

## ORIGINAL STUDY

# Development of a veterinary trauma score (VetCOT) in canine trauma patients with performance evaluation and comparison to the animal trauma triage score: A VetCOT registry study

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**Abstract**

**Objective:** To develop a population-derived, parsimonious, and objective risk stratification model for dogs following trauma and compare its predictive performance to the animal trauma triage (ATT) score.

**Design:** Observational cohort study using data from the American College of Veterinary Emergency and Critical Care Veterinary Committee on Trauma (VetCOT) trauma registry acquired between September 2013 and October 2017.

**Setting:** Nine Level I and Level II veterinary trauma centers.

**Animals:** Nine hundred eighty-four dogs assessed within 24 h of traumatic injury.

**Interventions:** None.

**Measurements and Main Results:** Patient mortality was 10.8%. The VetCOT model was constructed based on 4 variables: plasma lactate and ionized calcium obtained within 6 h of admission, and presence or absence of clinical signs consistent with either head or spinal trauma. The VetCOT score had good discriminatory performance (AUROC = 0.87, 95% CI = 0.83–0.91) comparable to that of the 6 variable ATT score for the same population (area under the receiver operator characteristic [AUROC] = 0.87; 95% CI, 0.84–0.90). No statistical difference in discriminatory performance between the 2 scores was identified ( $P = 0.98$ ). The VetCOT score showed good calibration on this population (Hosmer–Lemeshow test  $P = 0.93$ ), whereas the ATT score failed to calibrate ( $P = 0.02$ ) due to overprediction of mortality at low scores. Sensitivity and specificity for outcome of the VetCOT score at a risk probability cutoff of 0.5 for this population were 28.97% and 97.95%, respectively.

**Conclusions:** The VetCOT score is a more parsimonious model with comparable discriminatory performance and superior calibration to the ATT score for risk stratification in dogs following trauma. Further prospective validation studies are required to confirm the discriminatory performance of the VetCOT score.

**Abbreviations:** ATT, animal trauma triage; AUROC, area under the receiver operator characteristic; CI, confidence interval; IQR, interquartile range; MGCS, modified Glasgow Coma Score; VetCOT, Veterinary Committee on Trauma.

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## KEYWORDS

dogs, illness severity scores, risk stratification

## 1 | INTRODUCTION

Scoring systems predicting various clinically relevant outcomes have become ubiquitous in a wide variety of settings in human medicine, including the management of acute trauma.<sup>1–4</sup> Calculation of these scores both at time of presentation and throughout clinical treatment enables quantification of disease severity, which can be used to guide patient triage and medical intervention. Objective stratification of disease severity also facilitates analysis of patients enrolled in clinical research. Similar scoring systems are available in veterinary medicine and are becoming increasingly adopted for the description and analysis of clinical research populations.<sup>5–10</sup>

In the last 10 years, veterinary trauma research has been empowered by the development of the American College of Veterinary Emergency and Critical Care (ACVECC) Veterinary Committee on Trauma (VetCOT) registry and the identification and subsequent verification of Level I and II veterinary trauma centers. These centers routinely contribute trauma patient data to the registry, which, at the time of writing, contains data acquired from over 41,000 animals. However, trauma research may be hampered by the lack of a readily calculated stratification model based on objective data.

Current scoring systems in veterinary medicine used to assess mortality risk in acute trauma patients are the animal trauma triage (ATT) score, developed in 1994, and the modified Glasgow Coma Score (MGCS) for neurological trauma that was adjusted and validated for veterinary usage in 1983.<sup>5–10</sup> The ATT score is calculated on 6 physiological and anatomical domains and, since development, has been prospectively validated on large canine and feline populations.<sup>11–14</sup> However, several issues with this score may limit its uptake and use in clinical research. The score is challenging to apply retrospectively as it relies on information that may not be routinely captured in the medical record (eg, the quality of femoral pulses and the extent of injury to the deep wound bed after full-thickness cutaneous lacerations). Additionally, some categories within domains are not mutually exclusive, relying on the scorer to decide which category best fits the patient at hand. These both commit the score user to individual manual calculation and introduce an element of subjectivity. Finally, the relationship between the ATT score and mortality risk has been shown to be nonlinear, with overprediction of mortality risk at a score of 11 in dogs.<sup>11</sup> Although the score is simple to calculate and robust, these issues may limit uptake in clinical trauma research.<sup>11,13</sup>

The objective of this study was to develop a novel trauma scoring system (referred to herein as the VetCOT score) that was parsimonious in the number of required data entry points, utilized objective and readily available data, and was amenable to semiautomated retrospective calculation through incorporation into electronic data collection spreadsheets or medical records. The score was also required

to show a linear association with mortality risk, calibrate appropriately, and discriminate at least as well as the ATT score.

