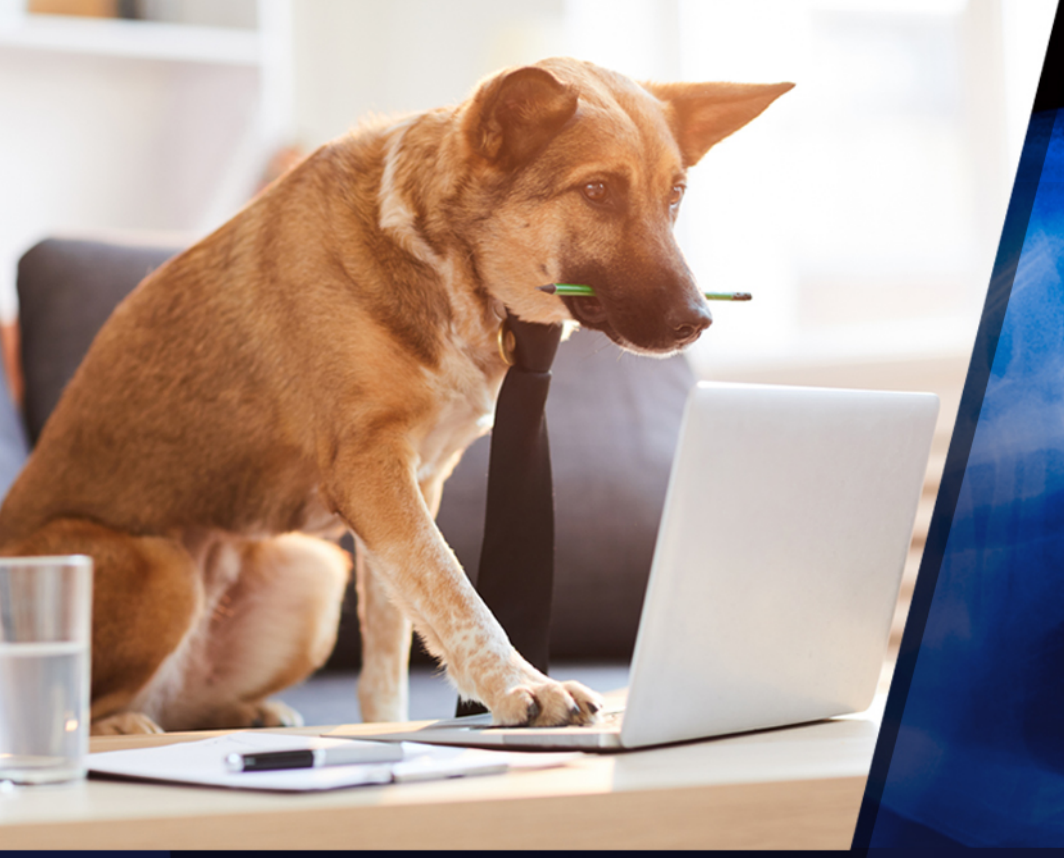

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BRIEF CLINICAL COMMUNICATION

Journal of Veterinary Emergency and Critical Care

WILEY

The pattern of mortality in dogs with gastric dilatation and volvulus

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Abstract

Introduction: The primary study objective was to characterize the pattern of in-hospital mortality in dogs with gastric dilatation and volvulus (GDV), with a focus on preoperative nonsurvival.

Materials and Methods: A retrospective review of medical records from a 10-year period was undertaken at a university teaching hospital. Data collected included signalment, physical examination parameters at hospital presentation, blood lactate concentration, and outcome.

Results: A total of 498 dogs were included. Overall, 319 (64.1%) survived to discharge and 179 (35.9%) were nonsurvivors. Of the nonsurvivors, 149 (31.3% of all dogs) were euthanized and 30 (6%) died. Of those dogs euthanized, the majority (n = 116) were euthanized at the time of hospital presentation prior to surgery (ie, without intent to treat). When dogs that were euthanized prior to surgery were excluded, 83.5% of dogs survived to discharge. Median group age was higher in those euthanized than in the group of dogs that survived to discharge.

