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Does lesion type or severity predict outcome of therapy for horses with equine glandular gastric disease? – A retrospective study

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Abstract

Background: Equine glandular gastric disease (EGGD) is a common condition of the horse. Misoprostol is reported to be superior to oral omeprazole and sucralfate for treatment. Long-acting intramuscular injectable omeprazole (LAIOMEP) is a novel treatment shown to be effective in a small population.

Objectives: This study aimed to determine LAIOMEP efficacy compared to misoprostol and oral omeprazole and identify characteristics that predict treatment outcome.

Methods: All horses that underwent gastroscopy between 2012 and 2019 were reviewed. Lesions were characterised by 4 blinded observers, all of whom are diplomates in equine internal medicine, using established descriptors from the ECEIM consensus statement and subjective severity. Treatment outcome was ranked as worsened, improved or healed. Consensus lesion type, lesion severity and treatment choice were compared to outcome and data screened using univariate analysis (chi-squared) to determine whether each predicted outcome. Lesion types where univariate analysis predicted a trend ($p<0.2$) were included in a multiple-regression analysis to identify predictors of outcome irrespective of treatment.

Results: Only severity significantly predicted final outcome ($p = 0.025$) with severe lesions being more likely to improve. Treatment choice did not significantly predict outcome. Overall healing rate was 29% (24 horses), and 43% (44 horses) improved. Treatment healing rates were 23% (10), 12% (7) and 27% (7) for LAIOMEP, misoprostol and oral omeprazole, respectively, with improvement in 69% (14), 76% (21) and 61% (9). 64% of the latter group received sucralfate. Worsening occurred in 7% (6). Treatment length varied with a median of 4 weeks (range 4–20 weeks).

Conclusions: This study showed poorer therapy outcome compared to previous studies. The only initial lesion descriptor to predict outcome was severity and treatment choice did not affect outcome.

KEYWORDS
equine glandular gastric disease (EGGD), LAIOMEP, misoprostol, omeprazole, sucralfate, treatment outcome

1 | INTRODUCTION

Equine glandular gastric disease (EGGD) is a non-ulcerative disease affecting the glandular gastric mucosa (Rendle et al., 2018). This condition is distinct from equine squamous gastric disease (ESGD) with different pathophysiology, risk factors and clinical signs (Sykes et al., 2019). Understandably therefore, treatment is different, and although there are many publications on EGGD, there are few outlining treatment, specifically long-acting injectable intramuscular omeprazole (LAIOMEP).

Treatment of EGGD is challenging due to limited options and minimal evidence on lesion response to therapy. This is further complicated by lesion diversity (Rendle et al., 2018). Lesion location and appearance may affect healing; Hepburn and Proudman (2014) demonstrated that cardia lesions are most responsive to oral omeprazole and sucralfate. Rendle et al. (2018) proposed flat or erythematous lesions are easier to treat than nodular and fibrinosuppurative lesions. Treatment options include oral omeprazole, oral omeprazole and sucralfate, LAIOMEP and misoprostol (Redpath & Bowen, 2019).

Omeprazole is a proton pump inhibitor that suppresses acid production. Although the recommended and authorised treatment for gastric ulceration in the United Kingdom, published healing rates for EGGD with oral omeprazole are poor (9–50%) (Gough et al., 2022; Sykes et al., 2015b; Sykes et al., 2014b) and worsening of EGGD was seen in 13–36% of horses treated with oral omeprazole only (Sykes et al., 2014a; Sykes et al., 2015b). Doses up to 8 mg/kg SID and twice daily administration have not improved healing rates (Rendle et al., 2018). Oral omeprazole bioavailability is increased by administration prior to feeding (Sykes et al., 2015b) although the importance of this on treatment outcomes of EGGD cases has not yet been determined.