## 2 | METHODS

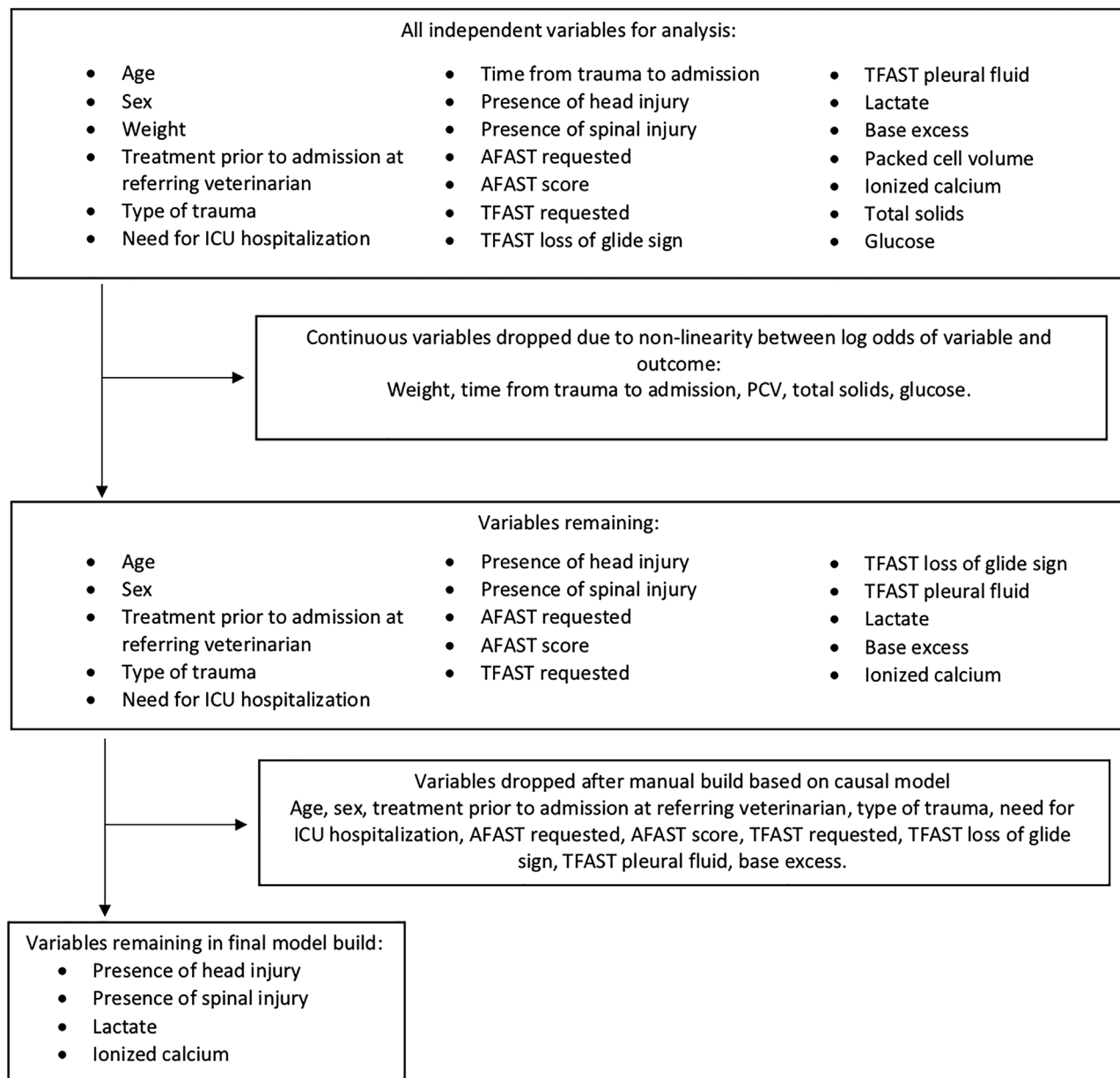
### 2.1 | Case selection

Canine and feline trauma patients entered into the VetCOT registry between September 2013 and October 2017 were available for review. This data registry included information from 9 veterinary hospitals located in North America representing Level I and Level II trauma centers in private referral and academic teaching hospitals. A subpopulation was defined following exclusion of noncanine species, outcome information not recorded, ATT score not recorded or incorrect (listed as <0 or >18), time between traumatic event and presentation >24 h, or traumatic event listed as or associated with “porcupine quilling.”

### 2.2 | Data collection and screening

Potential predictor variables for the model were selected based on availability in the registry and an anticipated relationship with mortality based on primary literature. These variables are listed in Figure 1 and included signalment, elements of the history (information on the type of trauma and the time interval between the traumatic event and admission), elements of admission physical exam findings (presence of head or spinal trauma), and laboratory diagnostics if performed (base excess [mmol/L]), plasma lactate (mmol/L), ionized calcium (mmol/L), glucose (mg/dl), total solids (g/dl), and PCV (%). Laboratory methods were those in use at the trauma center collecting the data and were not described. Laboratory testing was only performed if considered necessary for case management by the attending clinician and approved by the owner and was not a requirement of registry entry. When serial laboratory or imaging assessments were made, those closest to the time of admission were recorded. For inclusion in the registry, all laboratory diagnostics had to be run on samples collected within 6 h of admission, with no restrictions placed on the relationship between the time of sampling and any interventions made. Imaging findings available included the results of focused thoracic and abdominal assessment with sonography for trauma. Outcome was recorded as survival status at hospital discharge. Euthanasia and natural death were allotted equivalent nonsurvival status in the analysis.

All candidate variables were screened for physiologically impossible or incorrectly formatted data and were adjusted if the correct entry could be identified (eg, correction of year in a date). If this was not possible, erroneous data values were set as missing.