Conclusions: Preoperative euthanasia and hence nonsurvival without intent to treat accounted for the majority of GDV mortality in this study. Given the high rate of nonsurvival without intent to treat it is likely that efforts focused at disease prevention will ultimately affect a much greater improvement in overall disease mortality than those focused on improving treatment.

KEYWORDS

canine, critical care, emergency medicine, euthanasia, GDV, torsion

1 | INTRODUCTION

Gastric dilatation and volvulus (GDV) is a common condition in large and giant breed dogs with a documented mortality rate of 9.8-23.4% with intent to treat.[1–11] The onset of clinical signs attributable to GDV is acute, such that dogs with GDV usually present urgently. Given the recommendation for emergency surgery in dogs with GDV and the grave prognosis without surgical intervention, owners are faced with making an unexpected decision to send their dog to surgery or consider euthanasia. Complicating this decision-making is the relatively high cost of surgery and perioperative care, and the risk of perioperative complications that may result in nonsurvival despite a decision to treat. While the mortality rate of GDV has been documented in cases where treatment is chosen (ie, intent to treat),[1–10] most previous studies have excluded cases without intent to treat. As such, the overall mortality rate of GDV is poorly described but likely better represents the true burden of disease.[12] A recent cross-sectional study of dogs presenting alive with presumptive GDV to first-opinion emergency-care practices in the United Kingdom documented an overall mortality rate of 50.3%.[11] There are no reports of overall mortality of GDV in dogs in the United States. Understanding the true burden of disease is important so as to guide resource allocation to the study of GDV and education regarding disease prevention.

The primary objective of this study was to characterize the pattern of in-hospital mortality in dogs with GDV, with a focus on preoperative nonsurvival. The secondary objective was to determine whether there was any pattern in signalment or presenting vital signs that might explain an owner's choices for preoperative euthanasia. We

Abbreviations: EMR, electronic medical record; GDV, gastric dilatation and volvulus.

hypothesized that euthanasia without intent to treat would account for the majority of in-hospital nonsurvival from GDV and that older dogs would be more likely to be euthanized without the intent to treat.

2 | METHODS

For this retrospective study, the medical records of the Foster Hospital for Small Animals at the Tufts Cummings School of Veterinary Medicine were searched for dogs with confirmed GDV. The search period was from September 2001 to April 2011 inclusive. The search terms "GDV," "Gastric dilatation and volvulus," and "Gastric dilatation-volvulus" were used to search the electronic medical record (EMR) system. The EMR search was performed in May 2011, and the duration of the search period was determined by the duration of EMR at this institution. Medical records were subsequently manually reviewed by 1 of 3 authors (CRS, EF, EJB) to ensure that a definitive diagnosis of GDV had been made; this was done by review of radiology reports. A radiographic diagnosis of GDV was made on the basis of gastric dilatation with gastric volvulus on a right lateral abdominal radiograph reported by a board-certified veterinary radiologist. Medical records were reviewed and data collected into a standardized data collection sheet. Data were subsequently transferred into a computerized spreadsheet. Data collected included signalment information (age, sex, breed), objective physical examination parameters at the time of hospital presentation (body weight, temperature, heart rate), blood lactate concentration, and outcome. Additionally, it was noted as to whether or not dogs were receiving medication chronically as an indicator of the presence and severity of underlying chronic disease. Outcome was classified as survived to discharge or nonsurvival. Nonsurvival was further classified as died or euthanized, differentiating between death/euthanasia preoperatively, intraoperatively, or postoperatively. Lack of intent to treat was denoted based on preoperative euthanasia. Intent to treat was denoted by owner consent for surgery. When present in the medical record or client communication log, the reason for euthanasia was recorded.

Data were evaluated using commercially available software.* For the descriptive statistics, continuous variables were reported as median and range. Differences in distribution of continuous patient parameters were assessed among groups using Kruskal–Wallis analysis of variance, followed by pairwise comparisons with Bonferroni correction for multiple tests and reporting of adjusted significance. The chi-square test or Fisher's exact test were used to compare categorical data, followed by post hoc *z* tests. A *P*-value of < 0.05 was considered statistically significant.

3 | RESULTS

A total of 498 dogs with a confirmed diagnosis of GDV were included in the study. Greater than 50 individual dog breeds were represented. German Shepherd Dog was the most frequently represented purebred dog (20.9%), followed by mixed breed dog (13.1%), and Great Dane (9.6%).

