Papers

Severity and outcome of equine pasture-associated laminitis managed in first opinion practice in the UK

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Data from 107 cases of pasture-associated laminitis were obtained from first opinion practices to study factors associated with severity, survival and return to ridden exercise. There were 43 mares and 64 geldings, with a median age of 11 years. Of the 107 animals, 33 were small ponies, 45 were large ponies/cobs, 17 were small horses and 12 were large horses. Ninety-seven animals were categorised as having laminitis as defined by Cripps and Eustace (1999): 76 had mild (Obel grade 1 or 2) laminitis and 31 had severe (Obel grade 3 or 4) laminitis. Forty-three animals had previously had laminitis, and were significantly less likely (P=0.02) to have severe laminitis than those that had not. Eighty-nine animals were overweight, and there was a trend (P=0.09) towards severe laminitis cases having a higher body mass index. Eight weeks after disease onset, 102 animals were alive. Lower bodyweight, optimal body condition, mild laminitis and category of acute/chronic founder as defined by Cripps and Eustace (1999) were significantly associated with survival. There was a trend (P=0.06) towards treatment with acepromazine being associated with survival. Of the 81 animals that were used for riding, 48 were being ridden again; this was 2.6 times more likely in animals without previous laminitis. The clinical outcome was judged by a panel of three veterinarians as 'good' in 77 of 107 of cases. Clinical outcome was significantly associated (P=0.03) with horse type: the outcome was 'bad' in none of the small horses, compared with 15 of 45 large ponies/cobs, 11 of 33 small ponies and three of 12 large horses.

ALTHOUGH laminitis is thought to affect a large number of ponies and horses in the UK, epidemiological studies and studies evaluating the optimal treatment of this condition in first opinion practice are lacking. One study performed in the UK found that within a sample population of approximately 113,000 horses, laminitis affected more than 8000 horses (7.1 per cent) annually and led to more than 600 of these animals being euthanased (Hinckley and Henderson 1996). The only other UK study was performed on a single farm and found that over a three-year period, 20.1 per cent of the population had at least one episode of laminitis (Katz 2004). A national survey in 1998 by the US government revealed that 13 per cent of horse businesses had had at least one horse affected by laminitis in the previous 12 months; 1 per cent of the horse population was affected at any given time; laminitis was the most common cause of foot lameness and accounted for 7.5 to 15.7 per cent of all lameness; and horses were generally more affected by laminitis in the spring and summer (Kane and others 2000). In addition, this survey reported that 74 per cent of affected animals recovered completely and could again be used for their intended purpose, whereas 5 per cent died or were euthanased; and 50 per cent of cases were thought to be due to grazing lush pasture or grain overload (Kane and others 2000). Several case-control studies have been performed to identify risk factors for the development of laminitis, including age, breed and sex (Dorn and others 1975, Slater and others 1995, Polzer and Slater 1997, Alford and others 2001). However, these involved secondary and tertiary referral populations in the USA and therefore may not accurately reflect clinical disease as seen in first opinion practice in the UK.

There are three main theories relating to the pathogenesis of pasture-associated equine laminitis, which in turn may influence rational treatment. The vascular theory proposes that laminitis is a consequence of digital ischaemia and subsequent reperfusion (Hood and others 2004). The therapeutic implication is that treatment should include drugs that may prevent or reverse this vasoconstriction, such as acepromazine (ACP). In contrast, the toxic metabolic theory proposes that there is a period of increased digital perfusion that allows laminitis trigger factors to activate matrix metalloproteinase (MMP) enzymes (Mungall and others 2001, French and Pollitt 2004). Thus, the logical therapeutic approach would be to institute vasoconstrictor therapy such as cryotherapy, while vasodilator drugs could be deleterious. The inflammatory theory proposes that laminitis is a consequence of laminar inflammation (Blikslager and others 2006),

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so anti-inflammatory therapy should be used. In addition, although it is agreed that limitation of structural damage to the laminae during the early stages of laminitis is important, whether this should be achieved through support of the frog alone or via frog and sole support is unclear. Thus, currently the veterinary community is divided in its views; more importantly, despite the fact that this is an extremely common and life-threatening condition, no large-scale clinical trial has been conducted to provide evidence on the most effective therapeutic approach.

