DOI: 10.1590/1809-6891v24e-74401E

Ciência Animal Brasileira
Brazilian Animal Science

e-ISSN 1809-6891

Section: Veterinary medicine
Research article

Clinical and laboratory indicators predictive of the negative outcome of gastrointestinal emergencies in cattle

Indicadores clínicos e laboratoriais preditivos do desfecho negativo de emergências gastrointestinais em bovino

Gliére Silmara Leite Soares[1*], José Augusto Bastos Afonso[2], Luiz Teles Coutinho[2], Rodolfo José Cavalcanti Souto[2], Nivan Antônio Alves da Silva[2], Ângela Imperiano da Conceição[1], Jean Carlos Ramos Silva[1], Carla Lopes de Mendonça[2]

[1]Universidade Federal Rural de Pernambuco (UFRPE), Recife, Pernambuco, Brazil.
[2]Universidade Federal Rural de Pernambuco, Clínica de Bovinos de Garanhuns (UFRPE/CBG), Garanhuns, Pernambuco, Brazil.
*Corresponding author: glieresilmara@hotmail.com

Abstract
This study aimed to identify clinical and laboratory variables that could help predict the negative outcome in cattle affected by gastrointestinal emergencies. A retrospective cohort study was carried out using multivariate logistic regression analysis based on data collected from the clinical records of cattle hospitalized at the Garanhuns Bovine Clinic, UFRPE *campus*. One hundred and twenty-two cattle met the inclusion criteria established for the study. Among the clinical variables, heart rate (HR) and abdominal distension are associated with the outcome in animals with right displaced abomasum (RDA), and anorexia and 10% dehydration in animals with an obstructive intestinal disorder. Among the laboratory variables, plasma fibrinogen (PF) and total leukocyte count were associated with the outcome in animals with RDA, while PF and plasma L-lactate were associated with animals with an obstructive intestinal disorder. HR and the total leukocyte count remained in the final model of the regression adjusted for animals with RDA. On the other hand, plasma L-lactate and PF remained in the final model in the adjusted model for animals with an obstructive intestinal disorder. Cattle with RDA and HR higher than 90 bpm present an increased chance of having a negative outcome whereas cattle with obstructive intestinal disorder and plasma L-lactate higher than 1.84 mmol/L or PF higher than 850 mg/dL have a higher chance of not survive. Therefore, clinical and laboratory variables such as HR, fibrinogen, and plasma L-lactate are useful to predict the negative outcome in cattle with gastrointestinal emergencies, especially RDA and obstructive intestinal disorders.
Keywords: biomarkers; gastrointestinal disease; prognostic factor.

Resumo
Este estudo teve como objetivo identificar variáveis clínicas e laboratoriais que pudessem ajudar a predizer o desfecho negativo em bovinos acometidos por emergências gastrointestinais. Foi realizado um estudo de coorte retrospectivo por meio de análise de regressão logística multivariada com base em dados coletados dos prontuários de bovinos internados na Clínica de Bovinos de Garanhuns, campus da UFRPE. Cento e vinte e dois bovinos atenderam aos critérios de inclusão estabelecidos para o estudo. Dentre as variáveis clínicas, a frequência cardíaca e a distensão abdominal estão associadas ao desfecho em animais com deslocamento de abomaso à direita (DAD), e anorexia e 10% de desidratação em animais com distúrbio intestinal obstrutivo. Entre as variáveis laboratoriais, o fibrinogênio plasmáticao (FP) e a contagem total de leucócitos foram associados ao desfecho em animais com DAD, enquanto o FP e o L-lactato plasmático foram associados a animais com distúrbio intestinal obstrutivo. A frequência cardíaca (FC) e a contagem total de leucócitos permaneceram no modelo final da regressão ajustada para animais com DAD. Por outro lado, o L-lactato plasmático e o FP permaneceram no modelo final ajustado para animais com distúrbio intestinal obstrutivo. Bovinos com DAD e FC maior que 90 bpm apresentam maior chance de ter um desfecho negativo, enquanto bovinos com distúrbio intestinal obstrutivo e L-lactato plasmático maior que 1,84 mmol/L ou FP maior que 850 mg/dL têm maior chance de não sobreviver. Portanto, variáveis clínicas e laboratoriais como FC, FP e L-lactato plasmático são úteis para predizer o desfecho negativo em bovinos com doenças emergências gastrointestinais, especialmente DAD e distúrbios intestinais obstrutivos.
Palavras-chave: biomarcadores; doença gastrointestinal; fator prognóstico

1. Introduction

Abdominal emergencies represent a large part of the clinical situations that cattle veterinarians often face in their routine. An abdominal emergency can be defined as a process or disease of the abdominal cavity that often manifests with acute clinical signs and can be potentially fatal for the affected animal[(1)].