**FIGURE 1** Potential predictor variables assessed for inclusion into the VetCOT score

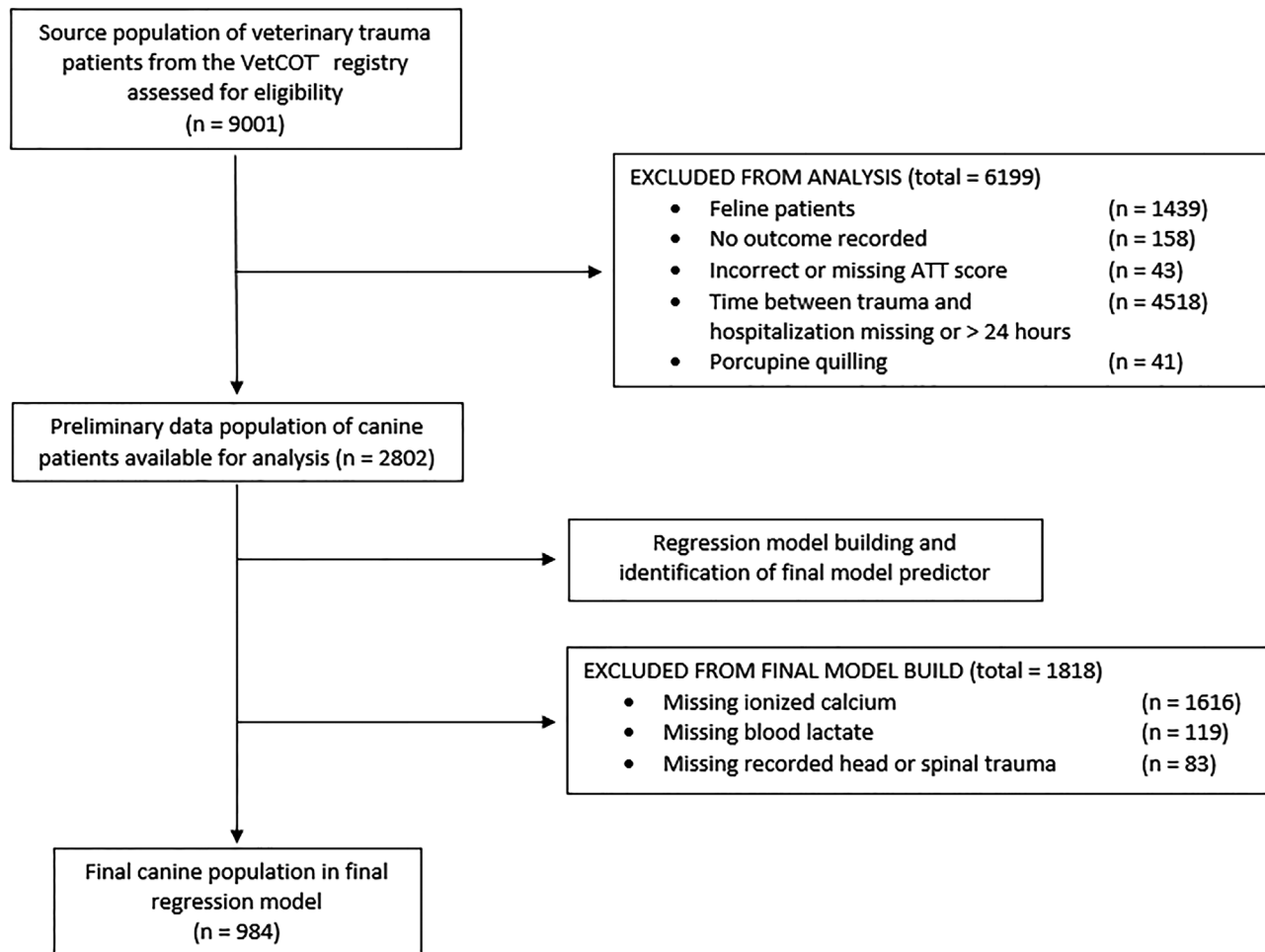
AFAST, abdominal focused assessment with sonography for trauma; TFAST, thoracic focused assessment with sonography for trauma; VetCOT, Veterinary Committee on Trauma

## 2.3 | Statistical methods

Continuous descriptive data were assessed for normality using the Shapiro–Wilk test. All descriptive data were determined to be non-parametric and were thus summarized as median (interquartile range [IQR]). Descriptive associations between categorical data were assessed using a chi-squared test if category  $n > 5$  and a Fisher's exact test if  $n \leq 5$ . Group differences in continuous data were assessed using the Wilcoxon rank-sum test for two groups or the Kruskal–Wallis test for more than two groups.

## 2.4 | Regression model-building, model diagnostics, and model comparisons

No data imputation was performed. The relationship between candidate continuous predictor variables and log odds of outcome was assessed graphically using locally weighted scatterplot smooth (LOWESS) plots. Nonlinearity suggested by graphical analysis on the logit scale was confirmed by identifying power terms significantly associated with outcome when entered in a univariable model. Continuous variables found to have a nonlinear relationship with the log



**FIGURE 2** Inclusion and exclusion of dogs over the process of the model build

of the odds ratio of the outcome were excluded. Remaining continuous variables were assessed for correlation using Spearman's rank correlation test. Univariable logistic regression was performed to assess associations between the remaining variables and outcome. Variables were put forward for consideration in the multivariable model if they achieved significance at  $P < 0.2$  in univariable analysis.