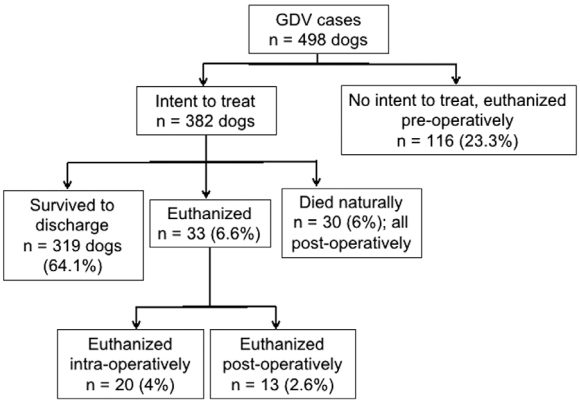

FIGURE 1 Outcome of dogs with GDV presenting to a veterinary teaching hospital. Percentages represent the percentage of all 498 dogs in that outcome category. GDV, gastric dilatation and volvulus; n, number

The outcome of all dogs with GDV is displayed in Figure 1. Overall, 319 (64.1%) survived to discharge, and 179 (35.9%) were nonsurvivors. Of the nonsurvivors, 149 (31.3% of all dogs) were euthanized, and 30 (6%) died. Of those dogs euthanized, the majority (116 [23.3% of all dogs]) were euthanized at the time of hospital presentation, prior to surgery (ie, without intent to treat). Fewer were euthanized intraoperatively (20 dogs = 4% of all dogs) or postoperatively (13 dogs = 2.6% of all dogs). All natural deaths occurred postoperatively. As such, 5 outcome groups were characterized: survived to discharge, euthanized preoperatively, euthanized intraoperatively, euthanized postoperatively, and died. When those dogs that were euthanized prior to surgery were excluded, 83.5% of dogs taken to surgery survived to discharge.

Of the 116 dogs euthanized preoperatively, the reason(s) for euthanasia were documented in 75 cases (~65%). Of these, the medical records of 53 cases mentioned one single reason for euthanasia, while 22 recorded multifactorial considerations that led to euthanasia. The reasons for preoperative euthanasia are documented in Table 1. Cost was the most common single reason for euthanasia, noted as the sole reason in 29 cases, followed by concurrent disease ($n = 10$), age ($n = 8$), and prognosis ($n = 6$). Including those cases with multiple reasons noted for euthanasia, cost was mentioned in 40 cases, age in 26, concurrent disease in 21, and prognosis in 13.

Age was recorded for 495 (99.4%) of dogs. The median (range) age of all dogs was 9.01 years (0.15–17.01). Age is displayed in Table 2 and Figure 2 by outcome group. Age was significantly different among the 5 outcome groups ($P < 0.001$). Pairwise comparisons revealed that dogs that were euthanized preoperatively and postoperatively were older than dogs that survived to discharge ($P < 0.001$, $P = 0.008$). Dogs that were euthanized postoperatively were significantly older than dogs that were euthanized preoperatively ($P = 0.008$).

Neutered males were most common (n = 245; 49%), followed by spayed females (n = 179; 36%). Fewer were sexually intact males (n = 54; 11%) and females (n = 20; 4%). Sex distribution by outcome group is displayed in Table 2. Sex was not significantly different among outcome groups (χ 10.085, *df* 12, $P = 0.608$).

TABLE 1 Reasons for preoperative euthanasia in dogs presenting with gastric dilatation and volvulus. The table is ordered from most common to least commonly cited reason for euthanasia

Reason for euthanasia	Number of dogs
Single reason cited for euthanasia	
Cost	29
Concurrent disease	10
Age	8
Prognosis	6
Multiple reasons cited for euthanasia	
Concurrent disease + age	7
Age + cost	6
Age + prognosis	2
Age + prognosis + concurrent disease	2
Cost + concurrent disease	2
Cost + prognosis	2
Cost + prognosis + age	1
Total dogs with reason for euthanasia documented	75

Body weight was recorded for 374 dogs (75.1%). The median body weight was 37.2 kg (range, 9.0–94.1). Body weight data by outcome group are displayed in Table 2; body weight distribution ($P = 0.415$) was not different among outcome groups.