A variety of diseases that affect the rumen,

Received: October 25, 2022. Accepted: February 27, 2023. Published: March 21, 2023.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License, which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

abomasum, and intestines can result in acute and emergency clinical conditions in cattle[1,2]. These clinical conditions are often characterized by varying degrees of abdominal distension, gastrointestinal motility disorders, decreased or complete absence of feces, anorexia, and different degrees of dehydration[3-7]. The failure rate in the treatment of these illnesses varies according to the severity of the clinical condition, but it can vary between 19% and 73% according to the different illnesses, considering the authors' experience[8]. Therefore, establishing parameters (clinical or blood) before treatment to assist in reliably predicting the therapeutic feasibility and prognosis after using the therapy is important.

The adjustment of models to predict patient outcomes based on multiple clinical variables and/or blood markers has become increasingly frequent in cattle medicine, but studies with right abomasal displacement and abomasal volvulus have been the pioneers and the most frequent[9-12]. This type of study has already been carried out for some clinical entities in cattle[13-15]. However, these models are scarce or absent in the literature for other digestive disorders of an emergency nature, in addition to displacement and abomasal volvulus. Thus, this study aimed to identify possible clinical and laboratory variables to assist in predicting the prognosis of cattle affected by emergency digestive diseases.

2. Materials and methods

A retrospective cohort study was carried out based on the analysis of the clinical records of cattle hospitalized at the Garanhuns Bovine Clinic, Federal Rural University of Pernambuco *campus* (CBG–UFRPE), from January 2012 to July 2020. Cattle with a clinical diagnosis of ruminal lactic acidosis, frothy bloat, right displaced abomasum (RDA), obstructive intestinal disorder, and cecum dilation, which are considered of an emergency nature in clinical routine, were considered eligible for the study. The measurement of plasma L-lactate before the establishment of any therapeutic procedure was considered an inclusion criterion for the study. On the other hand, the indication for slaughter was considered an exclusion criterion. The diagnosis of diseases was established through clinical examination[16] and complementary examinations, such as analysis of ruminal fluid[16], blood count, determination of total protein and plasma fibrinogen[17], and ultrasound examination[18]. Animals that died naturally or were euthanized, authorized by the owner, were submitted to necropsy.

The information collected from the medical records included clinical data regarding the general status of the animals (appetite, degree of dehydration, and heart rate) and specific examination of the digestive system (abdominal shape and tension, peristalsis and ruminal stratification, and presence of feces), in addition to laboratory data (Packed cell volume - PCV, total plasma protein – TPP, plasma fibrinogen – PF, total leukocytes, segmented and rod neutrophils, and plasma L-lactate). Other information included the clinical outcome of the animal observed during the hospital stay (discharge, natural death, or euthanasia). The outcome was considered positive (PO) when the animal was discharged from the hospital after the therapeutic procedure, while the negative outcome (NE) included animals that died naturally and those euthanized during the hospital stay. For data analysis, the animals were grouped based on the outcome, positive or negative, for each disease category.

Univariate analysis was applied to determine possible factors associated with the outcome in each disease category. To this end, the categorical independent variables were dichotomized to be described by frequencies and compared using Pearson's chi-square test or Fisher's exact test, when the expected frequency was lower than five in at least one of the cells in the 2 x 2 contingency table, considering the significance level of $p<0.10$. Quantitative independent variables were described using the median and 1st and 3rd quartiles (Q1 and Q3) and compared using the nonparametric Mann-Whitney U test at a 5% significance level.

The predictive ability of the variables that showed significance in the univariate analysis was assessed by constructing the receiver operating characteristic (ROC) curve. It included the calculation of the area under the curve (AUC), the 95% confidence interval of the AUC, the sensitivity (SE), specificity (SP), and positive (PPV) and negative predictive values (NPV). The value that offered the highest sum between sensitivity and specificity to predict the negative outcome was maintained as the best cutoff value to be included in the multivariate analysis.

Diagnostic tests can be distinguished based on the calculation of the area under the curve (AUC) into imprecise (AUC $\leq$ 0.50), poorly precise (AUC between 0.50 and 0.70), moderately precise or satisfactory (AUC between 0.71 and 0.90), and highly precise or perfect (AUC=1.00) [19]. The variables that presented the best areas under the ROC curve (>0.70) were included in the multivariate logistic regression model (backward stepwise). The odds ratio and 95% confidence interval were calculated in this analysis. The goodness of fit of the models was assessed using the Hosmer-Lemeshow test. All analyses were performed using the software IBM SPSS Statistic version 20[20].

3. Results

One hundred and twenty-two out of the total of

130 eligible cattle met the inclusion criteria established for the study. Most animals were crossbred females (n=114; 93.4%), with dairy aptitude (n=88; 72.1%) and aged over 24 months (n=107; 87.7%). Thirty-five animals were diagnosed with an obstructive intestinal disorder, 31 with RDA, 30 with frothy bloat, 17 with cecum dilation, and nine with ruminal lactic acidosis. The overall survival rate for emergency digestive disorders was 63.9% (78/122). The evaluation by disorder revealed a survival rate of 100% for animals with ruminal lactic acidosis, 48% in cases of obstructive intestinal disorders and cecum dilation, 64.5% in cases of RDA, and 80% in cases of frothy bloat.