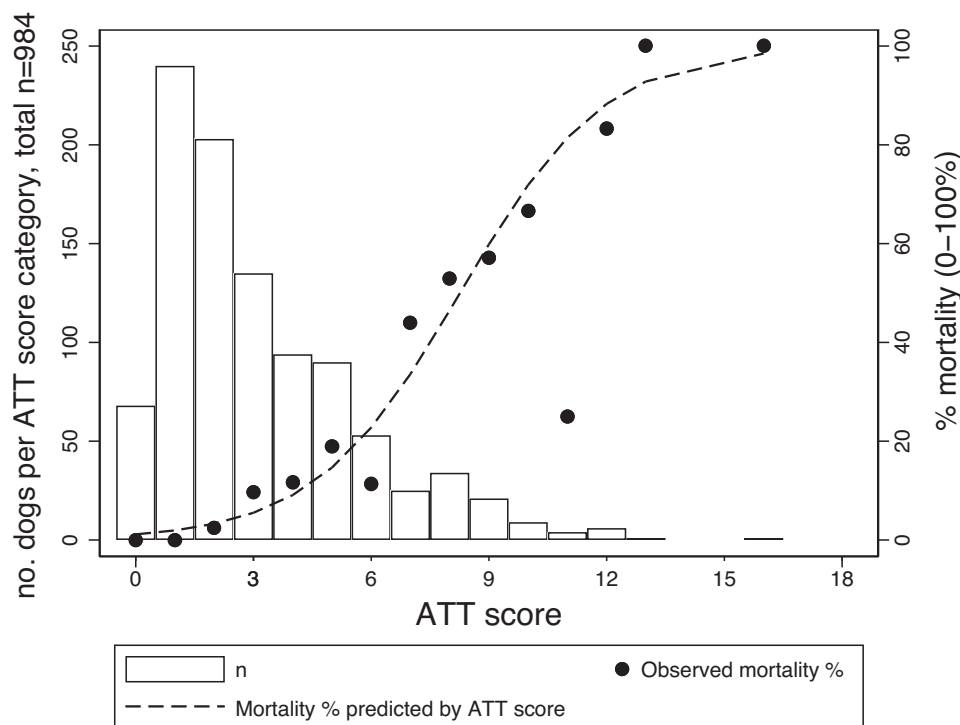
Calculation of the area under the receiver operator curve characteristic (AUROC) for the association between each remaining predictor and outcome was performed. The final multivariable model was then developed by a manual build with preference for variables with strong univariable discrimination, no evidence of collinearity, and no physiological basis to suggest the need for interaction terms. The final model was selected on the basis of high discrimination, appropriate calibration, parsimony, and ease of calculation. Case-wise deletion was used throughout the build process, and the final study population was dictated by the availability of the variables selected in the final model. The coefficients and 95% confidence intervals (CIs) for the model were reported after bootstrapping on this population with 1000 repetitions. Finally, model diagnostics were performed to assess appropriate model specification and absence of outliers.

Once model diagnostics were completed, the performance of the VetCOT score and the ATT score (discrimination and calibration) was assessed and compared on the final population. The sensitivity and specificity of each model were reported at a risk probability cut points of 0.5, as well as a cut point adjusted to achieve sensitivity of >80%. All statistical calculations were performed using commercial software.<sup>a</sup>

### 3 | RESULTS

#### 3.1 | Case selection

The initial VetCOT registry study population consisted of 9001 patient entries from nine different veterinary institutions. After exclusion criteria were applied, a total of 2802 dogs remained for the model build process (Figure 2). Fifteen data entries with erroneous dates were corrected to reflect the correct year. Forty-eight biochemical data points that were considered outside of physiologically possible ranges were set to missing. Values entered as 0 for age ( $n = 20$ ) and weight ( $n = 112$ ) were also set to missing; however, the remaining data for these entries were retained for entry into the build process.



**FIGURE 3** ATT score distribution with predicted and actual mortality percentages  
ATT, animal trauma triage

After applying exclusion criteria and applying case-wise deletion through the model build process, the final study population consisted of 984 dogs.

### 3.2 | Population characteristics

In the final study population of 984 dogs, the median age was 4.5 years (IQR, 6.2). There were 164 (16.7%) intact males, 359 (36.5%) neutered males, 95 (9.7%) intact females, 364 (37.0%) neutered females, and two unknown (0.2%). Median body weight was 13.5 kg (IQR, 19.8). Median time from trauma to hospitalization was 1.18 h (IQR, 1.75), and median time from hospitalization to outcome was 26.6 h (IQR, 58.8).

Overall mortality risk within this population was 10.87% ( $n = 107$ ), with 83.2% of deaths being due to euthanasia (18 died, 89 euthanized). Type of trauma documented at presentation was recorded as blunt trauma only ( $n = 561$ ; 57.0%), penetrating trauma only ( $n = 400$ ; 40.7%), and both blunt trauma and penetrating trauma ( $n = 23$ ; 2.3%). Mortality rate for dogs with blunt trauma only was 12.7%, penetrating trauma only was 8.0%, and both blunt and penetrating trauma was 17.4% ( $P = 0.04$ ). Evidence of head trauma was documented in 157 dogs (16.0%) and spinal trauma in 89 dogs (9.0%). Mortality risk in these 2 groups was higher compared to the general population, at 31.2% (49/157) dogs in the head trauma group ( $P < 0.01$ ) and 46.1% (41/89) dogs in the spinal trauma group ( $P < 0.01$ ).

