BEVA / AWF practice-based study on the factors affecting return to soundness in acute pasture-associated laminitis

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Summary

107 cases of acute pasture-associated laminitis were recruited from first opinion practice to study factors associated with clinical severity, survival and return to ridden exercise. There were 43 mares and 64 geldings, median age 11 years. 31% were small ponies, 42% large ponies/cobs, 16% small horses and 11% large horses. 90% had acute laminitis. 61% were mild and 29% were severe. 40% had previously had laminitis and were significantly (p=0.02) less likely to have severe laminitis than those which had not. 83% were overweight and there was a trend (p=0.09) towards severe laminitis cases having a higher BMI. Eight weeks after disease onset, 95% were alive. Lower body weight, optimal body condition, mild rather than severe laminitis and acute/chronic founder were significantly associated with survival. There was a trend (p=0.06) towards treatment with acepromazine being associated with survival. 59% 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 72% of cases. Clinical outcome was significantly (p=0.03) associated with horse type; outcome was bad in none of the small horses compared with 34.1% of large ponies/cobs, 32.4% of small ponies and 30.0% of large horses.

Introduction

Although laminitis is perceived to affect a large number of ponies and horses in the United Kingdom (UK), epidemiological studies and studies evaluating the optimal treatment of this condition in first opinion practice are lacking. The single study that has been performed in the UK found that within a sample population of approximately 113,000 horses laminitis affected over 8,000 horses (7.1%) annually and led to more than 600 of these animals being euthanased (Hinckley and Henderson 1996a). A national survey in 1998 by the US government revealed that 13% of horse businesses had had at least one horse affected by laminitis in the previous 12 months; 1% of the horse population was affected at any given time; laminitis was the commonest cause of foot lameness and accounted for 7.5-15.7% of all lameness; horses were generally more affected by laminitis in the spring and summer (Kane and others 2000). In addition, this survey reported that 74% of affected animals recovered completely and were reusable for their intended purpose, whereas 5% died or were euthanased; and 50% 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 in order to identify risk factors for the development of acute and chronic laminitis including age, breed and gender (Alford and others 2001; Dorn and others 1975; Polzer and Slater 1996; Slater and others 1995). 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. Furthermore, there are no previous studies aimed at identifying the optimal treatment regimens and other factors that affect outcome within laminitis cases seen in first opinion practice in UK or elsewhere.

There are two main theories relating to the pathogenesis of 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). A phase of selective digital venoconstriction results in laminar ischaemia (Allen and others 1990). Endotoxin, thromboxane A_2, interleukins and 5-hydroxytryptamine have all been implicated as key vasoactive mediators in these events (Bailey and others 2004). The therapeutic implication is that treatment should include drugs that may inhibit or reverse the effects of these vasoactive mediators. In contrast, the toxic metabolic theory proposes that there is a period of increased digital perfusion that allows laminitis trigger factors such as intracellular hypoglycaemia and bacterial exotoxins to activate matrix metalloproteinase (MMP) enzymes resulting in catastrophic separation of the lamellae (French and Pollitt 2004; Mungall and others 2001). Based on the toxic-metabolic theory, the logical therapeutic approach is to institute vasoconstrictor therapy such as cryotherapy whilst vasodilators might be deleterious.

It is agreed that limitation of structural damage to the laminae during the early stages of laminitis is important, but 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 and more importantly, despite the fact that this is an extremely common and life threatening condition, there is not one large-scale clinical trial to provide evidence on the most effective therapeutic approach.

Evidence-based medicine (EBM) is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients

(Sackett and others 2000). One of the most attractive facets of the EBM approach is its focus on the identification of evidence that directly address problems encountered in our patients. The practice of EBM is becoming an increasingly important goal within the equine veterinary community. The aim should be to conduct robust studies based on data collected by veterinarians in private practice that address focussed questions on common and important disease. These will provide data that will inform current practice by establishing evidence on commonly used treatment strategies and their association with optimal clinical outcome.