Six cattle died or had to be euthanized before any therapeutic procedure due to the seriousness of the clinical picture and poor general conditions. In these animals, the diagnosis was made during the necropsy examination. Thirty-eight cattle had a negative outcome after the therapeutic procedure, with two of them being clinically treated and 36 undergoing a surgical procedure (Figure 1). The median length of stay was 3 days (1.0–9.3) for animals that had a negative outcome and 7 days (5.0–9.0) for those that had a positive outcome.

The univariate analysis showed that abdominal distension (p=0.049) in animals with RDA and lack of appetite (p=0.032) and 10% dehydration (p=0.036) in animals with an obstructive intestinal disorder were the categorical variables associated with the negative outcome (Table 1). On the other hand, heart rate (HR), PF , and total leukocyte count in animals with RDA and PF and plasma L-lactate in animals with an obstructive intestinal disorder were the quantitative variables associated with the outcome (Table 2). The studied variables showed no association with the outcome in animals with frothy bloat and cecum dilation. The group of animals with ruminal lactic acidosis was excluded from subsequent analyses as there was no negative outcome. All quantitative variables with a significant association in the univariate analysis showed satisfactory predictive capacity, with areas under the ROC curve higher than 0.70 (Table 3). The cutoff points established by the ROC curve and predictive values are also shown in Table 3.

Table 4 summarizes the results of the regression models adjusted for data from animals with RDA and obstructive intestinal disorder. Both models fit the dataset satisfactorily based on the Hosmer-Lemeshow test (P>0.05). HR (OR=11.4; CI: 1.04–125.1) and total leukocyte count (OR=5.7; CI: 0.71–45.0) remained in the final model among the independent variables included in the regression model adjusted for animals with RDA. On the other hand, plasma L-lactate (OR=22.8; CI: 1.74–299.4) and plasma fibrinogen (OR=14.2; CI: 1.01–199.5) remained in the final model in the adjusted model for animals with an obstructive intestinal disorder.

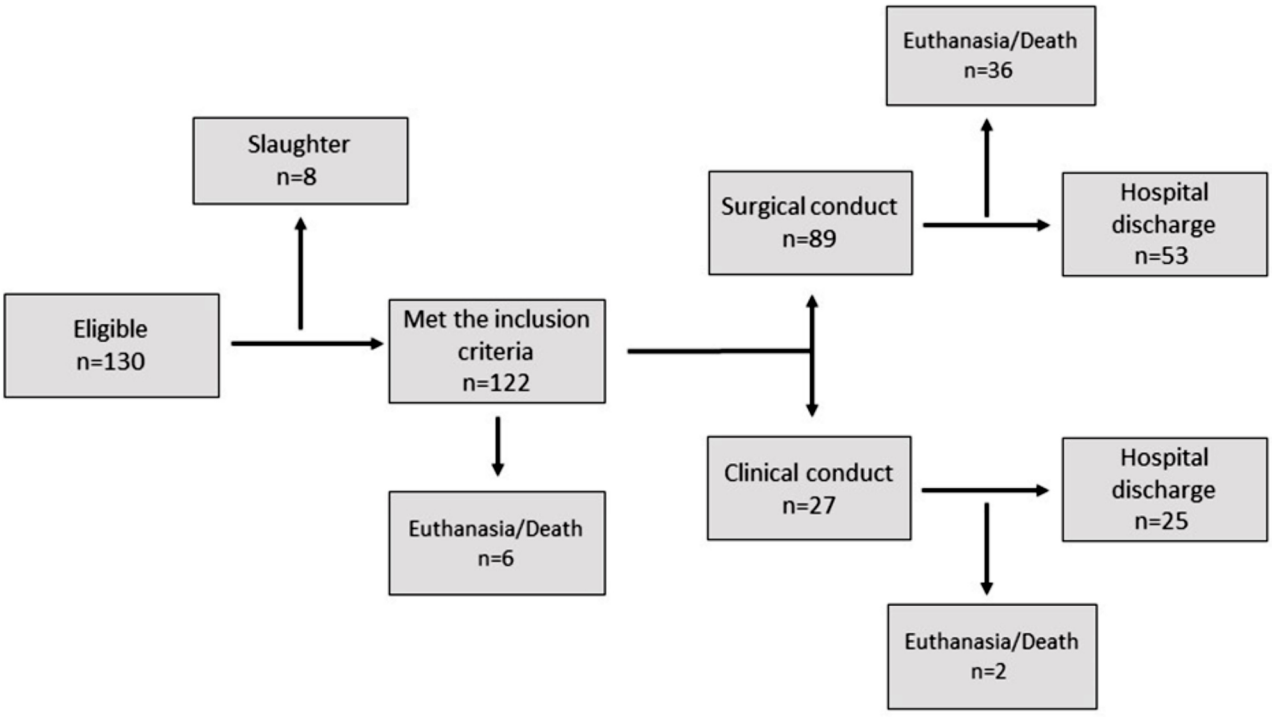

Figure 1. Flowchart illustrating the outcome of cattle affected by emergency digestive diseases.