Median plasma lactate obtained within 6 h of admission for the general population was 2.4 mmol/L (IQR, 2.2), and median ionized cal-

cium was 1.26 mmol/L (IQR, 0.1). When nonsurvivors were compared with survivors, median plasma lactate was higher (4.7 vs 2.3 mmol/L,  $P < 0.01$ ) and median ionized calcium was lower (1.23 vs 1.26 mmol/L,  $P < 0.01$ ).

The median MGCS in this population was 18 (IQR, 0). The median ATT score in this population was 2 (IQR, 3). Distribution of ATT scores within this population with associated observed and predicted mortality percentages is illustrated in Figure 3.

### 3.3 | Regression model build

The process of the model build is shown in Figures 1 and 2. Continuous variables excluded as a result of nonlinearity included weight, time from trauma to admission, PCV, total solids, and glucose. All remaining variables were associated with outcome at  $P < 0.2$  and were put forward for assessment in the final model build.

The final model included plasma lactate (retained as a continuous variable in mmol/L), ionized calcium (retained as a continuous variable in mmol/L), presence/absence of head trauma, and presence/absence of spinal trauma. Serum base excess was also found to have strong predictive performance (univariable AUROC = 0.7596); however, this variable was moderately correlated with blood lactate (Spearman's  $|r| = 0.495$ ,  $P < 0.001$ ). Plasma lactate was selected in preference to base excess as its inclusion resulted in higher discriminatory performance of the final model. Regression coefficients and 95% CIs for the final model are reported in Table 1.

**TABLE 1** The 4 final predictor variables in the VetCOT score logistic regression model using the final canine population ( $n = 984$ ). Coefficients provided represent the log of the odds ratio for each variable. All 4 final predictor variables were associated with outcome at  $P < 0.005$ . The 95% confidence interval (CI) reported for each predictor variable is that obtained after bootstrapping the final population data with 1000 repetitions

Variable	Coefficient	Standard error	z	P >  z	95% bootstrapped CI
Plasma lactate	0.342245	0.0466734	7.33	0.000	0.227737 to 0.456753
Ionized calcium	-3.89630	1.30663	-2.98	0.003	-6.65782 to 1.13478
Presence of head trauma	1.42343	0.256303	5.55	0.000	0.896957 to 1.94990
Presence of spinal trauma	2.01600	0.290014	6.95	0.000	1.41422 to 2.61777
Intercept	0.700473	1.62487	0.43	0.666	-2.72091 to 4.12185

**TABLE 2** The area under the receiver operating characteristic (AUROC) of the VetCOT score and ATT score for the final canine population ( $n = 984$ ) along with their 95% confidence intervals (CIs). Hosmer–Lemeshow (H–L) statistics and associated  $P$ -values for both scores were also recorded. Sensitivity and specificity were calculated using a probability risk cutoff value of 0.5

	AUROC	AUROC 95% CI	H–L statistic	H–L statistic P-value	Sensitivity	Specificity
VetCOT score	0.8682	0.82970–0.90670	3.00	0.9342	28.97%	97.95%
ATT score	0.8687	0.83818–0.89929	13.33	0.0204	24.30%	98.18%

Abbreviations: ATT, animal trauma triage; VetCOT, Veterinary Committee on Trauma.

The final model equation for the VetCOT score is as follows:

$$y = 0.700473 + 0.342245 (\text{lactate}) - 3.89630 (\text{iCa}) + 1.42343 (\text{head trauma}) + 2.01600 (\text{spinal trauma}),$$

where  $y$  represents the log of the odds ratio of the outcome (death or euthanasia), *lactate* is the plasma lactate concentration in mmol/L, *iCa* is the blood ionized calcium concentration in mmol/L, *head trauma* is the presence of head trauma (0 = no, 1 = yes), and *spinal trauma* is the presence of spinal trauma (0 = no, 1 = yes). Conversion into a risk probability percentage of mortality risk (from 0 to 1) can then be obtained by the following equation:

$$\text{Risk probability of mortality} = \frac{e^y}{1 + e^y}.$$

To provide an example of calculation, for a dog presenting within 24 h of traumatic injury with no evidence of head or spinal trauma on physical exam, a blood lactate of 4.2 mmol/L, and an ionized calcium concentration of 1.0 mmol/L:

1. Calculation of log odds:  $y = 0.700473 + 0.342245(4.2) - 3.89630(1.0) + 1.42343(0) + 2.01600(0) = -1.758398$ ;
2. Calculation of risk probability:  $\frac{e^y}{1 + e^y} = 0.146991 = 14.6991\%$  mortality risk.

### 3.4 | Model diagnostics and model performance

#### 3.4.1 | Model diagnostics

No significant two-way interaction terms were identified. No evidence of multicollinearity was identified.

#### 3.4.2 | Model performance and comparison to ATT score performance

Performance characteristics of the two models are shown in Table 2. Discriminatory performance of the VetCOT score and ATT score were both good, with an AUROC = 0.8682 versus 0.8687, respectively, and with no significant difference between the 2 models ( $P = 0.9770$ ). AUROC curves are shown in Figure 4.