One hundred of the dogs (20%) were receiving medications chronically for underlying diseases at the time of their hospital visit; these data are displayed by outcome group in Table 2. Whether or not dogs were receiving medication chronically was different among outcome groups (χ 15.261, $P = 0.003$); however, post-hoc tests with Bonferroni correction failed to achieve statistical significance when comparing column proportions.

Presenting temperature was recorded for 363 dogs (72.9%). Median (range) temperature is displayed in Table 2 and Figure 3 by outcome group. Presenting temperature was significantly different among the 5 outcome groups ($P = 0.030$); however, post hoc tests with Bonferroni correction failed to achieve statistical significance in pairwise comparisons.

Presenting heart rate was recorded for 425 dogs (85.3%). The median (range) heart rate of all dogs was 164/min (20–290). Median (range) heart rate is displayed in Table 2 and Figure 4 by outcome group. Presenting heart rate was significantly different among the 5 outcome groups ($P = 0.009$). Dogs that survived to discharge had a significantly lower presenting heart rate than dogs that were euthanized preoperatively ($P = 0.008$), but no other differences were observed in heart rate among groups.

Presenting blood lactate concentration was measured for 429 dogs (86.1%). The median (range) lactate concentration for all dogs was 4.4 mmol/L (0.5–20.0 mmol/L) (39.6 mg/dL [4.5–180 mg/dL]). Note that 20 mmol/L represents the upper limit of detection of the analyzers used. Lactate data are displayed by outcome group in Table 2 and Figure 5. Presenting blood lactate concentration concentration ($P < 0.001$) was significantly different among the 5 outcome groups. Dogs that were euthanized preoperatively, euthanized intraoperatively, and died postoperatively had a significantly higher presenting blood lactate concentration than dogs that survived to discharge ($P < 0.001$ for each comparison).

TABLE 2 Comparison of select patient parameters with outcome group in dogs presenting with gastric dilatation and volvulus. Results are displayed as group median (range). Adjusted *P*-values compare individual outcome groups to the survived to discharge group

	Survived to discharge ($n = 319$)	Euthanized preoperatively ($n = 116$)	Euthanized intraoperatively ($n = 20$)	Euthanized postoperatively ($n = 13$)	Died postoperatively ($n = 30$)
Age (years) $n = 495$	8.01 (0.48-15.44)	10.51 (0.15-17.01) $P < 0.001$	10.07 (2.02-15.01) $P = 0.106$	11.21 (5.84-14.01) $P = 0.008$	9.01 (2.0-12.67) $P = 1.000$
Sex $n = 498$	165 MN 35 MI 106 FS 13 FI	54 MN 11 MI 48 FS 3 FI	10 MN 2 MI 6 FS 2 FI	4 MN 3 MI 6 FS 0 FI	12 MN 3 MI 13 FS 2 FI
Body weight (kg) $n = 374$	37.7 (9-94.1)	38.0 (9.9-76.0)	35.0 (10-69.6)	33.75 (27.0-58.0)	30.0 (18.0-64.5)
Chronic medications $n = 498$	No 243 Yes 76	No 102 Yes 14	No 15 Yes 5	No 9 Yes 4	No 29 Yes 1
Temp, °C [°F] $n = 363$	38.3 (35.1-41.1) [101.0 (95.1-106)]	38.4 (33.1-41.8) [101.2 (91.6-107.3)] $P = 1.000$	37.8 (34.1-40.8) [100 (93.4-105.5)] $P = 0.075$	37.8 (34.6-39.6) [100 (94.3-103.2)] $P = 1.000$	37.7 (33.3-40.4) [99.9 (92-104.8)] $P = 1.000$
Heart rate (beats/min) $n = 425$	160 (20-290)	180 (49-280) $P = 0.008$	175 (75-280) $P = 1.000$	112 (180-270) $P = 1.000$	180 (45-250) $P = 1.000$
Lactate, mmol/L [mg/dL] $n = 429$	3.7 (0.5-20) [33.3 (4.5-180)]	6.1 (1.5-19.4) [55 (13.5-175)] $P < 0.001$	8.15 (2.7-15.7) [73.4 (24.3-141) $P < 0.001$	5.65 (2.1-16.5) [50.9 (18.9-149)] $P = 0.220$	10.1 (1.6-19) [91.0 (14.4-171)] $P < 0.001$

FI, female intact; FS, female spayed; MI, male intact; MN, male neutered; n, number.