A pilot study demonstrated that 85 per cent of horses and ponies managed identically were sound within eight weeks (C. Marr, personal communication). The objective of the present study was therefore to identify animal, disease and initial treatment factors associated with severity, survival and return to ridden exercise after eight weeks in horses and ponies diagnosed with pasture-associated laminitis in first opinion practice in the UK.

Materials and methods

Case definition and recruitment

Horse or ponies diagnosed with pasture-associated laminitis between March 1, 2005, and December 31, 2007, were recruited prospectively by members of the British Equine Veterinary Association (BEVA) for inclusion in the study. A case of pasture-associated laminitis was defined as a horse or pony seen by a participating veterinary surgeon in first opinion practice in the UK that had access to grass and exhibited clinical signs of increased hoof heat (subjectively detected manually), increased digital pulses and pain on hoof testers in the region just in front of the point of the frog in at least two feet and reluctance to move with a weight-relieving laminitic stance. In addition, for recurrent cases, any previous bout of laminitis had to have occurred at least four weeks before recruitment. The following were excluded from the study: donkeys, animals over 14 years old, animals in which pituitary pars intermedia dysfunction had been diagnosed, cases associated with excessive weight-bearing, cases associated with systemic illness or excessive quantities of grain, and animals that had received any medications in the four weeks before the onset of laminitis apart from anthelminthics or vaccines.

Data collection

Participating veterinary surgeons were given a weigh tape (Laminitis Clinic) and training CD containing detailed instructions for case assessment, including illustrations and descriptions of the Obel grading system (Obel 1948) and laminitis categories (Table 1) (Cripps and Eustace 1999). For each case the veterinary surgeon was required to obtain the owner's informed consent and to complete a standardised case description form giving details of signalment, phenotype, history and management factors and clinical findings; a standardised seven-day diary of veterinary interventions; and a standardised fax-back questionnaire detailing all relevant management practices implemented during the eight weeks after the onset of clinical signs and the clinical status of the animal eight weeks after the onset of the clinical signs. In addition, a standardised questionnaire relating to management practices was administered to all owners via a telephone interview eight weeks after the onset of clinical signs.

The body mass index (BMI) was calculated by dividing the weight (kg) by height (inches), as previously described (Katz 2004), to evaluate body configuration (short but heavy v tall but lean) objectively as a risk factor in addition to the subjective assessment of body condition.

Outcome measures

Clinical severity was assessed by the attending veterinarian on the first day of presentation and was based on the Obel grade (1 and 2 Mild, 3 and 4 Severe) (Obel 1948). Eight weeks after the onset of clinical signs the animal's recovery was defined according to three outcome measures: survival, return to ridden exercise and clinical outcome category (good v bad). Clinical outcome was designated good or bad on the basis of the consensus of a panel of three veterinarians (specialist orthopaedic surgeon [AB], specialist in internal medicine [CMM] and experienced equine practitioner [IC]) who reviewed all the information obtained from the owner and the veterinarian.

TABLE 1: Description of laminitis categories defined by Cripps and Eustace (1999)

Laminitis category	Description
Laminitis	Abnormal digital pulses, heel-loading stance and shifting lameness
Acute founder	Abnormal digital pulses, heel-loading stance and shifting lameness with supra-coronary depressions that do not go all the way back to both heels
Sinker	Abnormal digital pulse or stone-cold feet, stands square with supra-coronary depression extending back to both heels, tends to be very reluctant to move
Chronic founder	Divergent growth rings on the wall, wider at the heels, flattened soles, wider-than-normal dorsal white lines

Statistical analysis

Descriptive statistics were obtained for all continuous variables under consideration, and the Kolmogorov-Smirnov statistic was used to determine whether these variables were normally distributed. Separate univariate and multivariate analyses were conducted to identify factors significantly associated with severity, survival, return to ridden exercise and clinical outcome. For the univariate analysis chi-squared tests (or Fisher's exact tests when any of the cells contained fewer than five expected observations) were used to identify categorical variables significantly associated with each of the four outcome measures, and Mann-Whitney U tests or independent *t* tests were used to determine which of the continuous variables differed significantly between the two levels of each of the four outcome measures. Univariate analysis was followed by binary logistic regression based on a backward-stepwise variable selection method. All statistical analyses were performed using SPSS 17.0 for Windows (SPSS) and $P<0.05$ was assumed to indicate statistical significance.