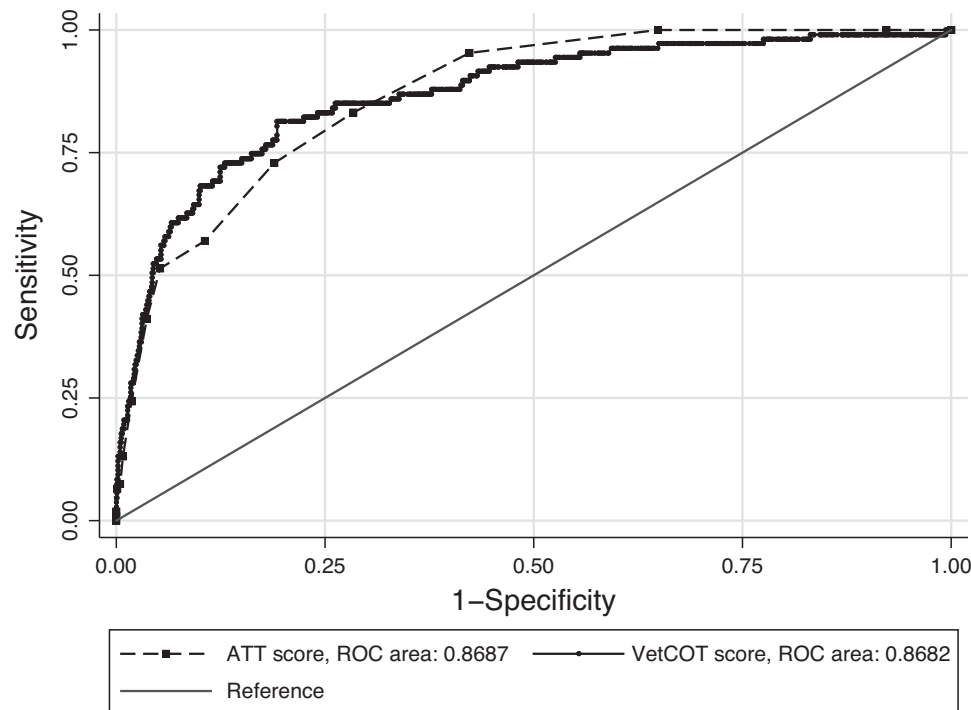
Model calibration was assessed by the Hosmer–Lemeshow goodness-of-fit test statistic, which indicated good fit of the VetCOT score model to the data ( $P = 0.93$ ) and poor fit of the ATT model ( $P = 0.02$ ). When observed mortality was compared with predicted mortality for the two scores over 10 deciles of mortality risk for the study population, the ATT score overpredicted mortality risk at low values of the score and showed a tendency to underpredict at higher values of the score, explaining the lack of calibration. In contrast, the VetCOT score appeared to show an improved fit to the data.

The sensitivity and specificity of the 2 scores for predicting mortality at a probability cutoff of 0.5 ( $P > 0.5$ , implying a prediction of nonsurvival) were assessed with reported values in Table 2. Both scores were highly specific and poorly sensitive at a 0.5 cut point, implying minimization of false-positive mortality predictions.

### 3.5 | Risk probability cutoff adjustments for utilization of VetCOT score in triage

Although the minimization of false positives may be desirable for prognostication to minimize the incidence of inappropriate euthanasia, the emphasis in triage may switch to the minimization of false negatives, which requires higher sensitivity. The sensitivity and specificity of the VetCOT model are reported at various probability cut points in Table 3. Lowering the risk probability cutoff resulted in increasing sensitivity





**FIGURE 4** Comparison of the area under the receiver operator characteristic (AUROC) between the ATT score and the VetCOT score. No difference was observed between the two scores ( $P = 0.9770$ )

ATT, animal trauma triage; AUROC, area under the receiver operator characteristic; VetCOT, Veterinary Committee on Trauma

**TABLE 3** Varying risk probability cutoffs of the VetCOT score with associated changes in sensitivity and specificity of the model and number of patients below the risk probability cutoff (total  $n = 984$ ). Application examples: A specialty center using the VetCOT model for triage purposes might consider accelerated imaging/intervention on patients with VetCOT probability scores calculated as  $>0.05$ , whereas rescue facilities trying to preserve resources by pursuing euthanasia for severely traumatized patients with high mortality risks might consider a calculated VetCOT probability indicator of  $>0.5$  as a trigger to consider not pursuing treatment

Risk probability cutoff	Sensitivity	Specificity	Number of patients $\leq$ risk probability cutoff
0.5	28.97%	97.95%	935
0.25	57.94%	94.18%	871
0.1	76.64%	81.98%	744
0.05	86.92%	62.26%	560

Abbreviation: VetCOT, Veterinary Committee on Trauma.