A pilot study conducted amongst 70 members of the British Equine Veterinary Association (BEVA) in 2003 estimated that they treated approximately 1500 cases of acute equine laminitis per year and revealed that treatment decisions are largely based on the severity of the clinical signs. The most commonly used drugs are phenylbutazone alone or in combination with acepromazine. This is typically combined with stable or pasture rest and frog only or frog and sole support. A separate pilot study showed that approximately 85% of 25 cases treated with phenylbutazone and acepromazine returned to soundness within 8 weeks. Thus, the aim of the study was to determine the treatment factors used in acute pasture-associated laminitis affecting the return to soundness within 8 weeks using an evidence-based approach.

Materials and Methods

Case definition and recruitment:

Cases of pasture-associated laminitis were recruited prospectively by members of BEVA between 1st March 2005 and 31st December 2007. A case of acute pasture-associated laminitis was defined as a case seen by a participating veterinary surgeon in first opinion practice in the UK; a horse or pony with access to grass; clinical signs of heat, increased digital pulses and pain on hoof testers in at least 2 feet; and in recurrent cases, the previous bout of laminitis was at least 4 weeks earlier. 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 which had received any medications within the 4 weeks prior to the onset of laminitis apart from anthelminthics, vaccines or Founderguard (virginiamycin) were excluded.

BEVA members were informed of the study via the association's newsletter, presentations at Congress and the Annual General Meeting and in a series of Regional meetings. Members were offered a CPD voucher for each case they submitted and each completed case was awarded a lottery ticket for a prize draw at the end of the study in which the winner received a trip to the American Association of Equine Practitioners Annual Convention. Articles in the Equestrian press and presentations to horse owners supplemented this publicity effort.

Data Collection:

Participating veterinary surgeons were given a weigh tape and training CD containing detailed instructions for case assessment including illustrations and descriptions of the

Obel grading system (Obel 1948) and laminitis category (Cripps and Eustace, 1999) and were required to obtain the owner's informed consent and to complete (1) a standardised case description form giving details of signalment, phenotype, historical and management factors and clinical findings; (2) a standardised seven-day diary of veterinary interventions; and (3) a standardised fax-back questionnaire reporting the clinical status of the case 8 weeks after the onset of the clinical signs and providing details of management during weeks 2-8. A standardised owners' telephone questionnaire giving details of management was completed 8 weeks after the onset of the clinical signs.

Outcome Measures:

Clinical severity was assessed by the attending veterinarian on the first day of presentation and was based on the Obel grade (1 & 2 = mild; 3 & 4 = severe). At eight weeks, the outcome measures that were used to define recovery were (i) survival, (ii) return to ridden exercise, and (iii) clinical outcome category (good versus bad) reached by a consensus panel of three veterinarians (specialist orthopaedic surgeon [AB], specialist in internal medicine [CM] and experienced equine practitioner [IC]) who reviewed all the information obtained from the owner and the veterinarian.

Statistical Analysis

Descriptive statistics were obtained for all continuous variables under consideration (age, weight, height, body mass index). Whether or not the continuous variables were normally distributed was determined using the Kolmogorov-Smirnov statistic. In order to identify animal factors significantly associated with severity of the laminitic episode, chi-square test (or Fisher's exact test if any of the cells contained less than

five observations) were performed on all categorical variables, Mann-Whitney U tests were performed on the continuous variables age, weight and height and an independent t-test was conducted on the variable BMI. Univariate statistical analysis was followed by binary logistic regression using an automated backward-stepwise method. In order to identify animal and treatment factors significantly associated with any of the three outcomes, (i) survival, (ii) return to ridden exercise and (iii) clinical outcome, chi-square test (or Fisher's exact test if any of the cells contained less than five observations) were performed on all categorical variables, Mann-Whitney U tests were performed on the continuous variables age, weight and height and an independent t-test was conducted on the variable BMI. Univariate statistical analysis was followed by binary logistic regression using an automated backward-stepwise method. Factors affecting these three measures of recovery were examined within the group as a whole and in both severity sub-groups. Only those animals that had been ridden prior to the bout of laminitis were included in the analysis of factors affecting whether the animal was ridden after the episode. All statistical analyses were performed using SPSS 16.0 for Windows (SPSS Inc., Chicago, Illinois, USA) and in all instances a *p*-value of less than 0.05 was assumed to indicate significance.