Sucralfate is a polyaluminium hydroxide complex salt. It is thought to provide a physical barrier against acid and stimulates mucus secretion, inhibits pepsin release, promotes re-epithelisation and increases mucosal blood flow (Rendle et al., 2018). It has limited use as a monotherapy; however, Hepburn and Proudman (2014) demonstrated lesion improvement rates of 61%, 67% and 96% for pyloric, antral and cardia lesions, respectively, in combination with oral omeprazole. By comparison, Varley et al. (2019) demonstrated only a 20% healing rate. It is important to note that the first study looked for lesion improvement, while the second assessed complete healing.

Misoprostol is a prostaglandin analogue that suppresses acid production, inhibits neutrophilic inflammation and increases gastric mucosal blood flow and mucus secretion (Redpath & Bowen, 2019; Rendle et al., 2018; Varley et al., 2019). Varley et al. (2019) demonstrated healing and improvement rates of 72% and 98% respectively. This is a human medication licensed for refractory glandular disease; however, it is abortogenic therefore requires specific handling instructions. Mild self-limiting diarrhoea has been reported although resolves with treatment cessation (Varley et al., 2019).

LAIOMEP has recently become available and provides acid suppression for 4–7 days. Along with improved treatment compliance due to once weekly administration, systemic omeprazole eliminates the withholding of feed prior to administration (Sykes et al., 2017a). A 75% healing rate was demonstrated in thoroughbreds after 2 doses, and all horses improved (Sykes et al., 2017a). Healing rates of 64% and improvement of 96% with 2 injections and 86% and 93% respectively with 4 injections weekly in sports and leisure horses have been reported (Rendle et al., 2018). In a recent retrospective study, a healing rate of 82% was seen after 4 weeks and 91% had improved (Gough et al., 2022).

These studies all demonstrate limited therapy response with some horses requiring multiple treatments (Rendle et al., 2018). Antimicrobials have not been shown to be effective (Sykes et al., 2014c) and are not recommended unless a biopsy result demonstrates neutrophilic inflammation and profuse bacterial growth on culture (Rendle et al., 2018). Ancedotally, glucocorticoids have been used with success following first line treatment failure, potentially due to the lymphoplasmacytic inflammation present in most cases (Rendle et al., 2018). However, no studies have yet investigated this.

Treatment duration varies on clinicians' judgement; however, 4–6 weeks prior to repeat gastroscopy is recommended (Rendle et al., 2018; Sykes & Jokisalo, 2015). Healing rates vary and are difficult to predict. Anecdotally, healing of raised, nodular, haemorrhagic and fibrinosuppurative lesions takes longer although no studies have confirmed this (Rendle et al., 2018). Treatment recommendations following initial therapy are outlined by Rendle et al. (2018). Following treatment, cessation clinical signs should be monitored for recurrence, especially if management has not improved. Early treatment discontinuation is likely to result in reoccurrence of clinical signs and lesions (Bowen, 2018), although recurrence rate has not been published (Sykes & Jokisalo, 2015). Horses may be refractory to treatment potentially due to inadequately treating the primary condition, disease chronicity or a persistent inflammatory process.

The study aimed to test the hypothesis that lesion type or severity predicts treatment outcome. Specific aims included determining if treatment choice predicts outcome, determining overall healing rates for each treatment and whether lesion type or severity can predict treatment outcome.

2 | METHODS

Horses that underwent gastroscopy between 2012 and 2019 were identified from the electronic patient record at a single UK equine hospital. Those where EGGD was diagnosed by the attending veterinary surgeon were evaluated further. Horses where digital images could not be retrieved or where no follow up examination occurred were excluded. Where horses underwent multiple therapies, each treatment period was assessed as an individual case with an outcome at the end of each treatment. Images of the pylorus and antrum before and after treatment were reviewed by 4 blinded observers all of whom are diplomates in equine internal medicine and who regularly treat horses with gastric disease. All observers work at the same UK equine hospital.

The observers documented the presence of hyperaemia, haemorrhage, raised, depressed, flat or fibrinosuppurative lesions as simple binary recordings. Lesion distribution was documented as focal, multifocal or diffuse. Lesion severity was ranked subjectively at each gastroscopy as mild, moderate or severe, and for each follow-up examination, observers subjectively recorded whether lesions were worse, improved, healed or unchanged. Lesions were defined as healed when the mucosa was intact and consistent with no focal lesions present. Using a modified Delphi method, a consensus for each case was determined which was used for further analysis (Powell, 2003). Lesions were described using descriptors from the ECEIM consensus statement (Sykes et al., 2015a).