Results

Study population

Forty-six members of BEVA participated in the study. The study population comprised 107 animals, of which 43 (40.2 per cent) were mares and 64 (59.8 per cent) were geldings. Thirty-three animals (31 per cent) were subjectively defined as small ponies, 45 (42 per cent) as large ponies or cobs, 17 (16 per cent) as small horses and 12 (11 per cent) as large horses. The median age of the study population was 11 years (interquartile range [IQR] eight to 12 years), median height was 146 cm (IQR 126.5 to 156.5 cm), median weight was 465 kg (IQR 304.0 to 596.5 kg) and median BMI was 3.20 (IQR 2.5 to 3.7 kg/inch). None of the animals was subjectively graded by the veterinary surgeon as thin; 18 animals (10 per cent) were graded as optimal, 54 (50 per cent) as slightly overweight and 35 (33 per cent) as obese. Of the study population, 27 animals (25.7 per cent) were unridden, 49 (46.7 per cent) were used for either showing or light riding, 20 (19.0 per cent) were involved in general riding, and nine (8.6 per cent) were competition horses.

The majority of the animals (97 [90 per cent]) were categorised as having laminitis, one (0.9 per cent) as sinker, five (4.8 per cent) as acute founder and five (4.8 per cent) as chronic founder (Cripps and Eustace 1999). Seventy-six animals (71 per cent) in the study population had mild laminitis (Obel grade 1: 18; Obel grade 2: 58) and 31 (29 per cent) had severe laminitis (Obel grade 3: 25; Obel grade 4: six). Forty-six animals (43 per cent) in the study population had previously had laminitis.

Treatment

Drug regimens for the first seven days were classified into those that included either phenylbutazone or suxibuzone (PBZ/SUX) (97 cases [90.7 per cent]) and those that did not (10 [9.3 per cent]). Ten of 97 animals (10.3 per cent) in the first group were given PBZ/SUX alone, 54 (55.6 per cent) were given PBZ/SUX with ACP, 28 (28.9 per cent) were given PBZ/SUX with ACP and other drugs, and five (5.1 per cent) were given PBZ/SUX and a drug other than ACP. Other drugs included flunixin (28 cases), ketoprofen (three), nitroglycerine applied percutaneously (one) and eltenac (one). Six animals (60 per cent) in the second group were not prescribed any drugs, and four (40

TABLE 2: Factors associated with severity of pasture-associated laminitis (severe v mild) in 107 horses from first opinion practices in England, as determined by logistic regression

Variable	Value	OR	95 per cent CI	P value
Previous laminitis	Yes	0·22	0·062 to 0·80	0·022
Foot support	None	Reference		0·035
	Frog	4·51	1·33 to 15·34	
	Frog and sole	0·94	0·11 to 8·13	
Use	Unridden	Reference		0·044
	Showing or light riding	2·34	0·45 to 12·19	
	General riding	10·31	1·69 to 62·85	
	Competition	1·70	0·17 to 17·09	
Drugs	PBZ/SUX	Reference		0·072
	PBZ/SUX and ACP	1·81	0·25 to 13·06	
	PBZ/SUX, ACP and other	6·66	0·93 to 47·65	
	Other	1·37	0·13 to 14·79	

Model diagnostics: Cox and Snell R square 0·32; Nagelkerke R square 0·45
ACP Acepromazine, PBZ/SUX Phenylbutazone and suxibuzone

TABLE 3: Factors associated with the survival of 107 horses diagnosed with pasture-associated laminitis from first opinion practices in England, as determined by univariate analysis