Results

Study population

46 BEVA members participated and a total of 107 cases were included in the study. Of these, 43 were mares and 64 were geldings. Median age of the study population was 11 years (inter-quartile range (IQR) 8 – 12 years). Thirty-one percent (n = 25) of the animals in the study were small ponies, 42% (n = 34) were large ponies or cobs, 16% (n = 13) were small horses, and 11% (n = 9) were large horses. A quarter (25.7%) of the study population was unridden (n = 27), 46.7% (n = 49) were used for either showing or light riding, 19.0% (n = 20) were involved in general riding, and 8.6% (n = 9) were competition horses. The median height of the study population was 146 cm (IQR 126.5 – 156.5 cm), median weight was 465 kg (IQR 304.0 – 596.5 kg) and median body mass index (weight/height) was 3.20 (IQR 2.5 – 3.7). None of the animals were subjectively graded by the veterinary surgeon as thin, 10% (n = 18) were graded as optimal, 50% (n = 54) as slightly overweight and 33% (n = 35) as obese. Forty percent (n = 43) of study population had previously had laminitis.

The majority of the animals (90%, n = 97) were diagnosed with acute laminitis, 0.9% (n = 1) with sinker, 4.8% (n = 5) with acute founder and 4.8% (n = 5) with chronic founder (Cripps and Easutace, 1995). Seventeen percent (n = 18) of cases were considered to be Obel grade 1, 54% (n = 58) Obel grade 2, 23% (n = 25) as Obel grade 3 and 6% (n = 6) as Obel grade 4 (Obel, 1948).

All animals in the study were prescribed rest (either box (92.5%, n = 99) or field (7.5%, n = 8)). The drugs given during the first seven days included phenylbutazone or suxibuzone (PBZ/Sux) alone in 9.3% of cases; PBZ/Sux with acepromazine (ACP)

in 50.5% of cases; PBZ/Sux with ACP and other drugs in 26.2% of cases; PBZ/Sux and a drug other than ACP in 14% of cases; and regimens not including PBZ/Sux or ACP in 9.3% of cases of which 6 were given no drugs. The other drugs included flunixin (28 cases) ketoprofen (3 cases), nitroglycerine applied percutaneously (4 cases), meloxicam (3 cases) and eltenac (1 case). Cold-hosing of the feet was prescribed in the minority of the animals (5.6%, n = 6). Foot support was used in half the cases (53.3%, n = 57); of these 84% (n = 48) had frog only supports and 16% (n = 9) had frog and sole supports.

Severity of laminitis

Seventy one percent of the study population (n = 76) had mild laminitis (Obel grade 1 or 2) and 29% (n = 31) had severe (Obel grade 3 or 4) laminitis. Univariate analysis identified severity to be significantly associated with what the animal was used for (Fisher's exact test: $p = 0.004$), whether or not it had previously had laminitis ($X^2 = 5.60$, $df = 1$, $p = 0.025$), the type of drugs that were administered (Fisher's exact test: $p = 0.016$) and the type of foot support prescribed. The majority of animals with mild laminitis were either unridden (32.4%, n = 24) or were used for showing or light riding (47.3%, n = 35); whilst the majority of those diagnosed with severe laminitis were used for either showing or light riding (45.2%, n = 14) or general riding (38. %, n = 12). In both instances, competition horses were the least likely to have laminitis. Of the animals with mild laminitis, 52.6% (n = 40) had previously had laminitis compared with only 16.1% (n = 5) of the severe cases. In addition, there was a trend towards a higher BMI (3.32 ± 0.81 versus 3.03 ± 0.79) in animals with severe laminitis ($p = 0.09$).

PBZ/Sux was used alone in 11.8% of mild cases and 3.2% of severe cases, while PBZ/Sux was used with ACP in 57.9% of mild cases and 32.3% of severe cases. PBZ/Sux was used with ACP and other drugs in 15.8% of mild and 51.6% of severe cases. 5.3% and 3.2% respectively of mild and severe cases received PBZ/Sux with a drug(s) other than ACP and 9.2% and 9.7% received neither PBZ/Sux nor ACP. For both mild and severe laminitis, combined frog and sole support was seldom used (9.2; n = 7 and 6.5%; n = 2 of cases respectively). Frog only support was used in 34.2% (n = 26) of the mild cases and 71% (n = 22) of the severe cases. More than half of the mild cases (56.6%, n = 43), but only 22.6 % (n = 7) of the severe cases were not prescribed any type of foot support.