Age, breed, sex, horse type and the presence of ESGD and EGGD were recorded along with gastroscopy number and treatment protocol. Gastroscopy was repeated every 4 weeks for the duration of the horses' treatment period. The same management recommendations were given to all clients which included increasing pasture turn-out, reducing the number of days of intense exercise, feeding ad lib forage, adding vegetable oil (0.5–1 ml/kg) and adding sugar beet into the feed.

Treatment choice was determined by case clinician which led to four treatment groups: LAIOMEP, misoprostol, oral omeprazole and oral omeprazole and sucralfate. Horses in the LAIOMEP group received 4 mg/kg intramuscularly into the gluteal muscle every 7 days until re-examination. Horses in the misoprostol group received 5 μg/kg per os twice daily until re-examination. Horses in the oral omeprazole group received buffered omeprazole at 4 mg/kg once daily until re-examination. Oral omeprazole administration was recommended to be given in the morning prior to any feed. Horses in the oral omeprazole and sucralfate group received oral omeprazole as previously described and sucralfate administered at 20 mg/kg per os twice daily given at least half an hour after the oral omeprazole.

2.1 | Statistical methods

Clinical data were recorded in Microsoft Excel (Excel Microsoft Corporation, USA). Sex, breed and lesion type and severity were compared between the four treatment groups using a chi-squared test (IBM SPSS for Windows, Version 28.0).

Consensus lesion type and lesion severity was compared to outcome and data screened using univariate analysis (chi-squared) to determine whether each predicted outcome. Lesion types where univariate analysis predicted a trend ($p < 0.2$) were included in a multiple-regression analysis to identify predictors of outcome irrespective of treatment. Univariate analysis were undertaken using an online statistical calculator (Vasserstats, UK) and multiple regression analysis using IBM SPSS for Windows, Version 28.0. Additionally, outcome for each treatment period was compared to the treatment administered using univariate analysis (chi-squared) to determine if outcome could be predicted for the same reasons mentioned previously.

3 | RESULTS

3.1 | Horses

A total of 104 horses had two or more gastroscopies and relevant treatment. Of these 84 horses were included, 12 were excluded as glandular mucosa was normal on first presentation and a further eight were excluded due to non-diagnostic gastroscopy images. Five horses presented twice during the study period and were included as separate cases. Of those included, 56 were geldings and 28 were mares with a mean age of 9.8 years (4–21 years). Within this population, 52 were sports horses (62%, eventers, showjumpers and dressage), 30 were leisure horses (35%, hunters, general purpose) and 2 were racehorses (3%). This included 29 warmbloods (35%), 21 Irish sports horses (25%), 19 thoroughbreds (23%) and 15 horses representing small numbers of various other breeds (17%).

3.2 | Observers

Three of the four observers have been performing gastroscopy for >20 years and the fourth has been performing gastroscopy for 6 years. All hold at least one Equine Internal Medicine Diploma and three are RCVS recognised specialists in Equine Medicine. Two of the observers contributed to the UK EGGD consensus statement and all have read the UK and ECEIM consensus statements (Rendle et al., 2018; Sykes et al., 2015a). All observers have contributed to research into equine gastric disease, and one observer has contributed to >15 publications in this area. All currently use the ECEIM recommended descriptive grading system in clinical practice.

3.3 | Presentation

Glandular mucosa was fully visualised in all cases including the pylorus and pyloric antrum. At initial presentation, 53% had ESGD and EGGD and 47% presented with EGGD only. When considering severity, 60% presented as moderate, 25% as mild and 15% as severe. Distribution was multifocal in 74%, focal in 16% and diffuse in 10%. Lesions were more commonly raised (65%) compared to flat (34%) or depressed (0%). Lesions were fibrinosuppurative in 42%, haemorrhagic in 51% and hyperaemic in 89%. The most common lesion combination was moderate, multi-focal, raised and hyperaemic, which was seen in 33% of cases. There was no significant difference in lesion presentation or severity between treatment groups ($p > 0.05$).