Table 1. Univariate analysis of categorical clinical variables of cattle with emergency digestive diseases with positive and negative clinical outcomes.

Variable	Frothy bloat		*p*	RDA[a]		*p*	Obstructive intestinal disorder		*p*	Cecum dilation		*p*
	Negative n=6	Positive n=24		Negative n=11	Positive n=20		Negative n=18	Positive n=17		Negative n=9	Positive n=8	
Lack of appetite (%)	50.0(3/6)	21.7(5/23)	*0.304*	55.6(5/9)	36.8(7/19)	*0.432*	75.0(12/16)	37.5(6/16)	*0.032*	66.7(6/9)	37.5(3/8)	*0.347*
10% dehydration (%)	33.3(2/6)	8.3(2/24)	*0.169*	36.4(6/20)	30.0(4/11)	*0.717*	58.8(10/17)	23.5(4/17)	*0.036*	55.6(5/9)	25.0(2/8)	*0.335*
Abdominal distension (%)	100(6/6)	91.7(22/24)	*NA*	88.9(8/9)	47.4(9/19)	*0.049*	81.2(13/16)	73.3(11/15)	*0.685*	88.9(8/9)	62.5(5/8)	*0.294*
Increased abdominal tension (%)	80.0(4/5)	87.5(21/24)	*0.553*	81.8(9/11)	63.2(12/19)	*0.419*	87.5(14/16)	60.0(9/15)	*0.113*	77.8(7/9)	75(6/8)	*0.893*
Indefinite ruminal strata (%)	100(6/6)	100(24/24)	*NA*	90.9(10/11)	70.0(14/20)	*0.372*	87.5(14/16)	70.6(12/17)	*0.398*	66.7(6/9)	75.0(6/8)	*0.707*
Ruminal atony (%)	33.3(2/6)	20.8(5/24)	*0.603*	18.2(2/11)	5.3(1/19)	*0.537*	18.7(3/16)	6.25(1/16)	*0.600*	0(0/8)	12.5(1/8)	*NA*
Absence of feces (%)	–	–	*NA*	–	–	*NA*	28.6(4/14)	6.7(1/15)	*0.169*	37.5(3/8)	12.5(1/8)	*0.569*

NA = not analyzed. [a]Right displaced abomasum.

Table 2. Univariate analysis of quantitative variables (clinical and laboratory) of cattle with emergency digestive diseases

Variable	Outcome	Frothy bloat (n=30)				RDA[a] (n=31)				Obstructive intestinal disorder (n=35)				Cecum dilation (n=17)			
		Q1	Median	Q3	*p*	Q1	Median	Q3	*p*	Q1	Median	Q3	*p*	Q1	Median	Q3	*p*
HR[b] (bpm)	Negative	63.0	70.0	90.0	*0.50*	95.0	106.0	128.0	*0.01*	77.0	98.0	103.0	*0.71*	74.0	80.0	108.0	*0.16*
	Positive	68.0	76.0	92.0		60.0	80.0	100.0		76.0	84.0	102.0		58.0	74.0	83.0	
PCV[c] (%)	Negative	26.0	31.0	32.5	*0.75*	24.5	31.5	38.3	*0.32*	36.0	41.0	45.3	*0.15*	31.0	35.0	39.0	*0.60*
	Positive	26.5	32.0	34.0		30.3	35.0	37.8		35.3	38.0	40.8		29.0	33.0	38.0	
PF[d] (mg/dL)	Negative	400.0	600.0	800.0	*0.58*	675.0	800.0	900.0	*0.01*	600.0	900.0	1000.0	*0.03*	550.0	800.0	950.0	*0.79*
	Positive	500.0	700.0	950.0		500.0	600.0	675.0		475.0	600.0	800.0		500.0	700.0	1000.0	
Total leukocytes ($\times 10^3$ μL^{-1})	Negative	13.8	14.05	16.3	*0.97*	14.67	18.12	27.51	*0.03*	11.42	13.42	22.95	*0.12*	11.22	14.95	24.75	*0.46*
	Positive	10.5	14.35	18.86		9.47	11.75	15.86		9.21	11.10	18.83		10.3	13.55	18.05	
Seg. Neutrophils ($\times 10^3$ μL^{-1})	Negative	5.72	6.98	7.16	*0.77*	3.67	9.17	17.50	*0.20*	6.10	8.97	11.94	*0.13*	6.06	7.79	18.51	*0.27*
	Positive	6.05	6.82	10.73		4.67	5.88	8.98		3.67	5.03	10.12		4.22	5.14	9.21	
Rod neutrophils ($\times 10^3$ μL^{-1})	Negative	0.0	0.0	352.0	*0.34*	118.0	283.0	932.3	*0.30*	134.0	367.0	1125.0	*0.24*	0.0	501.0	2647.0	*0.60*
	Positive	0.0	0.0	0.0		0.0	171.0	517.8		22.5	132.0	696.5		0.0	136.0	613.0	
Plasma L-lactate (mmol L^{-1})	Negative	1.6	1.8	3.2	*0.48*	1.7	3.8	9.4	*0.34*	2.5	4.2	7.3	*0.02*	1.4	1.9	4.1	*0.96*
	Positive	1.1	1.7	2.8		1.1	3.0	4.7		0.9	1.2	4.9		1.0	2.1	5.8	

