaired Pointers, 2 (7%) German Shepherd Dogs, 2 (7%) Viszlas, 2 (7%) Boxers, 8 (28%) mixed-breed dogs, and 1 each of various other breeds, including Maltese, Keeshond, Beagle, Weimeraner, pit bull–type dog, Pug, and Siberian Husky. Of the 8 cats, there were 5 domestic shorthairs, 2 domestic longhairs, and 1 of unspecified breed. Breeds generally considered working and hunting breeds (Labrador Retrievers, German Shorthaired Pointers, German Shepherd Dogs, Viszlas, and Weimeraners) were found more commonly in rural areas (defined by the US Census Bureau as a population < 50,000 residents), with the other breeds represented more frequently in urban areas (population > 50,000 residents). Of the 37 animals, 22 (59.5%) sustained injuries in urban and 15 (40.5%) in rural settings.

The median age of all animals was 41 months (range, 4 to 144 months), with young animals (< 4 years old) overrepresented (23/37 [62.2%]). Of the 37 animals, 29 were males (11 [37.9%] sexually intact and 18 [62.1%] castrated) and 8 were females (4 sexually intact and 4 spayed).

The majority of gunshot injuries (23/37 [62.2%]) were unwitnessed. Five of 37 (14%) injuries were inflicted exclusively to the head or neck, 8 (22%) to the forelimbs, 8 (22%) to the thorax, 5 (14%) to the abdomen, and 4 (11%) to the pelvic limbs. Seven of 37 (19%) injuries involved > 1 location, with the most frequently affected area used to subsequently categorize these patients. Animal gunshot wounds had equal distribution throughout the year. Of the 37 gunshot injuries, 9 occurred during winter (December, January, and February), 9 during Spring (March, April, and May), 7 during Summer (June, July, and August), and 10 during Autumn (September, October, and November); for 2 animals, date of injury was unknown. The majority of injuries (23/37) occurred during unknown times of day. Of the remaining 14 injuries, 10 occurred between 6 PM and 6 AM. Based on assessment of the projectile remnants and wounds, ballistics evaluation was performed by the attending veterinarian at the time of initial evaluation; if not previously performed or not noted in the medical reports, ballistics evaluation was performed by one of the authors (LEO) retrospectively on the basis of previously published guidelines.[5,7,8,9,11,14] Of the 37 gunshot injuries, 13 (35%) were inflicted by handguns or similar bullet-style firearms, 18 (49%) were inflicted by shotguns or pellet-style firearms, 1 (3%) was inflicted by other types of firearms not containing projectiles (air gun), and 5 (14%) were inflicted by an unknown firearm type; cases of an unknown firearm type were typically due to through-and-through injury without presence of a retained projectile for assessment of firearm type (**Table 1**). Further classifying the injuries on the basis of environment, of the 19 wounds in an urban setting with a known firearm type, 10 were inflicted by handguns or other bullet-style firearms, 8 by shotguns or other pellet-style firearms, and the remaining 1 by a high-powered nonprojectile (air) weapon. Of those 13 injuries inflicted in rural settings with known firearm type, 3 were inflicted by bullet-style firearms and 10 by pellet-style firearms. No significant association was found between the type of firearm and an animal's duration of stay, cost of care, ATT score, or outcome (**Table 2**).

Of the 37 animals included in this study, 32 (86.5%) survived to discharge; the remaining 5 (13.5%) patients died. Of those animals that died, 3 had injuries known to have been inflicted by handguns, 1 had injuries inflicted by a shotgun at close range, and 1 had injuries by an unknown firearm type (wounds suggestive of handgun trauma). No significant association was found between location of injury (head or neck, limbs, abdomen, thorax, and multiple locations) and survival to discharge from the hospital (Table 2).