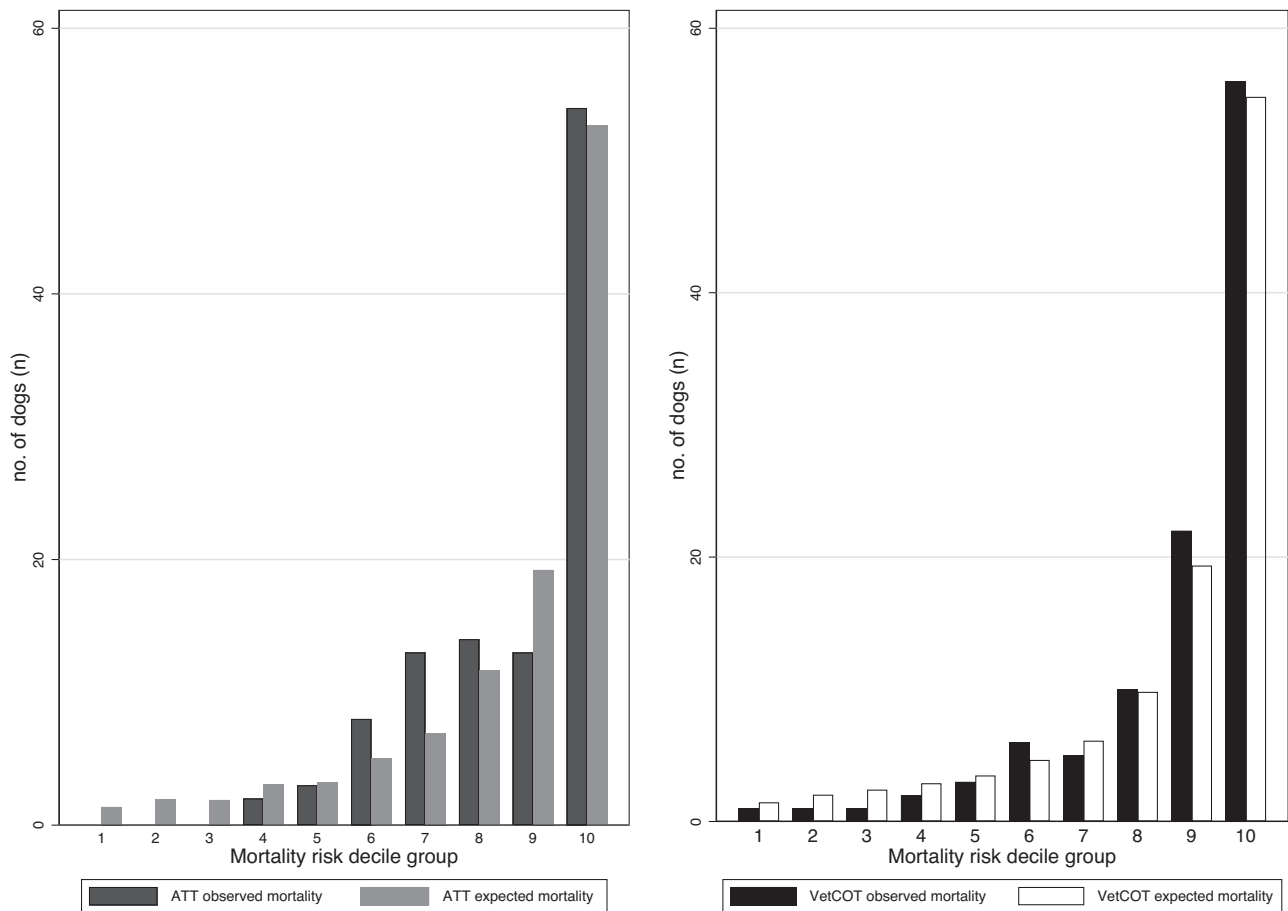
and decreasing specificity. At a risk probability cutoff of 0.05, the sensitivity of the VetCOT score was 86.92% and the specificity was 62.26%. Thus, a specialty center using the VetCOT model for triage purposes might consider accelerated imaging/intervention on patients with VetCOT probability scores calculated as  $>0.05$ , whereas rescue facilities trying to preserve resources by pursuing euthanasia for severely traumatized patients with high mortality risks might consider a VetCOT probability indicator of  $>0.5$  as a trigger to consider not pursuing treatment.

## 4 | DISCUSSION

This analytic study developed a canine trauma score based on objective information from 4 variables that should be straightforward to employ

in studies founded on retrospective data. The score is presented in a format that facilitates incorporation into an electronic spreadsheet or medical record system. The final predictor variables chosen for inclusion into the model were blood ionized calcium and plasma lactate concentrations obtained within 6 h of admission, presence of head trauma, and presence of spinal trauma. The score is intended for application on dogs presenting for assessment within 24 h of the trauma event. Predictive value of the score on other species or outside of this time window has not been assessed.

Compared to the ATT score, the VetCOT score showed similar discrimination and improved calibration, implying that the score could be expected to predict not only the correct total number of deaths within a particular population but also the appropriate number of deaths at both low and high levels of trauma severity. The ATT is a robust score



**FIGURE 5** Side-by-side comparison of observed with predicted mortality over 10 deciles of mortality risk probability for the ATT and VetCOT score ( $n = 984$ )

ATT, animal trauma triage; VetCOT, Veterinary Committee on Trauma

that has stood the test of time and has been used to index trauma severity in multiple studies. The goal of this study was not to replace the ATT but, rather, to offer an alternative tool that could be used to objectively index trauma cases if ATT calculation was not possible.