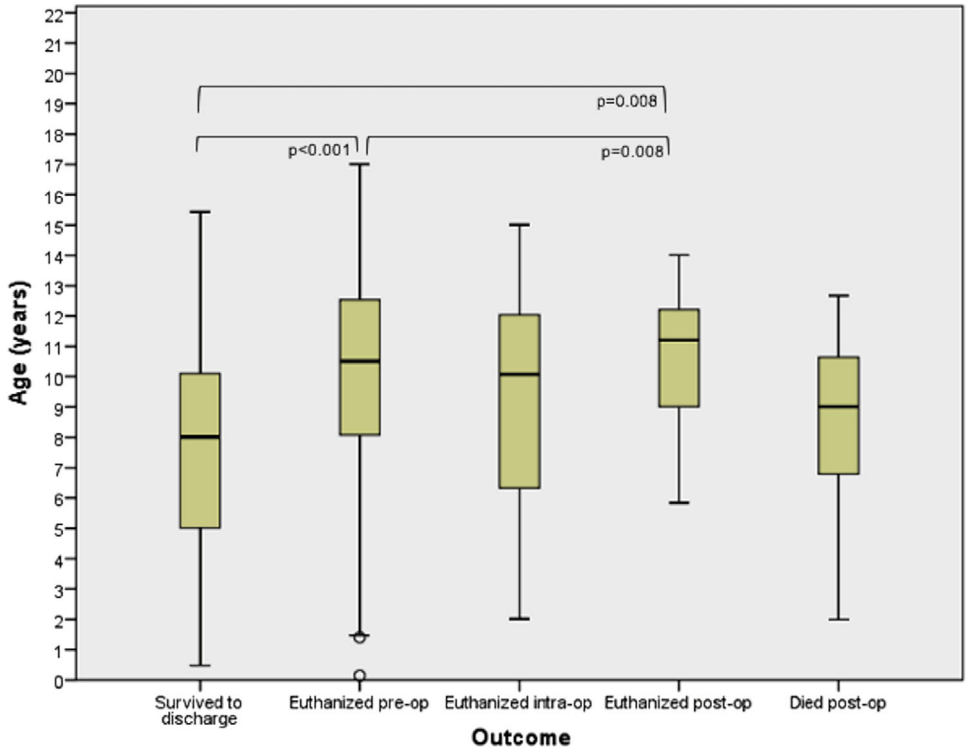

FIGURE 2 Box and whisker plot comparing age among outcome groups of dogs presenting with gastric dilatation and volvulus. Dogs that were euthanized preoperatively and postoperatively were older than dogs that survived to discharge ($P < 0.001$, $P = 0.008$). Dogs that were euthanized postoperatively were significantly older than dogs that were euthanized preoperatively ($P = 0.008$). op, operatively