3.4 | Treatment

All horses received treatment following initial gastroscope, and treatment choice was decided by the case clinician. Treatment included LAIOMEP in 28% (23 horses), misoprostol in 50% (42), omeprazole paste in 8% (7) and omeprazole paste and sucralfate in 14% (12) of cases. For statistical purposes, the oral omeprazole groups were combined. Additional treatments were used in 21% (9 horses) of misoprostol cases and included sucralfate (2 horses) and omeprazole paste (7 horses). These were not considered as separate groups due to small numbers. Length of treatment varied from 4 to 20 weeks with a median of 4 weeks. There was no statistically significant difference in the median treatment length between groups. If healing had not occurred, repeat gastroscopy and further treatment was recommended. In some cases, healing as defined by the case clinician was different to that of the panel consensus; therefore, treatment may have been discontinued sooner than the panel would have recommended and therefore subsequent data were not available for these cases. Additionally, 27% of cases were not represented for repeat gastroscopes; therefore, subsequent data were not available for analysis. Once no more data were available from a case, it was removed from the analysis at that time point and, therefore, was not considered a treatment failure at that stage. There were no adverse events recorded for any treatment.

3.5 | Reoccurrence

Five cases presented twice with a recurrence rate of 5.4%. Time between initial and second presentation varied from 5 to 60 months with a median of 16 months. Two presented with the same lesion and the others presented with similar lesions.

3.6 | Final outcome

Final outcome was normal/healed in 29%, improved in 43%, unchanged in 21% and worsened in 7% cases. In cases described as healed by the observers, if lesions were still present at treatment cessation, this was a mild hyperaemia, present in 35% of normal/healed cases. In those that worsened, 84% were multi-focal; however, no other trends were seen. When comparing final outcome to initial presentation only severity was a significant predictor of outcome ($p = 0.025$), all other descriptors had a p value >0.05. Severe cases were more likely to improve whereas mild cases were more likely to worsen (Figure 1). The percentage of focal and multi-focal/diffuse lesions was equivalent in each outcome group and similar for haemorrhagic lesions (Table 1). All other descriptors showed no trends.

3.7 | Healing rates at 4, 8 and 12 weeks

At 4 weeks post-treatment, 23% had healed, 40% had improved, 35% had not changed and 12% had worsened. At 8 weeks, 13% healed, 36% improved, 44% were unchanged and 7% worsened. At 12 weeks, 20% healed, 40% improved, 26% were unchanged and 13% worsened.

3.8 | Treatment efficacy

Treatment choice did not significantly predict outcome ($p > 0.05$). The majority did improve or heal with treatment; however, worsening was seen with all treatments (Table 2). A single medication was used in 67% of horses and of those 35% healed, 45% improved and 20% were unchanged or worsened. 33% of horses were treated with multiple medications. Following a lack of improvement after 4 weeks with one medication, a different medication was administered for a further 4-weeks period and of those 17% healed, 38% improved and 45% were unchanged or worsened.

4 | DISCUSSION

This study demonstrated a poorer therapy outcome compared to previous studies when considering LAIOMEP and misoprostol. Previous studies demonstrated healing rates of 75%–86% and improvement rates of 93%–100% with LAIOMEP (Gough et al., 2022; Rendle et al., 2018; Sykes et al., 2017a). In comparison, the healing and improvement rates seen in this study were significantly lower. This is also the case for misoprostol, as previous studies report healing and improvement rates of 72% and 98% respectively (Varley et al., 2019). Healing rates seen in this study with oral omeprazole and sucralfate were consistent with those reported by Varley et al. (2019) who also looked at complete lesion healing. Improvement rates seen in this study with this combination were similar to those published by Hepburn and Proudman (2014). As a retrospective study, there were many factors that could not be controlled including treatment choice, owner commitment and horse management, which may have affected the healing rates observed. Additionally, when considering the healing rates for each treatment, it is important to note that these were all small groups in a single UK hospital and therefore these results, although representative of this population, may not be representative of the UK equine