The median duration of stay for the 37 animals was 0 days (range, 0 to 16 days), as a large proportion of patients (18/37 [49%]) were treated as outpatients. Of those with known cost of treatment, median was $1,550 (range, $125 to $5,250). Diagnostic testing determined necessary in managing gunshot wounds was at the discretion of the attending clinician and included hematologic evaluation (16/37 animals), serum biochemical analysis (15/37), electrolyte analysis (11/37), blood gas analysis (4/37), radiography (25/37), ultrasonography (5/37), microbial culture and antimicrobial susceptibility testing (3/37), and coagulation assays including prothrombin time, activated partial thromboplastin time, and activated clotting time (3/37). Of the 37 animals evaluated at the hospital, 5 required transfusion. All patients requiring transfusion were administered packed RBCs, with 1 animal concurrently receiving a plasma transfusion. Significantly higher ATT scores were noted in the 5 animals requiring transfusion (**Table 3**), with a median score for these animals being 11 (range, 4 to 15), whereas the median ATT score for those not requiring transfusion was 5 (range, 0 to 11). Surgical management, including both orthopedic and soft tissue surgical procedures, was performed in 11 of 37 (29.7%) animals. Of those patients requiring surgery, injuries comprised abdominal wounds (n =3), extrem-

Table 1—Duration of stay, cost of care, and ATT score for 37 animals with firearm wounds from a pellet, bullet, or unknown source.

Variable	Type of projectile			*P* value
	Pellet (n = 18)	Bullet (n = 13)	Unknown (n = 6)*	
Duration of stay (d)	0 (0–6)	3 (0–5)	2 (0–16)	0.621
Cost of care ($)	750 (250–4,750)	750 (250–5,250)	2,500 (250–4,750)	0.422
ATT score	3 (0–15)	5 (0–11)	5 (1–13)	0.498

*Airgun (n = 1) is included in the unknown category as a non-projectile type of weapon. Values are median (range).

ity wounds (6), 1 head and neck wound, and 1 case with multiple wounds. All 3 animals with abdominal wounds undergoing surgery had disruption of hollow organs identified. Stochastic ordering of ATT scores was significantly different between animals undergoing surgery, compared with those not undergoing surgery, with the surgery group distribution being stochastically smaller than the nonsurgery group (Table 3). The median ATT score of animals undergoing surgery was 6 (range, 3 to 13), and the median of those not undergoing surgery was 4 (range, 0 to 15).

The median ATT score for all animals was 5 (range, 0 to 15), of a maximum (most severe) score of 18. Median ATT score for survivors was 5 (range, 0 to 11), which was considerably lower than the median ATT score of 11 (range, 3 to 15) among nonsurvivors. By characterizing outcome as survival to discharge from the hospital versus nonsurvival, not considering the cause of nonsurvival, a significant (Wald test $P = 0.007$; exact test $P = 0.001$; **Table 4**) relationship was found between ATT score and survival to discharge from the hospital. For every 1-point increase in the ATT score, the odds of the animal dying increased by a factor of 1.60 (95% confidence interval, 1.14 to 2.25). Used as a classifier, the logistic regression model correctly classified 32 of the 37 cases in the cross-validation analysis (misclassification rate, 13.5%) and provided an area under the curve of 0.775. However, no significant relationship was found between the type of firearm and the ATT score or between the type of firearm and patient survival rate. No significant correlation could be found between the survival rate and location of injury, between the survival rate and duration of stay, or between the survival rate and cost of care.

One animal in the present study sustained soft tissue injuries of moderate severity to the forelimb (ATT score, 5) and was discharged from the hospital after an extended duration of stay of 16 days, with a cost of care of $2,639. This patient required extended hospitalization for owner convenience, rather than because of disease characteristics, and required daily sedation and bandage changes. This animal represents an outlier in the relationship between ATT score and duration of stay, which makes inference based on the simple linear regression model inappropriate. By classifying ATT score as low (< 4.5) or high (> 4.5) and duration of stay as zero (discharged the day of evaluation), low (1 to 3 days), or high (> 3 days), the relationship could be appropriately tested. Six of 19 animals with duration of stay of zero days had ATT scores > 4.5 (**Table 5**). On the basis of a Freeman-Halton test and rejection of the null hypothesis (interpreted to mean the distribution of duration of stay was not the same across all ATT score classes), a significant positive relationship was found, such that longer duration of stay coincided with higher ATT scores.