[a]Right displaced abomasum; [b]Heart rate; [c] Packed cell volume; [d]Plasma fibrinogen.

Table 3. Predictive capacity of the outcome of clinical and laboratory variables of cattle with RDA (n=31) and obstructive intestinal disorder (n=35).

Diagnosis	Variable	AUC[a]	95% CI (AUC)	*p*	*Cut off*	SE[b] (%)	SP[c] (%)	PPV[d] (%)	NPV[e] (%)
RDA[f]	HR[g] (bpm)	0.80	0.64–0.96	0.008	90	90.0	70.0	59.7	93.4
	PF[h] (mg/dL)	0.82	0.65–0.99	0.005	650	80.0	75.0	61.2	71.6
	Total leukocytes ($\times 10^3/\mu L$)	0.74	0.56–0.93	0.031	15275	80.0	75.0	61.2	88.4
	Abdominal distension	0.70	0.51–0.92	0.082	–	89.0	53.0	53.6	88.8
Obstructive intestinal disorder	Plasma L-lactate (mmol/L)	0.74	0.57–0.92	0.014	1.84	94.4	58.8	70.3	91.0
	PF[h] (mg/dL)	0.74	0.56–0.92	0.024	850	58.8	92.9	90.9	65.0
	Lack of appetite	0.69	0.50–0.88	0.070	–	75.0	62.5	66.7	71.4
	10% dehydration	0.68	0.49–0.86	0.079	–	58.8	76.5	63.6	73.0

[a]Area under the ROC curve; [b]Sensitivity; [c]Specificity; [d]Positive predictive value; [e]Negative predictive value; [f]Right displaced abomasum; [g]Heart rate; [h]Plasma fibrinogen.

Table 4. Multivariate analysis of clinical and laboratory variables that remained in the regression model adjusted for cattle with RDA (n=31) and obstructive intestinal disorder (n=35).

Diagnosis	Variable	Coefficient	Odds ratio	95% CI of OR	*p*	Hosmer-Lemeshow	
						X^2	*P*
RDA[a]	Constant	−3.24				1.24	0.538
	HR[b] (bpm)						
	>90	2.43	11.4	1.04–125.1	*0.047*		
	<90	Reference					
	Total leukocytes (×10³/µL)						
	>15275	1.73	5.7	0.71–45.0	*0.101*		
	<15275	Reference					
Obstructive intestinal disorder	Constant	−2.77				2.42	0.298
	Plasma L-lactate (mmol/L)						
	>1.84	3.13	22.8	1.74–299.4	*0.017*		
	<1.84	Reference					
	PF[c] (mg/dL)						
	>850	2.65	14.2	1.01–199.5	*0.049*		
	<850	Reference					

[a]Right displaced abomasum; [b]Heart rate; [c]Plasma fibrinogen.

4. Discussion

Publications on clinical or laboratory prognostic factors for digestive diseases considered to be emergency in adult cattle have not been widely developed previously, except studies on right displaced abomasum and abomasal volvulus, which have been carried out for decades[9-12], and the research carried out recently by Giertzuch et al.[21], who evaluated the prognostic value of plasma L-lactate in cows with a wide spectrum of acute abdominal emergencies, but with no clinical variables.

Abdominal distension, inappetence, and 10% dehydration were not included in the regression model although they presented a significant association with the outcome and an area under the ROC curve equal to or lower than 0.70, which is considered a little precise predictive capacity[19]. Moreover, the positive predictive value (PPV) for these variables showed that the probability of an animal with RDA and abdominal distension to have a negative outcome is slightly higher than 50% and the probability of an animal with obstructive intestinal disorder and inappetence or 10% dehydration to have this outcome is over 60%. Inappetence and degree of dehydration were considered by Constable et al.[10] the best preoperative indicators of prognosis in cows diagnosed with abomasal volvulus. However, these authors considered a cutoff of 0.50 for PPV to allow the inclusion of the variables into the regression model. The degree of dehydration provides important information regarding the general state of the animal, but this assessment can produce variable results among professionals despite the existence of guidelines for estimating this clinical sign in animals, compromising its predictive capacity[9].