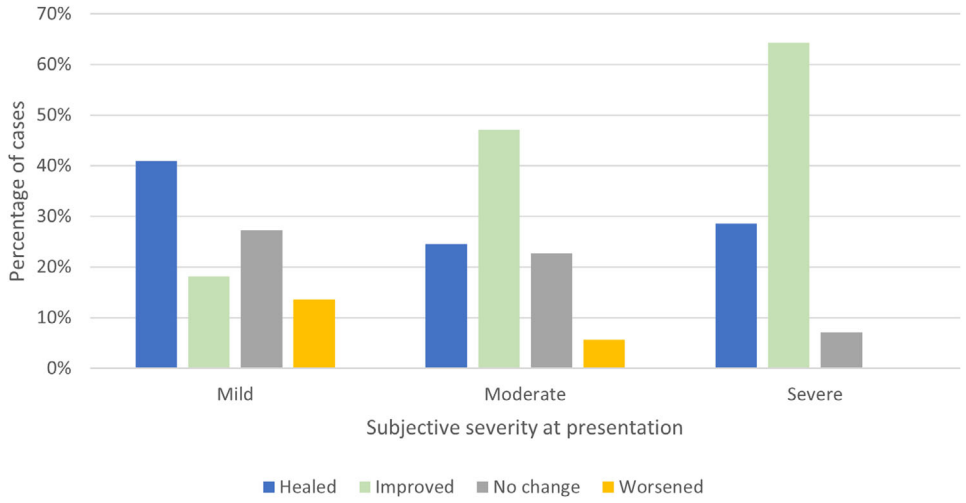

FIGURE 1 Percentage in each final outcome category distributed by initial severity based on the consensus of 4 blinded observers.

TABLE 1 Total number and percentage of horses that presented with each lesion descriptor in each final outcome group based on the consensus of 4 blinded observers

		No change	Improved	Healed/normal	Worsened
Severity	Mild	6 (27%)	3 (18%)	9 (41%)	3 (14%)
	Moderate	12 (23%)	25 (47%)	13 (25%)	3 (6%)
	Severe	1 (7%)	10 (64%)	4 (29%)	0 (0%)
Distribution	Focal	3 (21%)	6 (43%)	4 (29%)	1 (7%)
	Multi-focal/diffuse	16 (21%)	32 (43%)	22 (29%)	5 (7%)
Raised	No	7 (23%)	9 (29%)	13 (42%)	2 (6%)
	Yes	12 (21%)	29 (50%)	13 (22%)	4 (7%)
Fibrinosuppurative	No	13 (26%)	18 (36%)	15 (30%)	4 (8%)
	Yes	6 (15%)	19 (51%)	11 (28%)	2 (5%)
Haemorrhagic	No	9 (20%)	19 (45%)	12 (27%)	3 (7%)
	Yes	10 (22%)	19 (40%)	14 (31%)	3 (7%)
Hyperaemic	No	2 (20%)	2 (20%)	4 (40%)	2 (20%)
	Yes	17 (22%)	36 (46%)	22 (28%)	4 (5%)

TABLE 2 Percentage of horses within each treatment group that were recorded in each outcome group at the end of a treatment period based on the consensus of 4 blinded observers

Treatment	No change	Improved	Healed/normal	Worsened
Long-acting injectable omeprazole	33%	35%	23%	9%
Misoprostol	29%	47%	12%	12%
Oral omeprazole ± sucralfate	23%	38%	27%	12%

population. However, it highlights that these treatments potentially do not work as well as previously published in all populations and therefore a large-scale, prospective trial across multiple equine hospitals should be performed to compare healing rates between treatments for EGGD.