Table 1: Factors associated with severity of pasture-associated laminitis (severe versus mild) in 107 horses from first-opinion practices in England, as determined by logistic regression

Variable	**Value**	**OR**	**95 % CL**	***P*-value**
Previous laminitis	Yes	0.22	0.062 – 0.80	0.022
Foot support	None	Reference		0.035
	Frog	4.51	1.33 – 15.34	
	Frog & sole	0.94	0.11 – 8.13	
Use	Unridden	Reference		0.044
	Showing / light riding	2.34	0.45 – 12.19	
	General riding	10.31	1.69 – 62.85	
	Competition	1.70	0.17 – 17.09	
Drugs	PBZ/Sux	Reference		0.072
	PBZ/Sux and ACP	1.81	0.25 – 13.06	
	PBZ/Sux, ACP and other	6.66	0.93 – 47.65	
	Other	1.37	0.13 – 14.79	

Model diagnostics: Cox and Snell R square 0.32; Nagelkerke R square 0.45
PBZ = phenylbutazone, Sux = suxibuzone, ACP = acepromazine

Logistic regression (Table 1) showed that animals that had previously been diagnosed with laminitis were had lower odds (OR 0.22, CI 0.062 - 0.80) of having severe laminitis than animals that had not previously had laminitis. Animals with severe

laminitis were almost five times more likely to be prescribed frog only support rather than no foot support (OR 4.51; 95 % CI 1.33 - 15.34), and these animals were most likely to be used for general riding (OR 10.31, 95 % CI 1.69 - 62.85) and least likely to be used for competitive purposes (OR 1.70, 95 % CI 0.17 - 17.09). Furthermore, cases of severe laminitis were most likely to be prescribed PBZ/Sux with ACP and another drug (OR 6.66, 95 % CI 0.93 - 47.65) compared with phenylbutazone or suxibuzone alone.

Recovery

Survival

Eight weeks after the onset of the acute laminitis 95% (n = 102) of the cases were still alive; 5 (5%) animals had been euthanased, of which one was for reasons unrelated to laminitis. Univariate analysis revealed that weight, BMI, body condition, Obel grade and laminitis category were significantly associated with survival with smaller, optimal body condition, mild laminitis, and acute and chronic founder being significantly associated with survival (Table 2). In addition, there was a trend (p = 0.062 and p = 0.08) towards the inclusion of ACP within the treatment to be associated with survival (Table 2).

Table 2: 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**	**Euthanased**	***P*-valve**
Weight	439 ±156.4	593.6 ±135.05	0.03
BMI (weight/height)	3.07 ± 0.79	3.91 ± 0.63	0.02
Optimal body condition	18	0	<0.001
Slight overweight	52	2	
Obese	32	2	
Obel grade 1 or 2	75	1	0.0241
Obel grade 3 or 4	27	4	
Acute 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	
Phenylbutazone or suxibuzone only	8	2	0.062
Phenylbutazone or suxibuzone with ACP	53	1	
ACP	80	2	0.0821
No ACP	22	3	

Horse or pony ridden again

At the end of the study, of the 81 animals normally used for riding, 59% (n = 48) were being ridden again and 41% (n = 33) were not. Whether or not the animal was ridden again was significantly associated with whether or not it had previously experienced laminitis (X^2 = 4.06, df = 1, p = 0.044). Of the animals that were being ridden again, 69.6% (n = 32) had no prior episodes of laminitis, while of those animals not ridden again the converse was apparent; 53.1% (n = 17) had been previously diagnosed with laminitis. Logistic regression showed the odds of an animal, without previous laminitis, being ridden again by the end of the study were 2.59 times greater (95% CI 1.02 – 6.61; p = 0.046)) than that of an animal with previous laminitis.