HR was the only clinical variable that remained in the adjusted regression model for animals with RDA. The model shows that HR above 90 bpm increases the chance of a negative outcome in these animals. This variable has also been considered by other authors as a good preoperative indicator in cattle with RDA and abomasal volvulus[10,12]. According to Grohn et al.[12], an increase of 10 heartbeats per minute under these clinical conditions increases the chance of death by up to 30% (odds ratio of 1.3). According to Constable et al.[10], HR ≥ 120 bpm was the variable that presented the highest predictive capacity (PPV=0.67) in the preoperative period of cattle with abomasal volvulus. Thus, HR can be considered a more objective clinical indicator with better prognostic capacity obtained before the therapeutic procedure in cases of RDA. However, despite the tachycardia found in animals with an obstructive bowel disorder, this variable was not significantly associated with the outcome under this clinical condition probably due to its lower intensity or because it can be modulated by several other factors[9]. HR alone has an unsatisfactory predictive capacity of outcome in cattle with abomasum displacement, and this capacity is improved when associated with other variables, such as plasma L-lactate[9, 11].

Plasma L-lactate was significantly associated with the outcome only in animals with an obstructive intestinal disorder. Hyperlactatemia was found mainly in animals with a negative outcome. This metabolite is the product of the anaerobic metabolism of tissues during ischemic episodes[22]. Therefore, systemic or peripheral hypoperfusion caused by hypovolemia and the presence of ischemia in segments of the gastrointestinal tract are considered mechanisms that lead to increased plasma L-

lactate concentration due to insufficient oxygen supply to tissues[23]. Also, the endotoxemia present in animals with functional or mechanical obstruction of the intestinal tract due to prolonged interruption of intestinal transit may be responsible for the increase in lactatemia, as it causes changes in microcirculation and, consequently, damages to cell respiration[21]. The increase in L-lactate in the plasma of adult cattle with intestinal diseases such as obstruction by phytobezoars, intussusception, torsion, and enteritis, was previously observed by Coutinho et al.[24] and Santos et al.[25]. Lausch et al.[2] concluded that hyperlactatemia is also common in calves affected by acute abdominal, intestinal, and abomasal emergencies or those involving the mesentery or peritoneum.

The regression model adjusted for data from animals with obstructive intestinal disorder showed that plasma L-lactate concentrations above 1.84 mmol/L increase the chance of death in these animals. Similarly, other authors[2, 21, 26] have found that plasma concentrations of L-lactate are associated with mortality in cattle with intestinal diseases such as small intestine volvulus, paralytic ileus, and mesenteric torsion. However, these studies indicated that a single preoperative measure of L-lactate has limited clinical utility for predicting death in cattle with acute abdominal emergencies, with the evaluation of this variable in the immediate postoperative period (first 6 to 12 hours) being a more reliable predictive variable for the prognosis.

Our results showed no association between hyperlactatemia and the negative outcome in animals with RDA. Hyperlactatemia intensity found in animals with a negative outcome was similar to that in animals with a positive outcome. These results are different from those found in other studies[9, 11], and this divergence may be related to the criteria considered to define the negative outcome. In these studies, the outcome was only established 30 days after surgery, being considered negative when the animal was no longer in the herd after this period (died or was euthanized) due to conditions related to the disease or when the owner reported being dissatisfied with its production. In the present study, the outcome was defined in the short term, being considered positive when the animal was discharged from the hospital and negative when the animal died or was euthanized during hospitalization. Thus, the negative outcome in the present study may have been underestimated since 75% of the animals classified as positive were discharged from the hospital until the ninth day of hospitalization, and the length of stay of the animal in the herd after treatment or its return to productivity was not monitored.

Plasma fibrinogen was associated with a negative outcome in animals with RDA and obstructive intestinal disorder. Furthermore, plasma fibrinogen remained in the model adjusted for an obstructive intestinal disorder, showing that fibrinogen concentrations above 850 mg/dL increase the chance of death in these animals. The PPV of this variable for obstructive intestinal disorder stood out as the highest, showing that the probability of an animal with this type of disorder and hyperfibrinogenemia higher than 850 mg/dL to have a negative outcome is about 90%. The increase in this positive acute-phase protein has been evidenced under these clinical conditions by other authors[3, 7, 27], being often associated with the severity of the inflammatory nature of the disease. Its use in clinical routine has great value, as its concentration rises early before there is neutrophilia against inflammatory processes and may also remain high in chronic processes when antigenic stimulation and the capacity for hepatic synthesis are maintained[17].

This study provided valuable information regarding the prognostic relevance of some clinical and laboratory indicators in cattle affected by emergency digestive diseases. However, the generalization of the results should be cautious considering that retrospective hospital-based studies have limitations related to sampling, which in this case is pre-selected due to the severity of the clinical condition and possible gaps in the collected information. In addition, the sample size is another factor to be considered when evaluating the results.