Factor	Survived (mean [sd])	Euthanased (mean [sd])	P valve
Weight (kg)	439 (156·4)	593·6 (135·05)	0·03
BMI (weight/height, kg/inch)	3·07 (0·79)	3·91(0·63)	0·02
Optimal body condition	18	0	<0·001
Slightly overweight	52	2	
Obese	32	2	
Obel grade 1 or 2	75	1	0·0241
Obel grade 3 or 4	27	4	
Laminitis	93	4	0·001
Sinker	0	1	
Acute founder	4	0	
Chronic founder	5	0	
Previous laminitis	43	0	0·077
No previous laminitis	57	5	
PBZ or SUX only	8	2	0·062
PBZ or SUX with ACP	53	1	
ACP	80	2	0·0821
No ACP	22	3	

ACP Acepromazine, PBZ Phenylbutazone, SUX Suxibuzone

per cent) were treated with meloxicam and nitroglycerine applied percutaneously.

All animals in the study were prescribed rest; either box rest (99 cases [92.5 per cent]) or rest in a stable-sized sectioned-off part of a field (eight [7.5 per cent]). Cold-hosing of the feet was prescribed for the minority of cases (six [5.6 per cent]). Foot support was used in half of the cases (63 [58.9 per cent]); of these, 53 (84 per cent) had frog-only supports and 10 (16 per cent) had frog and sole supports. The frog supports used included rolled-up bandages (23 cases), TLC Frog Supports (Equi Life) (15), lilypads (13), a Newmarket frog support (one) and heart bar shoes (one). The frog and sole supports used included dental impression material (five), Styrofoam (three) and Newmarket sole support (two).

Severity of laminitis

Seventy-six of 107 (71 per cent) horses had mild laminitis (Obel grade 1 or 2), and 31 (29 per cent) had severe laminitis (Obel grade 3 or 4). Univariate analysis identified the following variables to be significantly associated with severity of the laminitic episode: whether the animal had previously had laminitis (chi-squared test P<0.001), the type of foot support prescribed (Fisher's exact test P=0.002), the drugs administered (Fisher's exact test P=0.004) and what the animal was used for (Fisher's exact test P=0.004). In addition, animals with severe laminitis had a higher BMI than animals with mild laminitis, although this difference was only marginally significant (mean [sd] 3.32 [0.81] kg/inch v 3.03 [0.79] kg/inch, respectively; P=0.09).

The majority of animals with mild laminitis were either unridden (24 cases [32.4 per cent]) or used for showing or light riding (35 [47.3 per cent]); the majority of those diagnosed with severe laminitis were used for either showing or light riding (14 [45.2 per cent]) or general riding (12 [38.7 per cent]). In both instances, competition horses were the least likely to have laminitis. Of the animals with mild laminitis, 40 (52.6 per cent) had previously had laminitis, compared with only five (16.1 per cent) of the severe cases.

PBZ/SUX was used alone in 11.8 per cent of mild cases and 3.2 per cent of severe cases; together with ACP in 57.9 per cent of mild cases and 32.3 per cent of severe cases; with ACP and other drugs in 15.8 per cent of mild cases and 51.6 per cent of severe cases; and with a drug or drugs other than ACP in 5.3 per cent of mild cases and 3.2 per cent of mild severe cases. Neither PBZ/SUX or ACP was used in 9.2 per cent of mild cases and 9.7 per cent of severe cases. For both mild and severe laminitis, combined frog and sole support was seldom used (seven [9.2 per cent] and three cases [9.7 per cent], respectively). Frog-only support was used in 29 (38.2 per cent) of the mild cases and 24 (77.4 per cent) of the severe cases. Just under half of the mild cases (40 [47.3 per cent]) but only four (12.9 per cent) of the severe cases were not prescribed any type of foot support.

Logistic regression (Table 2) identified two factors as significantly associated with severe laminitis: whether the animal had previously had laminitis and the type of foot support prescribed. Horses with severe laminitis were less likely to have previously had laminitis (OR 0.20, 95 per cent CI 0.06 to 0.47, P=0.001) and animals diagnosed with severe laminitis were most likely to be provided with frog-only support (OR 4.35, 95 per cent CI 1.56 to 12.16, P=0.015). Animals with severe laminitis were most likely to be used for general riding (OR 10.31, 95 per cent CI 1.69 to 62.85) and least likely to be used for competitive purposes (OR 1.70, 95 per cent CI 0.17 to 17.09). Furthermore, cases of severe laminitis were most likely to be prescribed PBZ/SUX with ACP and another drug (OR 6.66, 95 per cent CI 0.93 to 47.65) compared with PBZ or SUX alone.