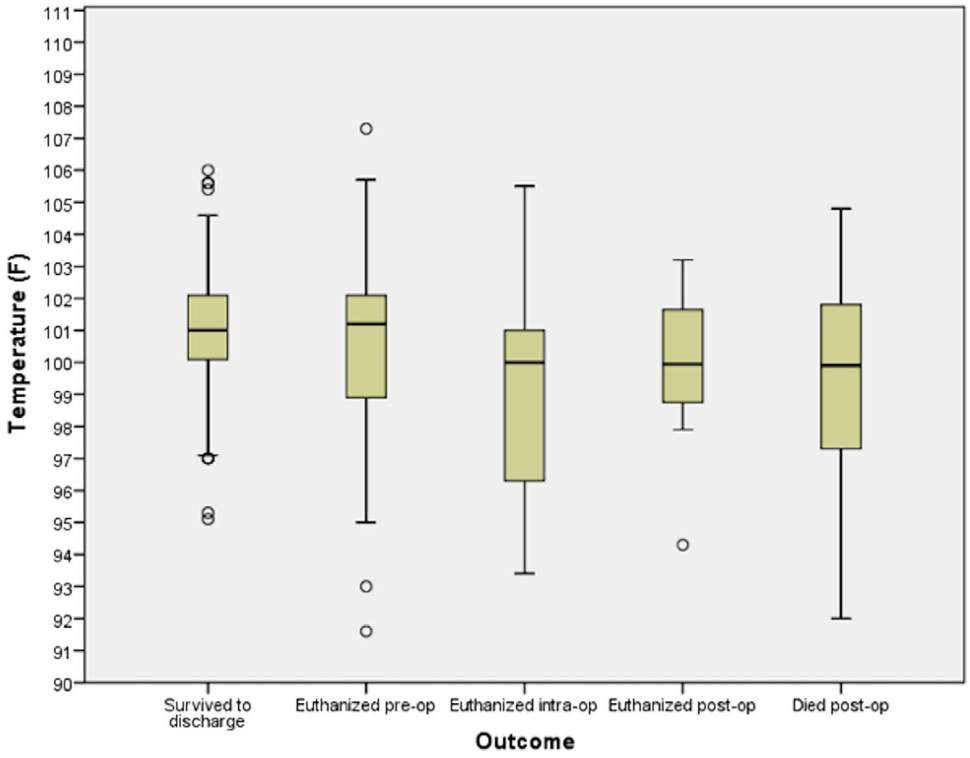

FIGURE 3 Box and whisker plot comparing body temperature (in °F) at the time of presentation among outcome groups of dogs presenting with gastric dilatation and volvulus. op, operative

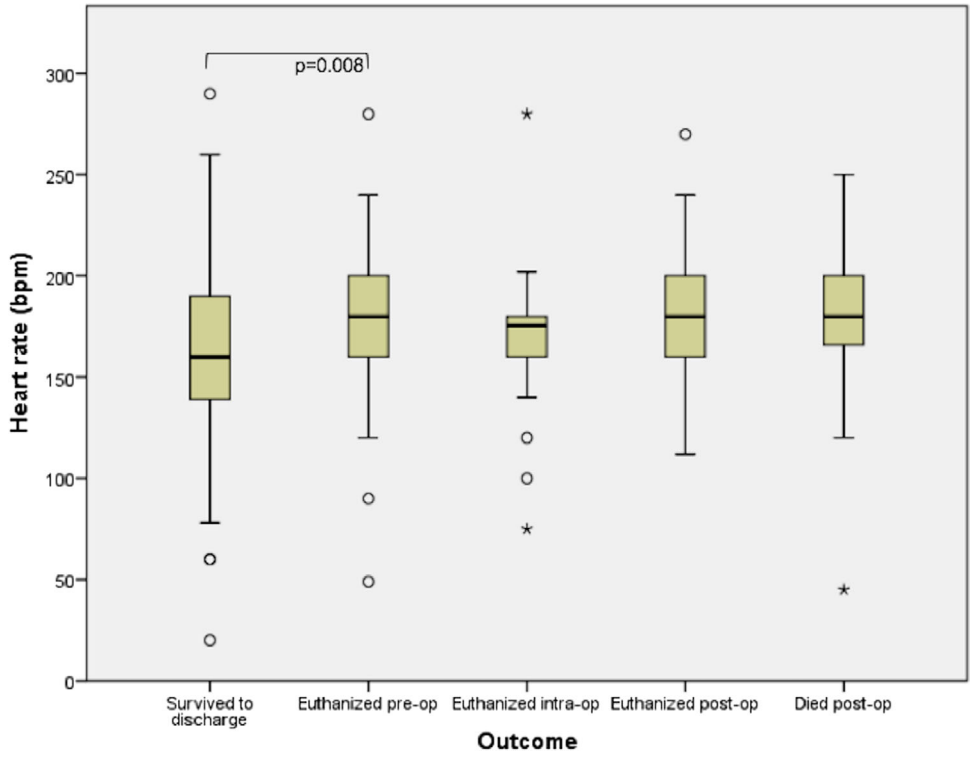

FIGURE 4 Box and whisker plot comparing heart rate (in beats/min) at the time of presentation among outcome groups of dogs presenting with gastric dilatation and volvulus. Dogs that survived to discharge had a significantly lower presenting heart rate than dogs that were euthanized preoperatively ($P = 0.008$). bpm, beats/min; op, operative