Table 2—Categorical variables for 37 animals with trauma that did and did not survive to discharge from the hospital.

Variable	Survivors (n = 32)	Nonsurvivors (n = 5)	*P* value
Location of injury			0.087
Trunk	9 (28.1)	4 (80.0)	
Limbs	12 (37.5)	0 (0.0)	
Head or neck	4 (12.5)	1 (20.0)	
Multiple	7 (21.9)	0 (0.0)	
Type of projectile			0.288
Pellet	14 (43.8)	2 (40.0)	
Bullet	14 (43.8)	1 (20.0)	
Unknown	4 (12.5)	2 (40.0)	

Data are number (%) of animals.

Table 3—Animal trauma triage score for 37 animals categorized by the requirement for transfusion, surgery, or both.

Variable		No. of animals	Median ATT (range)	*P* value
Transfusion	No	32	5 (0–11)	0.006
	Yes	5	11 (4–15)	
Surgery	No	26	4 (0–15)	0.039
	Yes	11	6 (3–13)	

Table 4—Results of simple logistic regression analysis of variables associated with failure to survive to discharge from the hospital.

Variable	OR	95% confidence interval
ATT score	1.60*	1.14–2.25
Duration of stay (d)	0.85	0.54–1.35
Cost of care ($)	1.17	0.89–1.53

*Odds ratio is significant (ie, 95% confidence interval does not include 1).

Table 5—Animal trauma triage score for 37 animals categorized according to duration of treatment.

Duration of treatment (d)	No. of animals	Low ATT score (< 4.5)	High ATT score (> 4.5)
0*	19	13/19	6/19
Short (1–3)	8	2/8	6/8
Long (> 3)	10	1/10	9/10

*Patients that did not survive or were euthanized < 1 day after initial examination.

Discussion

The present study of cats and dogs treated for gunshot injuries over a 5-year period between 2003 and 2008 at a private referral practice in Cedar Rapids, Iowa, and veterinary teaching hospital in Ames, Iowa, found no difference in outcome, defined as survival to discharge from the hospital or nonsurvival, related to the type of firearm inflicting the injury. However, similar to the 1974 study by Kolata et al,[2] it is likely that the incidence of trauma in the present study does not accurately represent the true incidence of gunshot trauma. Many animals with minimal injuries from low-velocity firearms likely do not receive medical attention because owner perception of the injury is mild or animals are not transferred from local veterinary hospitals, as care can adequately be performed without the need for tertiary-center services.[1,2,5,10] Animals with retained gunshot projectiles, often gunshot pellets, found incidentally were excluded from this study. These injuries represent a subset of animals having successfully recovered from gunshot injuries without known medical intervention, few complications, and minimal morbidity. If included, results of this study may further indicate high survivability from long-range gunshot wounds with minimal wound severity and with lower ATT scores.

In the present study, young male dogs of breeds generally considered working breeds (Weimeraner, German Shorthaired Pointer, Labrador Retriever, Viszla, and German Shepherd Dog) were overrepresented, consistent with previous reports of veterinary gunshot injuries.[2,4] This association may be a result of a tendency to roam and defend territory or because of limited confinement by fence or property lines in rural environments. The present study's working breed overrepresentation is attributed to regional breed and husbandry preferences.