Recovery

Survival

Eight weeks after the onset of laminitis, 102 (95 per cent) of the animals were still alive; five animals (5 per cent) had been euthanased, one for reasons unrelated to laminitis. As shown in Table 3, univariate analysis revealed that Obel grade was significantly associated with survival: all animals that were euthanased had severe laminitis (Fisher's exact test P=0.01). In addition, type of laminitis was marginally significantly associated with survival: all animals that were euthanased were categorised as either laminitis or sinker (Fisher's exact test P=0.07). Although the result was not significant, animals that were euthanased were heavier and had a higher BMI than the animals that survived (Table 2). In addition, there was a trend (P=0.062 and P=0.08) towards the inclusion of ACP as part of the treatment to be associated with survival (Table 3). Multivariate analysis could not be performed on the data as there were too few animals in the euthanased group (four cases).

Horse or pony ridden again

At the end of the study, 47 (59 per cent) of the 79 animals normally used for riding were being ridden again. Univariate analysis showed that whether the horse had previously had laminitis was marginally significantly associated with the animal being ridden again (chi-squared test P=0.07). Of the animals that were ridden again, 32 (68.1 per cent) had not previously had laminitis. Logistic regression showed that the odds of an animal without previous laminitis being ridden again were 2.41 times the odds of an animal that had previously had laminitis being ridden again (95 per cent CI 0.96 to 6.12, P=0.062).

Veterinary consensus outcome

Veterinary consensus outcome was 'good' in 76 (71 per cent) cases and 'bad' in 31 (29 per cent) cases. Outcome was significantly associated with animal type (chi-squared=6.97, df=3, P=0.036). Of the small and large horses, 65 per cent or more were assigned a 'good' outcome; all small horses (15) were assigned a 'good' outcome, compared with only 65.9 per cent (29) of small ponies. None of the small horses was assigned a 'bad' outcome, compared with 34 per cent (15) of large ponies and cobs, 33 per cent (11) of small ponies, and 25 per cent (three) of large horses. In the mild laminitis subgroup (76 cases),

outcome was significantly associated with cold-hosing. Horses with a 'bad' clinical outcome were more likely to be treated with cold-hosing than those with a 'good' clinical outcome (OR 12.2, 95 per cent CI 1.18 to 126.48, P=0.036). Within the severe laminitis subgroup, there was no significant association between outcome and any of the variables under consideration.

Discussion

In this study, eight weeks after the onset of the episode of laminitis, 95 per cent of animals were still alive, 72 per cent were considered to have a good clinical outcome, and 59 per cent of those that had previously been ridden were being ridden again. In the two previous studies available for comparison, 77 per cent of animals with laminitis returned to their original athletic function and 16 per cent died or were euthanased within six months of diagnosis (Cripps and Eustace 1999), and 74 per cent of affected animals recovered completely and could be used again for their intended purpose and 5 per cent died or were euthanased (Kane and others 2000). However, it must be acknowledged that the percentages of animals within each of the laminitis categories in the present study and the first of the two previous studies differed greatly and that the second of the two previous studies included all cases of laminitis not just those associated with pasture, preventing a direct comparison. The present study is particularly pertinent because it focused on a specific population in the UK, that is, cases of laminitis associated with pasture, exclusively recruited via first opinion practitioners.

This study has shown that an excessive bodyweight increases the risk of severe clinical signs and also the risk of non-survival in animals that develop pasture-associated laminitis. Multiple variables have been evaluated as risk factors for the development of laminitis, and the findings have generally been inconsistent among studies. Bodyweight greater than 550 kg was associated with an increased risk of developing laminitis in hospitalised patients in one study (Cohen and others 1994), but other studies have found no association between weight and the prevalence of laminitis (Slater and others 1995, Peloso and others 1996). The median weight of animals in the present study was 465 kg. More recently, research has focused on obesity rather than bodyweight as being a significant risk factor for the development of laminitis (Johnson and others 2004, Treiber and others 2005). In the present study, 83 per cent of animals were thought to be slightly overweight or obese; however, it must be acknowledged that body condition was assessed subjectively rather than using the widely accepted nine-point modified scoring system (Henneke and others 1983) and that regional adiposity affecting particularly the crest and tail head, which appears to be associated with a predisposition to laminitis (Treiber and others 2006), was not assessed separately.