The data presented here were collected retrospectively; therefore treatment choice was decided by the case vet, the horses' management was not controlled although recommendations were given and outcome may be affected by owner compliance with therapy administration. In comparison, the studies completed by Sykes et al. (2017a)

and Varley et al. (2019) were prospective clinical studies. In the study by Sykes et al. (2017a), diet was controlled and owner compliance was not an issue due to the intramuscular administration. The study by Varley et al. (2019) allowed horses to continue with their normal management and diet, and although the administration of the therapies was specifically outlined to the owners, this could be affected by owner compliance. Therefore, these data are more comparable to the data presented in this study and that of clinical practice. The study completed by Gough et al. (2022) was also a retrospective study with similar methods to the present study; therefore, although recommendations for management were given, it is unknown how well these were followed.

A consideration for the poorer therapy outcome reported in this study is the lesion presentation. In comparison to the study by Gough et al. (2022), lesions were more likely to be raised in the present study whereas lesions were more likely to be flat in the study by Gough et al. (2022) and this study also included 15% with depressed lesions which was not seen in the present study. Lesion severity and the frequency of haemorrhagic lesions were very similar between studies; however, lesions in the present study were more likely to be hyperaemic or fibrinosuppurative. Fibrinosuppurative, hyperaemic and raised lesions are anecdotally suggested to be more difficult to treat (Rendle et al., 2018), which may potentially contribute to the poorer healing and improvement rates seen in the present study. This difference in lesion presentation may also have affected the outcome. In this study, only severity was found to be associated with outcome whereas it may be that with a larger population with a more varied lesion presentation, more descriptors may predict outcome. Ultimately, if the lower healing rates presented here are not limited to this hospital, it suggests healing rates may be lower than previously reported.

When looking at outcome, these results suggest severe lesions were more likely to improve, which may be due to the reduced severity of gastritis seen on histopathology in these cases (Crumpton et al., 2015). This may be one explanation why we reported that milder lesions are harder to treat, as visual severity does not indicate underlying pathology. Anecdotal evidence has suggested that raised or fibrinosuppurative lesions may be more difficult to treat than flat hyperaemic lesions although our data do not support this (Rendle et al., 2018). However, it may also be easier to determine improvement in the severe cases as there is a greater visual change, which may be why none of the severe lesions worsened throughout the study period and few were unchanged. Varley et al. (2019) suggested that subjectively the lesions present within the misoprostol group were more severe than those receiving oral omeprazole and sucralfate, which could have contributed to the vastly different healing and improvement rates seen in this study for the two groups. Additionally, this study demonstrated that lesion appearance does not predict outcome in this population. Therefore, lesion distribution and appearance may not be important in terms of healing although this must be investigated in a larger population across multiple centres.

We found no statistical difference between outcomes when different treatments were used in this study. This was unexpected as based on a previous evidence, LAIOMEP and misoprostol were expected to be more efficacious due to the higher healing rates previously reported (Sykes et al., 2017a; Varley et al., 2019). It is therefore important to consider whether this result is due to the consistently low healing rates seen in this study, which is why multiple treatments were often required, or if it is the case that certain lesions will or will not heal no matter what treatment is administered. In this study, LAIOMEP was administered every 7 days as has been previously recommended (Rendle et al., 2018). However, the preliminary study performed on LAIOMEP demonstrated that acid suppression was not maintained in all study horses for the entire 7 days (Sykes et al., 2017a). It may be that some of the lesions that did not improve or resolve in this study may have done so had the LAIOMEP been administered more frequently. This is another area of research to be developed.

A large proportion of cases remained unchanged or worsened during the treatment period, even with multiple treatments. This suggests these horses are refractory to treatment. Previous studies have shown worsening of glandular lesions (13–36%) with oral omeprazole treatment (Sykes et al., 2014b; Sykes et al., 2015b). No lesions have been observed to worsen with oral omeprazole and sucralfate, misoprostol or LAIOMEP in previous studies (Sykes et al., 2017a; Varley et al., 2019), although 20% cases were unchanged and could have worsened with oral omeprazole and sucralfate in a study of 204 horses (Hepburn & Proudman, 2014); however, exact figures are not given. The number of horses that worsened in this study who were treated with oral omeprazole was similar to those with previously reported. To the author's knowledge, this is the first report of worsening with both misoprostol and LAIOMEP. The reasons for this are unclear; it may be that unknown management factors caused treatment failure. It is clear from the high proportion of horses' refractory to treatment that this may be a bigger problem than previously reported and, therefore, requires further investigation into the cause of treatment failure.