In the present study, 22 of 37 (59%) injuries occurred in an urban environment, defined by the US Census Bureau as within the limits of a city with a population > 50,000; the remaining 15 of 37 (41%) occurred in rural settings (population < 50,000 residents). Of dogs with witnessed injuries, the greatest proportion had wounds inflicted by the owners or neighbors, during hunting excursions or roaming property near the residence. In the present study, 12 of 37 (32.4%) injuries were inflicted to the limbs, 5 of 37 (13.5%) to the abdomen, and 8 of 37 (21.6%) to the thorax, with the remainder evenly distributed between the head and neck (6 [16.7%] each). Previous studies[1,2,4,6,12,13] have documented that the greatest proportion of injuries is to the head and neck in urban environments. In a previous report,[1] distribution of injuries was similar to the present study, with the greatest number occurring to the limbs (43%), followed by the thorax (26%) and abdomen (14%), with the remainder evenly distributed among the head and neck. This may support the previous suggestion that differences exist between rural and urban settings in the intentions of those yielding the weapons, as well as differences in the circumstances surrounding the injury, such as during hunting trips, or in defense of property or livestock. Incidence of head and neck wounds in urban environments in a previous study would suggest potential aggressive intentions on the part of the animal or the animal's attention directed toward the individual yielding the weapon, with the gunfire directed toward the animal as it was facing the firearm.[13] In the present study, animals living in rural settings may predispose to utility and housing differences among the dogs. This may help to explain a greater incidence of nonfatal extremity wounds, either due to intentional direction toward the limbs with the goal of scaring the animal off property or accidental injuries inflicted while sport hunting.

Previous studies[1,5,6,8,12,13] have shown that a higher proportion of gunshot injuries occur during twilight hours, during winter months, and in lower-income urban and suburban environments, with an overrepresentation among young male dogs. Similar results were found in the present study, with the highest frequency of injuries in young (< 4 years old) male dogs during evening hours, although no significant seasonal increase in frequency during the winter months was observed. This may reflect times of limited owner supervision to prevent the animal's inclination to explore, at which time diminished ambient lighting may lend toward greater inclination to wield a weapon in defense of property, livestock, or residents.[8]

Previous recommendations regarding need for surgical care in the successful management of gunshot wounds has varied on the basis of the location of injury. Surgical intervention for treatment of thoracic wounds is based on the severity of cavitary penetration, presence of perforation of vital structures, and adequacy of management with thoracostomy tube alone.[1,5,7,9,10,12,13] In the present study, none of the thoracic wounds required surgery. In previous studies,[5,13] surgical management has been recommended for all abdominal injuries. One study[13] involving gunshot wounds demonstrated evidence, during surgery, of serious injury to intra-abdominal structures in all 5 patients with penetrating abdominal wounds. In the present study, 5 of 37 (14%) injuries were sustained to the abdomen. Despite the frequency of these injuries being low for our patient population, our results support previous recommendations[5,13] for surgical management. In 3 of 5 patients, management of the abdominal injuries involved exploratory laparotomy; all 3 of these animals showed evidence of bowel perforation at the time of surgery. In the animals with abdominal wounds that did not undergo surgery, one had free fluid obtained at the time of evaluation with characteristics of septic peritonitis, although surgery was declined by the owner, and the other had no diagnostic testing performed to evaluate for bowel trauma, was discharged to the owner against medical advice, and was lost to follow-up.

Regional differences in the firearm inflicting the injuries could lead to variability in the required care. Previous studies[1,4–12] in urban environments have shown that the most frequent projectiles retrieved were from higher-velocity, higher-kinetic-energy weaponry such as handguns, fired at close range. The most common projectiles retrieved in the present study were small (low-velocity) pellets, fired at long range, with less generable kinetic energy at the time of skin contact. Low-velocity, low-kinetic-energy firearms generally produce more shallow entry wounds, with less potential for internal injury to vital structures or luminal organs.[5,7,9] However, when fired at close range, these firearms have the potential to cause some of the most destructive wound patterns, even in comparison with high-velocity, high-kinetic-energy firearms.[9] Of the injuries causing death, the distribution of firearm type inflicting the injury would suggest that the characteristics of the wound and circumstances of the injury at the time it is inflicted (close vs long range) play a greater role in the extent of tissue injury than the type of firearm itself. Nevertheless, despite regional differences in firearm type identified in this study, results supported previous recommendations[1,5,7,11,13] regarding management of gunshot trauma in veterinary patients based on location and severity of injury.