5. Conclusion

This study indicated that clinical and laboratory variables such as HR, fibrinogen, and plasma L-lactate are useful variables to predict the outcome in cattle with emergency digestive diseases, especially RDA and obstructive intestinal disorders. However, a single measurement or evaluation of these parameters before the use of therapy may have limited clinical utility to predict the negative outcome in these diseases. Thus, additional prospective studies are indicated to assess the predictive capacity of the studied variables more accurately, as well as other possible outcome indicators, especially in obstructive intestinal disorders.

Conflicts of interest

The authors declare that there are no conflicts of interest regarding this study.

Author contributions

Conceptualization: G. S. L. Soares, C. L. Mendonça and J. A. B. Afonso. *Formal Analysis*: G. S. L. Soares. *Investigation*: G. S. L. Soares, C. L. Mendonça and J. A. B. Afonso. *Methodology*: G. S. L. Soares, C. L. Mendonça and J. C. R. Silva. *Project administration*: C. L. Mendonça. *Resources*: L. T. Coutinho, R. J. C. Souto and N. A. A. Silva. *Supervision*: C. L. Mendonça. *Validation*: G. S. L. Soares and C. L. Mendonça. *Writing (original draft)*: G. S. L. Soares. *Writing (review & editing)*: G.

S. L. Soares and A. I. Conceição.

Acknowledgments

To the Coordination for the Improvement of Higher Education Personnel (CAPES) for the financial support through the granting of a scholarship. To all technical veterinarians and residents who make up the CBG/UFRPE and to those who were part of this institution throughout the study period. We thank them for recording the information in the medical record to make this research possible.

References

1. Van Metre DC, Callan RJ, Holt TN, Garry FB. Abdominal emergencies in cattle. Vet. Clin. North Am. - Food Anim. Pract. 2005;21(3):655-696. https://doi.org/10.1016/j.cvfa.2005.06.003

2. Lausch CK, Lorch A, Knubben-Schweizer G, Rieger A, Trefz FM. Prognostic value of preoperative plasma L-lactate concentrations in calves with acute abdominal emergencies. J. Dairy Sci. 2019;102(11):10202-10212. https://doi.org/10.3168/jds.2019-16871

3. Afonso JAB, Pereira ALL, Vieira AC, Mendonça CL, Costa NA, Souza MI. Alterações clínicas e laboratoriais na obstrução gastrintestinal por fitobezoários em bovinos. Rev. Bras. Saúde e Produção Anim. 2008;9:91-102. https://periodicos.ufba.br/index.php/rbspaindex.php/rbspa/article/view/784

4. Braun U, Beckmann C, Gerspach C, Hässig M, Muggli E, Knubben-Schweizer G, Nuss K. Clinical findings and treatment in cattle with caecal dilatation. BMC Vet. Res. 2012;8(75):0-8. https://doi.org/10.1186/1746-6148-8-75

5. Coutinho LT, Afonso JAB, Costa NA, Mendonça CL, Faria PAR, Soares PC. Avaliação da conduta terapêutica em casos de timpanismo espumoso em bovinos. Ciência Anim. Bras. 2009;10(1):288-293.

6. Rohn M, Tenhagen BA, Hofmann W. Survival of dairy cows after surgery to correct abomasal displacement: 1. Clinical and laboratory parameters and overall survival. J. Vet. Med. Serie A. 2004;51(6):294-299. https://doi.org/10.1111/j.1439-0442.2004.00649.x

7. Silva Filho AP, Afonso JAB, Souza JCA, Costa NA, Mendonça CL. Análise clínica e patológica em 20 casos de intussuscepção em bovinos. Veterinária e Zootec. 2010;17:421-430. https://www.bvs-vet.org.br/vetindex/periodicos/veterinaria-e-zootecnia/17-(2010)-3/analise-clinica-e-patologica-em-20-casos-de-intussuscepcao-em-bovinos/

8. Soares GSL, Costa NA, Afonso JAB, Souza MI, Cajueiro JFP, Silva JCR, Ferreira F, Mendonça CL. Digestive diseases of cattle diagnosed at the "Clínica de Bovinos de Garanhuns"-UFRPE: retrospective study and influence of seasonality. Pes. Vet. Bras. 2021;41:1-13. https://doi.org/10.1590/1678-5150-pvb-6800

9. Boulay G, Francoz D, Doré E, Dufour S, Veillette M, Badillo M, Bélanger AM, Buczinski S. Preoperative cow-side lactatemia measurement predicts negative outcome in Holstein dairy cattle with right abomasal disorders. J. Dairy Sci. 2014;97(1):212-221. https://doi.org/10.3168/jds.2013-6898

10.Constable PD, St Jean G, Hull BL, Rings DM, Hoffsis GF. Preoperative prognostic indicators in cattle with abomasal volvulus. J. Am. Vet. Med. Assoc. 1991;198(12):2077-2085.

11.Figueiredo MD, Nydam DV, Perkins GA, Mitchell HM, Divers TJ. Prognostic value of plasma L-lactate concentration measured cow-side with a portable clinical analyzer in Holstein dairy catlle with abomasal disorders. J. Vet. Intern. Med. 2006;20(6):1463-1470.