Due to the nature of the study, treatment duration does not reflect time to healing but instead was controlled by owner decision to continue treatment or repeat gastroscopy and, therefore, was affected by financial concerns or clinical improvement. This adds an element of bias, which we were unable to control. It is unknown therefore whether some cases would have resolved, had they been administered different medications following a treatment failure. This study had a variable treatment duration, which was very wide; therefore, we have reported healing rates at 4, 8 and 12 weeks to attempt to reduce the effect of this factor on the results. The percentages observed in each outcome group did not appear to change with time suggesting that potentially extending treatment duration does not improve outcome; however, it is only possible to speculate from the data presented here.

Additional treatments were administered with misoprostol in a small proportion of cases; these were clinician dependent and may have affected results. No data have yet been published on any combination including misoprostol. All of these were considered part of the misoprostol group as oral omeprazole monotherapy at 4 mg/kg has been demonstrated to be an ineffective therapy for glandular disease (Rendle et al., 2018). Additionally sucralfate is also not recommended as a monotherapy (Rendle et al., 2018). This is a limitation of this study however and due to the retrospective nature, this was unabled to be

controlled. Another limitation of this study is that the oral omeprazole and oral omeprazole and sucralfate groups were combined. Previous data report EGGD healing rates of oral omeprazole of 14% and of oral omeprazole and sucralfate of 20% suggesting that both are ineffective at treating EGGD (Sykes et al., 2015b; Varley et al., 2019). Therefore, these two groups were combined for statistical purposes.

There are multiple limitations of this study. In addition to the limitations discussed already, this study population largely consisted of sports horses, which is representative of the hospital caseload and may not be representative of the UK equine population. The sample size considered is also small and only from a single UK equine hospital. Due to the period over which data were collected, multiple gastroscope systems were used, some of which were of a better quality than others, and eight horses were excluded due to non-diagnostic dark images. As it has been suggested, appearance and colour of the gastric mucosa can be affected by different light settings and endoscopy systems (Rendle et al., 2018); this may have affected lesion descriptions. Additionally, only still images were shown to the medicine specialists in this study, whereas video is typically used in clinical practice. As this was a retrospective study, there are also limitations to the data analysis. These include combining treatment groups due to small numbers. Treatment length was variable as this was controlled by the owners' or attending veterinary surgeons' decision as to whether to continue treating. And the fact that the univariate analysis assessed each lesion type individually, therefore, if there was a cofounding effect of multiple lesion types on outcome, this was not able to be analysed. However, the data presented both for healing rates and prediction of likely outcome from presentation and treatment are interesting and warrant further investigation in a larger population as a prospective study.

5 | CONCLUSIONS

The only initial lesion descriptor to predict outcome was severity and treatment choice did not affect outcome. Healing and improvement rates seen in this study were much lower than those previously reported for misoprostol and LAIOMEP; however, they were similar for oral omeprazole with sucralfate. The percentage of horses' refractory to treatment was also much higher in this study than previously reported. Further investigations into severity, in particular its prevalence and whether it can predict outcome in a larger multi-centre study, are warranted.

AUTHOR CONTRIBUTIONS

SL Pratt contributed to the collection of data, data analysis and writing of the manucript. M Bowen and A Redpath contributed to the data analysis, gastroscope image assessment and writing of the manuscript. GD Hallowell, E Shipman and J Bailey assisted in assessing the gastroscope images.

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CONFLICT OF INTEREST

The authors declare that there is no conflict of interest that could be perceived as prejudicing the impartiality of the research reported.

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DATA AVAILABILITY STATEMENT

Data are available on request due to privacy/ethical restrictions.

ETHICS STATEMENT

This study was approved by the University of Nottingham's Committee for Animal Research and Ethics (CARE).

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