Of 37 patients enrolled in this study, 32 (86.5%) survived initial treatment and were discharged from the hospital, consistent with a previous report[13] from tertiary-care centers. Animals with gunshot wounds having higher ATT scores had a longer duration of stay and greater risk of poor outcome. These results are similar to a previous study[3] of animals from urban environments, demonstrating higher ATT scores in nonsurvivors, compared with survivors, with sources of trauma including vehicular injuries, bite wounds, and uncategorized blunt trauma. A previous study[14] that used ATT scores in predicting outcome in veterinary medicine showed that with each 1-point increase in ATT score, an animal's likelihood of not being discharged from the hospital increases 2.3 times. Similar results were documented in the present study, with each 1-point increase in ATT score associated with a likelihood of nonsurvival to discharge 1.6 times as great. Similarly, individuals with injuries to the extremities had a consistently lower ATT score (median, 4.5; range, 0 to 11) than those with injuries to the thorax (median, 5; range, 0 to 15) and abdomen (median, 5; range, 3 to 8). These results suggested that ATT score can be used as an early predictor of outcome, although prospective studies would be helpful to validate this hypothesis.

The present study had a number of limitations, notably a small sample size. Few animals in this study died, although it is likely that only those animals most severely affected by their wounds were represented. True prevalence of gunshot injuries in rural populations is likely greater than that among dogs receiving care and thus available for study. This is attributed to determination by either the owner or primary care veterinarian that the wounds did not require more extensive tertiary-facility care or that euthanasia was preferable to referral because of the severity of injuries. Additionally, this study did not differentiate animals with longer duration of stay due to severity of illness from those hospitalized for reasons distinct from severity of illness (owner convenience for daily management of persistent, although mild, injuries). As such, duration of stay may not be a reasonable surrogate for duration of care required for recovery and survival to discharge from the hospital. With a larger sample size and higher proportion of nonsurvivor animals with more defined categorization of duration of stay and duration of care required for successful outcome, more accurate indices could be established for outcome, cost, and hospital stay prediction on the basis of physical examination findings or initial diagnostic testing.

Results of the present study suggested that use of the ATT score has promise as an early predictor of survival to discharge from the hospital in dogs and cats with gunshot trauma. Use of the ATT score early in patient management may help predict need for surgery or blood products, cost of care, and outcome. Future utility of the ATT score may include use in serial evaluation of animals recovering from trauma, including that from gunshot injuries, as an objective tool to monitor response to treatment. The score has limitations in that a high score may correlate with a lower (albeit nonzero) probability of survival to discharge from the hospital.[3] With proper training and use, trauma scores have great potential as a triage tool to direct and prioritize appropriate patient care. Further prospective studies are suggested to determine the value of the ATT score for management of veterinary trauma patients.

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Appendix appears on next page.

Appendix

Animal trauma triage scoring system.[3]