12.Grohn YT, Fubini SL, Smith DF. Use of a multiple logistic regression model to determine prognosis of dairy cows with right displacement of the abomasum or abomasal volvulus. Am. J. Vet. Res. 1990;51(12):1895-1899. https://pubmed.ncbi.nlm.nih.gov/2085213/

13.Bilodeau MÈ, Achard D, Francoz D, Grimes C, Desrochers A, Nichols S, Babkine M, Fecteau G. Survival associated with cerebrospinal fluid analysis in downer adult dairy cows: A retrospective study (2006-2014). J. Vet. Intern. Med. 2018;32(5):1780-1786. https://doi.org/10.1111/jvim.15305

14.Pardon B, Ribbens S, Van Damme L, Vlaminck L, Martens A, Deprez P. Use of a national identification database to determine the lifetime prognosis in cattle with necrotic laryngitis and the predictive value of venous pCO2. J. Vet. Intern. Med. 2018;32:1462-1470. https://doi.org/10.1111/jvim.15223

15.Windeyer MC, Leslie KE, Godden SM, Hodgins DC, Lissemore KD, LeBlanc SJ. Factors associated with morbidity, mortality, and growth of dairy heifer calves up to 3 months of age. Prev. Vet. Med. 2014;113(2):231-240. https://doi.org/10.1016/j.prevetmed.2013.10.019

16.Dirksen G, Grunder HD, Stober M. Rosenberger: Exame Clínico dos Bovinos. 3rd ed. Guanabara Koogan, Rio de Janeiro; 1993. 419p.

17.Harvey JW. Hematology procedures. In: Harvey, J.W. (eds.) Veterinary hematology. A diagnostic guide and color atlas (pp.). St.Louis: Elsevier; 2012. p. 11-32

18.Braun U. Ultrasonography of the Gastrointestinal Tract in Cattle. Vet. Clin. North Am. - Food Anim. Pract. 2009;25(3):567-590. https://doi.org/10.1016/j.cvfa.2009.07.004

19.Greiner M, Pfeiffer D, Smith RD. Principles and practical application of the receiver-operating characteristic analysis for diagnostic tests. Prev. Vet. Med. 2000;45(1-2):23-41. https://doi.org/10.1016/S0167-5877(00)00115-X

20.Dohoo I, Martin W, Henrik S. Veterinary Epidemiologic Research. Charlottetown, Prince Edward Island: VER inc.; 2003. 865p.

21.Giertzuch S, Lorch A, Lausch CK, Knubben-Schweizer G, Trefz FM. Prognostic utility of pre- and postoperative plasma L-lactate measurements in hospitalized cows with acute abdominal emergencies. J. Dairy Sci. 2020;103(12):11769-11781. https://doi.org/10.3168/jds.2020-19102

22.Radcliffe RM, Buchanan BR, Cook VL, Divers TJ. The clinical value of whole blood point-of-care biomarkers in large animal emergency and critical care medicine. J. Vet. Emerg. Crit. Care. 2015;25(1):138-151. https://doi.org/10.1111/vec.12276

23.Constable PD, Hinchcliff KW, Done SH, Grunberg W. Diseases of the alimentary tract-Ruminant, in: Constable, P.D., Hinchcliff, K.W., Done, S.H., Grunberg, W. (Eds.), Veterinary Medicine: A Textbook of the Diseases of Cattle, Horses, Sheep, Pigs, and Goats. Elsevier, St.Louis. 2017;436-621.

24.Coutinho LT, Mendonça CL, Soares GSL, Oliveira Filho EF, Souto RJC, Cajueiro JFP, Souza MI, Silva NAA, Costa NA, Soares PC, Afonso JAB. Avaliação da bioquímica sanguínea de vacas leiteiras acometidas por desordens digestivas de natureza mecânica. Rev. Agrar. Acad. 2019;2(5):87-100. https://doi.org/10.32406/v2n52019/87-100/agrariacad

25.Santos JF, Rego RO, Afonso JAB, Soares PC, Mendonça CL. Biomarkers blood and peritoneal fluid of bovines with intestinal diseases and traumatic reticulitis. Cienc. Anim. Bras. 2020;21:1-16. https://doi.org/10.1590/1809-6891v21e-50941

26.Lausch CK, Lorch A, Giertzuch S, Rieger A, Knubben-Schweizer G, Trefz FM. Prognostic relevance of pre- and post-operative plasma L-lactate measurements in calves with acute abdominal emergencies. J. Dairy Sci. 2020;103(2):1856-1865. https://doi.org/10.3168/jds.2019-17224

27.Câmara ACL, Afonso JAB, Costa NA, Mendonça CL, Souza MI, Borges JRJ. Fatores de risco, achados clínicos, laboratoriais e avaliação terapêutica em 36 bovinos com deslocamento de abomaso. Pes. Vet. Bras. 2010;30(5):453-464. https://doi.org/10.1590/S0100-736X2010000500014