In the present study, 73 per cent of affected animals were ponies rather than horses, and previous studies have shown that ponies are at increased risk for developing laminitis compared with other breeds (Dorn and others 1975, Hinckley and Henderson 1996, Kane and others 2000). The use of the animal was associated with the clinical severity of the laminitis, and the type of animal (small pony, large pony, small or large horse) influenced the recovery as defined by the clinical outcome category. All small horses were assigned a 'good' outcome, compared with only 65.9 per cent of small ponies. None of the small horses was assigned a 'bad' clinical outcome, compared with 34.1 per cent of large ponies and cobs, 32.4 per cent of small ponies and 30.0 per cent of large horses. In a previous study of factors associated with survival, the height of the animal was not significantly related to outcome, and the prognosis for horses was not significantly different from that for ponies, although the outcome was significantly worse for Arabs and thoroughbreds (54 per cent failure) than for other breeds (combined failure rate 16.7 per cent) (Cripps and Eustace 1999).

Sex has been determined by some groups to be a positive risk factor for laminitis (Slater and others 1995, Dorn and others 1975, Amoss and others 1979, Alford and others 2001), but others have found no relationship (Hunt 1993, Hinckley and Henderson 1996, Polzer and Slater 1997). Age has also been found to be a significant risk factor (Slater and others 1995, Polzer and Slater 1997, Alford and others 2001). In the present study, 40 per cent of animals were mares and 60 per cent were geldings, and the median age was 11 years. Neither sex nor age influenced the clinical severity or recovery in the current study; however, it is important to note that the population was biased towards younger animals, as animals over 14 years of age were excluded to focus on pasture-associated laminitis and avoid the inclusion of animals with undiagnosed pituitary pars intermedia dysfunction. In addition, no stallions were included in the study.

Laminitis can be defined according to the categories previously described by Cripps and Eustace (1999) and by severity (Obel grade). The majority (90 per cent) of the current population was categorised as having laminitis, and the most common level of severity was Obel grade 2 (54 per cent). In contrast, Cripps and Eustace (1999) reported that 7.6 per cent of cases were laminitis, 36.5 per cent were acute founder, 48.8 per cent were chronic founder, and 7.1 per cent were sinker; however, this categorisation was based on all cases of laminitis presented to a specialist centre rather than first opinion, pasture-associated cases. In these first opinion cases, because of the small number of animals within each grade, Obel grades 1 and 2 were combined to form a mild group, and grades 3 and 4 were combined to make a severe group. Both severity and laminitis category were significantly associated with survival on univariate analysis, but, with only five non-survivors, it was not possible to confirm this observation in a multivariate analysis, and thus a larger practice-based study is required to address this point.

Treatment of laminitis is seen as a medical emergency, as the best results are obtained when intensive treatment is initiated within the first several hours of the appearance of clinical signs (Redden 1986). Many therapeutic regimes have been described, but there are few published reports to support their efficacy. In addition, the majority of studies focus on the effects of farriery (Goetz and Comstock 1985) and surgical interventions (Hunt and others 1991) rather than the effect of medical treatments in the initial stages of the disease, which was the focus of the present study. In the present study, and in previous pilot work, it was clear that decisions on treatment within the first seven days are highly influenced by the clinical severity at the outset. For example, other drugs were used in combination with PBZ/SUX and ACP in 51.6 per cent of severe cases, compared with only 15.8 per cent of mild cases. In 28 of 33 cases this other drug was flunixin. Thus, it would appear that additional analgesia in the form of flunixin was employed more frequently in severe cases. In addition, frog-only support was used in 38.2 per cent of the mild cases, compared with 77.4 per cent of the severe cases, and just under half of the mild cases (47.3 per cent) but only 12.9 per cent of the severe cases were not prescribed any type of foot support.