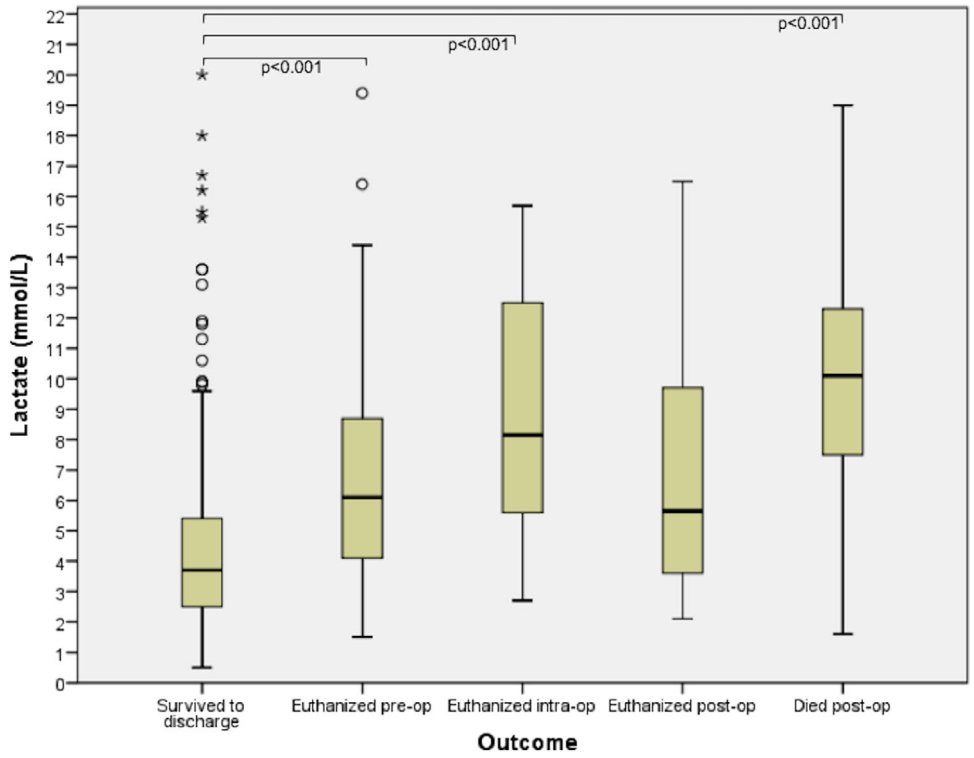

FIGURE 5 Box and whisker plot comparing blood lactate concentration (in mmol/L) at the time of presentation among outcome groups of dogs presenting with gastric dilatation and volvulus. Dogs that were euthanized preoperatively, euthanized intraoperatively, and died postoperatively had a significantly higher presenting lactate concentration than dogs that survived to discharge ($P < 0.001$ for each comparison). op, operative

4 | DISCUSSION

The majority of mortality in dogs with GDV in this study was attributable to preoperative euthanasia and consistent with a lack of client intent to treat. This study is unique in its inclusion of dogs euthanized without intent to treat and thereby improves our understanding of the true nonsurvival rates associated with GDV in dogs. The considerable nonsurvival rate (35.9%) reported here reinforces the need for ongoing resource allocation to research efforts to better understand the etiology of GDV and investigation of improved methods of prevention.

The population of dogs reported herein is similar to previous studies on GDV with regard to the reported age, sex, and breed distribution.[1–10,13] The authors believe that the study population is also comparable since the survival rate for dogs with intention to treat was 83.5%, which is similar to previous studies reported in the veterinary literature.[1–10]

Age, presenting body temperature, presenting heart rate, and presenting blood lactate concentration were significantly different among outcome groups. Consistent with our hypothesis, and the frequent owner reporting of age as either a sole reason for or contributor to the decision for preoperative euthanasia, dogs that were euthanized preoperatively were significantly older than dogs that survived to discharge. This is perhaps not surprising when considering that the median age of dogs with GDV in this study would be considered geriatric for many of the breeds included. Although the need for chronic medication was not associated with outcome in this study, many owners cited age and the presence of concurrent disease as either sole reasons for or contributors to the decision for euthanasia. This apparent discrepancy may be due to type II error and the statistical methods chosen. Specifically, the use of Bonferroni correction for multiple comparisons may result in failure to identify an association that is truly there. A larger study, particularly with more dogs in the nonsurvival outcome groups would be required to further evaluate the potential for an influence of requirement for chronic medications on outcome.