This study found that high lactate was associated with increased risk of nonsurvival in traumatized animals. Plasma lactate has been identified as a marker of cellular hypoxia, and elevations are typically associated with various shock states.<sup>15,16</sup> Previous veterinary studies evaluating plasma lactate as a predictor of mortality following trauma have found conflicting results; Hall et al. identified high plasma lactate concentrations to be predictive of nonsurvival, whereas Simpson et al. failed to identify a statistically significant increase in mortality risk in hyperlactatemic patients despite nonsurvivors having a higher mean lactate in that study.<sup>12,17</sup>

Ionized hypocalcemia was also identified as an independent predictor of nonsurvival in the current study. This is similar to the study by Holowaychuk et al. that identified associations between ionized hypocalcemia and longer ICU and hospital stays, as well as increased mortality risk and a greater need for intensive therapy (oxygen supplementation, colloid and vasopressor therapy, blood transfusions) when compared to normocalcemic traumatized dogs.<sup>18</sup> Ionized cal-

cium is fundamental to the regulation of vascular tone, blood clotting, myocardial contraction, neuronal signaling and conduction, and hormone release.<sup>18,19</sup> The pathophysiology behind the development of ionized hypocalcemia in trauma patients remains unknown, although a variety of mechanisms, including impacts of inflammatory cytokines, parathyroid hormone, blood pH alterations with subsequent intracellular sequestration of calcium, hypomagnesemia, and increased calciuresis, have been proposed.<sup>18–20</sup>

Evidence of head trauma and spinal trauma in this study was shown to be predictive of mortality in the final VetCOT score model. Trauma of the head and spine leading to neurological deficits is associated with high mortality in both human and veterinary literature.<sup>10,21–23</sup> An MGCS has been adapted for veterinary usage for classifying severity of brain injury by identifying neurological deficits and generating a score from 0 to 18. Worsening scores have been demonstrated to be associated with increased mortality in canine head trauma patients.<sup>10</sup> Additionally, the study done by Simpson et al. in 2009 evaluating 235 dogs with severe blunt trauma demonstrated that nonsurvivors were significantly more likely to have evidence of head injury as evidenced by epis-taxis or skull fractures.<sup>17</sup> The same study identified 17% of the nonsurvivors in that study had spinal fractures compared to only 9% in the



survivor group. In our study, both evidence of head trauma and evidence of spinal trauma were associated with increases in mortality odds.

The sensitivity and specificity of the VetCOT score were reported at several risk probabilities ranging from 0.05 to 0.5. Despite the VetCOT score's good model discrimination, the predictive abilities of the score must be evaluated with respect to the goals of score calculation. Accordingly, consideration should be given to the risk probability cut-off value employed and the associated changes in the sensitivity and specificity of the model. For cases in which the predicted mortality risk might serve as an aid for deciding between continued medical intervention and the election of euthanasia, higher specificity should be sought to minimize false-positive rates and avoid unwarranted classification of patients to poor prognoses. For these cases, a higher risk probability cutoff such as 0.5 could be chosen. Contrarily, if the predicted mortality risk is to be utilized to guide triage of patients and to identify patients that may require more immediate attention due to a potential higher risk of mortality, higher sensitivity may be considered more important in order to minimize false-negative rates. In these cases, lower risk probability cutoffs, such as 0.1 or 0.05, could be considered.

Several exclusion criteria were applied to define the population in this study that merit discussion. First, animals presenting with an elapsed time >24 h since the trauma event were excluded. This was done in order to develop a score that is applicable to the acute trauma population but also to avoid the model being overinfluenced by the large referral subpopulation of stable dogs being referred solely for orthopedic management of appendicular fractures or lameness. Second, dogs presenting for management of porcine quilling events were excluded. Although technically this is a traumatic injury, the trauma is typically minor unless quill migration occurs. This, however, takes place often days to weeks after the primary event. This clinical latency is atypical compared to most other types of traumatic injury and was the reason for exclusion from the study. Finally, the exclusion of dogs that did not have a lactate or ionized calcium performed likely restricted the study population to patients with a higher level of illness severity compared to the general population.

Several limitations were present in this study. Although the data used for model construction were entered contemporaneously into the registry, entry was performed by multiple registry contributors from multiple centers, and data entry consistency could not be assessed. Laboratory methods were unknown and likely varied between centers with inconsistency between whether samples were collected before or after resuscitation. For the head or spinal trauma variables, only the presence or absence of injury was entered, and the exact descriptions or specifics of the head or spinal trauma, such as the type of injury, severity, or whether these injuries were confirmed by advanced imaging modalities, were not recorded. Finally, and likely of greatest importance, the performance of the VetCOT model was not externally validated in this study, and thus the measures of performance reported may be inflated compared with those that would be identified on a new population.

Overall, the VetCOT score provided a rapid and effective method for calculating a risk probability of mortality in this population of canine

trauma patients and performed with comparable discriminatory performance to the ATT score, with improved calibration. Further prospective studies evaluating the use of the VetCOT score in other canine trauma patient populations should be conducted to validate the predictive ability of the score.

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## CONFLICT OF INTEREST

The authors declare no conflict of interest.

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## ENDNOTES

<sup>a</sup> Stata 15.0, StataCorp, College Station, TX.

<sup>b</sup> VetCOT-Registry subcommittee writing group. ACVECC-Veterinary Committee on Trauma (VetCOT) registry report 2013–2017. *J Vet Emerg Clin Care*. 2018;28(6):489–652.

<sup>c</sup> Paul A, Harris PA, Robert Taylor R, et al. Research electronic data capture (REDCap): a metadata-driven methodology and workflow process for providing translational research informatics support. *J Biomed Inform*. 2009 Apr;42(2):377–381.

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