Whether vasodilator or vasoconstrictor therapy should be used in the treatment of laminitis remains unclear, but the evidence from this study tends to support the former strategy. ACP is a phenothiazine derivative that is commonly used as a tranquiliser in horses and an α-adrenergic antagonist that may be beneficial in the treatment of the vasoconstriction that is thought by some to accompany the initial stages of laminitis. ACP has been shown to increase blood flow to the digit in normal healthy horses (Ingle-Fehr and Baxter 1998, Leise and others 2007). However, its effects in clinical laminitis have not been investigated previously. ACP formed part of the commonest drug combinations prescribed in the present study, and there was a trend towards the inclusion of ACP within the treatment regime to be associated with survival. In contrast, topical nitroglycerine was infrequently prescribed in this study. Previous studies on the effects of the vasodilator nitroglycerine in the equine digit have produced conflicting data (Hinckley and others 1996, Hoff and others 2002, Gilhooly and others 2005). Vasoconstrictor therapy in the form of cryotherapy is advocated by some veterinarians because, when applied to one limb distal to the carpus continuously before experimental carbohydrate overload, it markedly reduced the clinical and histological severity of laminitis compared with the non-cooled contralateral limb (van Eps and Pollitt 2004). Cold-hosing was used in the minority of cases in the present study, and thus, although cold hosing was associated with a poorer outcome in the mild subgroup, it is not possible to draw any conclusions regarding its efficacy.

Digital pain can be alleviated by the administration of analgesics, the most commonly used of which are NSAIDs. NSAIDs are also

thought to be beneficial in the treatment of laminitis owing to their anti-inflammatory and anti-thrombotic effects. SUX is rapidly transformed in the horse following oral or intravenous administration into its main active metabolites, PBZ and oxyphenbutazone, which are responsible for the analgesic and anti-inflammatory effects of the drug (Jaraiz and others 1999). Thus, in the present study, animals that had received either PBZ or SUX were combined. PBZ/SUX was used most commonly in both mild and severe cases. The analgesic effects of the various NSAIDs in animals with laminitis have only been compared in one previous study. Ketoprofen and PBZ were compared in seven horses defined by the authors as having chronic laminitis; ketoprofen at 1.65 times the recommended therapeutic dose was more potent than PBZ in alleviating chronic pain and lameness (Owens and others 1995). The effectiveness of the drug in providing adequate analgesia was not evaluated; however, there was no association with the use of any individual NSAID and either survival or outcome.

The principal objective of supportive therapy is to prevent further laminar injury by reducing the stresses on the laminae most at risk of secondary mechanical injury (Parks and others 1999). Achieving this objective generally contributes significantly to pain relief. As the maximum stresses within the laminae are associated with the horse moving, box rest is advisable for all horses (Parks and others 1999). Although exercise may indirectly increase blood flow through the foot (Stashak 1987), there is no evidence that it improves laminar perfusion, and it also increases the mechanical forces thought to contribute to distal rotation and sinking of the pedal bone and may increase pain-related feedback (Goetz 1989). Thus, exercising of laminitis cases should be avoided. All animals in the present study were rested, the majority by being confined in a stable. In addition, concentration of stress within any one anatomical area of the laminae must be avoided, and stress must be directed away from the laminae principally at risk. This involves recruiting as much of the ground surface of the foot as possible to bear weight. The simplest way to do this is to use deep conforming bedding. An alternative is to apply a material to all or part of the concavity of the ground surface of the foot, although the techniques advocated vary (Goetz 1987, 1989, Eustace and Caldwell 1989) and include frog-only and frog and sole support. In the present study, foot support, mostly in the form of frog-only support, was used in approximately half the cases. Combined frog and sole support was rarely used. The severity of the laminitis appeared to influence the use of foot support. However, it was not possible to demonstrate significant effects of the use of foot support on any of the recovery outcome measures, possibly as a result of the relatively small numbers of cases in the study. It must be acknowledged that foot supports are beneficial only if correctly fitted. Use of supports in the wrong place, for example, a frog support that extends beyond the point of the frog or frog and sole supports that extend into the cranial third of the sole, will be detrimental.