In a retrospective study such as this, elucidating why presenting heart rate was associated with outcome is not possible. The lower presenting heart rate in survivors compared to dogs euthanized preoperatively may suggest less severe shock. However, due to the retrospective nature of the study and because other factors such as pain and the presence of arrhythmias can also affect heart rate, it is unlikely that this factor alone independently influenced the decision for preoperative euthanasia.

Many previous studies have evaluated the prognostic significance of plasma lactate concentration in dogs with GDV.[1,4,6,7,9] The finding in our study that 3 of the groups of nonsurvivors had significantly higher lactate concentrations at presentation is thus not surprising. That being said, there were many dogs in the group of survivors that also had extremely high lactate concentrations (including at the upper limit of detection of the analyzer of 20 mmol/L), and thus marked hyperlactatemia should not be a reason to provide a poor prognosis or recommend euthanasia in a dog with GDV. While serial lactate concentration may be a more useful prognostic indicator than a single lactate measurement in population based studies,[4,9] and many dogs in this study had serial lactate measurements performed, analysis of lactate clearance as a prognostic indicator was outside the scope of this study.

There are certain inherent limitations in a single-center retrospective veterinary study such as this. First, the findings in this population of dogs seen at a university teaching hospital in the northeast of the United States cannot necessarily be extrapolated to other populations where owners may be more or less likely to consider euthanasia than those reported here. For example, a recent cross-sectional study of dogs presenting alive with presumptive GDV to first-opinion emergency care practices in the United Kingdom documented a preoperative euthanasia rate of 37% (178/481 dogs) compared to 23.3% in the study reported here.[11] Potential reasons for this difference include differences in client expectations between countries/regions, variation in client financial capability between countries/regions, different veterinary settings, and inclusion of presumptive versus confirmed cases of GDV. In both studies, the incomplete documentation of reasons for euthanasia makes assessment challenging, particularly preoperatively. Additionally, when prognosis is cited as a reason for euthanasia, it was not always clear what the discussion involved between the clients and the clinician. How different clinicians use clinically available data, such as age, heart rate, and presenting lactate concentration to make a clinical assessment of the patient and discuss prognosis with the client cannot generally be elucidated from retrospectively reading an EMR. Another limitation that became apparent during statistical analysis was that although this was quite a large veterinary study, the numbers of dogs in some outcome groups (ie, euthanized intraoperatively, euthanized postoperatively, and died postoperatively) were relatively small and thus may have precluded identification of significant difference between groups, particularly in pairwise comparisons. Additionally, there were missing data for some baseline vitals in the medical records that further reduced sample size for some analyses. Type II error is particularly likely for those statistical analyses (chronic medications, temperature) where a difference was detected among groups but pairwise comparisons with Bonferroni correction failed to identify differences between groups. The somewhat stringent process of Bonferroni correction for multiple comparisons reduces the likelihood of type I error but increases the type II error rate.

As mentioned above, it is also likely that the requirement for a definitive diagnosis of GDV by radiography resulted in the exclusion of some dogs that were euthanized without intent to treat, where a presumptive diagnosis of GDV was made based on history and physical examination, further underestimating the proportion of dogs euthanized pre-operatively. The authors of this study preferred a definitive diagnosis of GDV for inclusion; however, a recent study included both confirmed and presumptive cases of GDV.[11] Additionally, the current study did not account for out-of-hospital death due to GDV.

In conclusion, this study documented that preoperative euthanasia accounts for the majority of the mortality associated with GDV in dogs. Although surgical intervention with perioperative care leads to >80% survival, disease prevention could ultimately affect a greater improvement in survival rates.

CONFLICT OF INTERTEST

The authors declare no conflict of interest.

ENDNOTE

* IBM SPSS for Windows, Version 21.0, IBM Corporation, Armonk, NY.

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