Grade	Perfusion	Cardiac	Respiratory	Eye/muscle/integument	Skeletal	Neurologic
0	MM pink and moist; CRT approx 2 s; rectal temperature ≥ 37.8°C (100°F); femoral pulses strong or bounding.	HR (dog) 60–140 beats/min; HR (cat) 120–200 beats/min; normal sinus rhythm.	Regular rate with no stridor; no abdominal component.	Abrasion or laceration: none or partial thickness. Eye: no fluorescein uptake.	Weight bearing on 3 or 4 limbs; no palpable fracture or joint laxity.	Central: conscious, alert to slightly dull, and interested in surroundings. Peripheral: normal spinal reflexes, purposeful movement, and nociception in all limbs.
1	MM hyperemic or pale pink; MM tacky; CRT 0–2 s; rectal temperature ≥ 37.8°C; femoral pulses fair.	HR (dog) 140–180 beats/min; HR (cat) 200–260 beats/min; normal sinus rhythm or ventricular premature contractions (< 20/min).	Mildly increased respiratory rate and effort with or without some abdominal component; mildly increased upper airway sounds.	Abrasion or laceration: full thickness and no deep tissue involvement. Eye: corneal laceration or ulcer and not perforated.	Closed appendicular fracture or rib or any mandibular fracture; single-joint laxity or luxation including sacroiliac joint; pelvic fracture with unilateral intact sacroiliac joint, ilium, and acetabulum; single-limb open or closed fracture at or below carpus or tarsus.	Central: conscious but dull, depressed, and withdrawn. Peripheral: abnormal spinal reflexes with purposeful movement and nociception in all 4 limbs.
2	MM very pale pink; MM very tacky; CRT 2–3 s; rectal temperature < 37.8°C; femoral pulses not detected.	HR (dog) > 180 beats/min; HR (cat) > 260 beats/min; consistent arrhythmia.	Moderately increased respiratory effort with abdominal component; elbow abduction; moderately increased upper airway sounds.	Abrasion or laceration: full thickness; deep tissue involvement; and intact arteries, nerves, and muscle. Eye: corneal perforation and punctured globe or proptosis.	Multiple grade 1 conditions (see above); single long-bone open fracture above carpus or tarsus with cortical bone preserved.	Central: unconscious and responsive to noxious stimuli. Peripheral: absent purposeful movement, intact nociception in 2 or more limbs, or nociception absent in only 1 limb. Decreased anal or tail tone.
3	MM gray, blue, or white; CRT > 3 s; rectal temperature < 37.8°C; femoral pulses not detected.	HR (dog) ≤ 60 beats/min; HR (cat) ≤ 120 beats/min; erratic arrhythmia.	Marked respiratory effort; gasping or agonal respiration or irregularly timed effort; or little or no detectable air passage.	Penetration into thoracic and abdominal cavity. Abrasion or laceration: full thickness and deep tissue involvement. Arterial, nervous, and muscle compromise.	Vertebral-body fracture or luxation (except coccygeal); multiple long-bone open fractures above tarsus or carpus; single long-bone open fracture above carpus or tarsus with cortical bone compromise.	Central: nonresponsiveness to all stimuli, refractory seizures. Peripheral: absent nociception in 2 or more limbs. Absent tail or peripheral nociception.

CRT = Capillary refill time. HR = Heart rate. MM = Mucous membranes.

From this month's *AJVR*

Protective immunity of a modified-live cyprinid herpesvirus 3 vaccine in koi (*Cyprinus carpio koi*) 13 months after vaccination

Matthew R. O'Connor et al

Objective—To evaluate the long-term protective immunity of a cyprinid herpesvirus 3 (CyHV3) vaccine in naïve koi (*Cyprinus carpio koi*).

Animals—72 koi.

Procedures—Vaccinated koi (n = 36) and unvaccinated control koi (36) were challenge exposed to a wild-type CyHV3 strain (KHVp8 F98-50) 13 months after vaccination.

Results—The CyHV3 vaccine provided substantial protective immunity against challenge exposure. The proportional mortality rate was less in vaccinated koi (13/36 [36%]) than in unvaccinated koi (36/36 [100%]). For koi that died during the experiment, mean survival time was significantly greater in vaccinated than in unvaccinated fish (17 vs 10 days).

Conclusions and Clinical Relevance—The CyHV3 vaccine provided substantial protective immunity against challenge exposure with CyHV3 13 months after vaccination. This provided evidence that koi can be vaccinated annually with the CyHV3 vaccine to significantly reduce mortality and morbidity rates associated with CyHV3 infection. (*Am J Vet Res* 2014;75:905–911)

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