Several studies have attempted to improve the accuracy of the determination of prognosis for laminitis cases. The prognosis has been related to the severity of onset, number of affected feet and speed of recovery (Colles and Jeffcott 1977); horses with pedal rotation of more than 11.5 degrees tend to remain lame (Stick and others 1982); and the greater the severity of lameness, the worse the prognosis (Hunt 1993). In the present study, of these parameters only the severity of lameness was recorded, and mild laminitis was significantly associated with survival. Cripps and Eustace (1999) evaluated the significance of clinical and radiological parameters as prognostic indicators for laminitis, including all cases presenting to the referral hospital, not limited to pasture-associated laminitis. Animals were assigned to one of four groups on the basis of the initial clinical examination, namely, laminitis, acute founder, chronic founder and sinker. This grouping was found to be the most important prognostic parameter studied. Outcome was successful in 100 per cent of laminitis, 81 per cent of acute founder, 20 per cent of sinker and 79 per cent of chronic founder cases. In the present study, 95 per cent of laminitis cases, 100 per cent of acute and chronic founder cases, and none of the sinker cases survived. However, there were only four cases of acute founder, five cases of chronic founder and one sinker, limiting the conclusions that can be drawn. Less significant prognostic parameters found by Cripps and Eustace (1999) included the severity of the lameness and the number of feet affected. Outcome was successful in 83.5 per cent of animals with mild laminitis (grades 0 to 3) and 48.8 per cent with severe laminitis (grades 4 to 5).

Certain animals appear to be predisposed to recurrent episodes of pasture-associated laminitis and, in the present study, 43 per cent of animals had had previous laminitis. This figure is similar to that given in the one previous report documenting the recurrent nature of the disease, in which 35 per cent of animals had repeated episodes (Katz 2004). Of the animals with mild laminitis, 52.6 per cent had previously had laminitis, compared with only 16.1 per cent of the severe cases. This could be due to the owners of animals with recurrent laminitis being more vigilant and detecting the clinical signs sooner than in animals that had not had laminitis previously. Nevertheless, whether the animal was ridden again was significantly associated with whether it had previously experienced laminitis. The odds of an animal without previous laminitis being ridden again by the end of the study were 2.41 times greater than those for an animal with previous laminitis. This may be due to the laminar damage caused by repeated episodes of the disease.

It must be acknowledged that the study design might have led to bias in the selected population. The study relied on participating veterinary surgeons in first opinion practices in the UK submitting cases. Ideally, all cases of laminitis seen by a participating veterinary surgeon during the study period would have been submitted; however, each veterinary surgeon submitted only between one and 10 cases over the 34-month study period. Numerous factors will have influenced the selection of cases for submission, including owner permission. Ideally, all first opinion equine veterinary surgeons would have submitted cases to minimise the effect of individual preferences with respect to therapeutic regimes advocated. Although all members of BEVA were invited to participate and 157 members expressed an interest in the study, only 46 members submitted cases. Despite this, no obvious bias was apparent, and we believe that the conclusions of this study are relevant to veterinary practice.

In conclusion, the majority of animals with pasture-associated laminitis were overweight or obese, and a higher BMI tended to be associated with severe laminitis, whereas optimal body condition was associated with survival. The most common treatment recommendations were rest in combination with PBZ/SUX and ACP with or without other drugs. Cold-hosing was rarely prescribed. Foot support was used in approximately half the cases, most commonly frog-only support. Eight weeks after disease onset 95 per cent of animals were alive, with lower bodyweight, optimal body condition, mild rather than severe laminitis, and acute/chronic founder status being significantly associated with survival. There was a trend towards treatment with the vasodilator ACP being associated with survival. The clinical outcome was significantly associated with horse type, being most favourable in small horses. These data are unique in that they relate specifically to cases seen in first opinion practice in the UK and thus may be more useful to practitioners than data derived from referral or foreign populations.

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Severity and outcome of equine pasture-associated laminitis managed in first opinion practice in the UK

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