Veterinary Consensus Outcome

Veterinary-consensus outcome was 'good' for 72% (n = 77) and 'bad' for 28% (n = 30) of the cases. Outcome was significantly associated with animal type (X^2 = 6.97, df = 3, p = 0.036); of the small and large horses, 65% or more received a 'good' outcome; all small horses (n = 15) received a 'good' outcome compared with only 65.9% (n = 29) of small ponies. None of the small horses received a 'bad' outcome, compared with 34.1% (n = 15) of large ponies and cobs, 32.4% (n = 12) of small ponies, and 30.0% (n = 3) of large horses. In the mild laminitis subgroup, there was a significant association between whether or not the case received cold hosing and the outcome: three of four cases that were cold-hosed had a 'bad' outcome while 14 of 72 (19.4%) that were not cold-hosed had a 'bad' outcome (Fischer's exact test: p = 0.034) but this was not significant on multivariate analysis. Within the severe laminitis subgroup there was no significant association between any of the variables and whether or not the outcome was 'good' (n = 17) or 'bad' (n = 7).

Discussion

In the present study, eight weeks after the onset of acute laminitis 95% of animals were still alive, 72% were considered to have a good clinical outcome and 59% were being ridden again. This compares favourably with one study in which 77% of animals with laminitis returned to their original athletic function and 16% died or were euthanased within 6 months of diagnosis (Cripps and Eustace 1999) and a second in which 74% of affected animals recovered completely and were reusable for their intended purpose and 5% died or were euthanased (Kane and others 2000). The current study is particularly pertinent as it is focussed on a specific population in the UK, namely cases of laminitis associated with pasture, exclusively recruited via first opinion practitioners.

This study has shown that excessive body condition not only increases the risk of severe clinical signs but also increases the risk of non-survival in animals that develop pasture-associated laminitis. Multiple variables have been previously evaluated as risk factors for the development of laminitis with the findings generally being inconsistent amongst different studies. Body weight greater than 550kg was associated with an increased risk of developing of laminitis in hospitalised patients (Cohen and others 1994), while other studies have found no association between weight and the prevalence of laminitis (Peloso and others 1996; Slater and others 1995). The median weight of animals in the present study was 465kg. Recent research has focussed on obesity rather than body weight as being a significant risk factor for the development of laminitis (Johnson and others 2004; Treiber and others 2005). Eighty three percent of animals were thought to be slightly overweight or obese in the present study.

In the present study, 73% of affected animals were ponies rather than horses and previous studies have shown that ponies are at increased risk of developing laminitis compared to other breeds (Dorn and others 1975; Hinckley and Henderson 1996b; Kane and others 2000). The use of the animal was associated with the clinical severity of the laminitis while 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% of small ponies. None of the small horses were assigned a 'bad' clinical outcome, compared with 34.1% of large ponies and cobs, 32.4% of small ponies and 30.0% 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% failure) compared to other breeds (combined failure rate 16.7%, (Cripps and Eustace 1999).

Gender has been determined by some groups to be a positive risk factor for laminitis (Alford and others 2001; Amoss and others 1979; Dorn and others 1975; Slater and others 1995), whilst others have found no relationship (Hinckley and Henderson 1996a; Hunt 1993; Polzer and Slater 1996). Age has also been found to be a significant risk factor for both acute (Alford and others 2001) and chronic laminitis (Alford and others 2001; Polzer and Slater 1996; Slater and others 1995). In the present study, 40% were mares and 60% were geldings and the median age was 11 years. Neither gender nor age influenced the clinical severity or the recovery in the current study. However, it is important to note that in the current study the population was biased towards younger animals as animals over 14 years of age were excluded in

order to focus on pasture-associated laminitis and avoid the inclusion of animals with undiagnosed pituitary pars intermedia dysfunction.

Laminitis can be defined according to both severity (Obel grade) and the categories previously described by Cripps and Eustace (1999). The majority (90%) of the current population was diagnosed with acute laminitis and the most common severity was Obel grade 2 (54%). In contrast, Cripps and Eustace (1999) reported that 7.6% of cases were acute laminitis, 36.5% were acute founder, 48.8% were chronic founder and 7.1% were sinker; however this is based on all cases of laminitis presented to a specialist centre rather than first opinion pasture-associated cases. In these first opinion cases, due to the small number of animals with each grade, Obel grades 1 and 2 were combined to form a mild group and grades 3 and 4 combined to make a severe group. Both Obel grade and laminitis category were significantly associated with survival on univariate analysis but, with only 5 non-survivors, it was not possible to confirm this observation in a multivariate analysis and thus a larger practice-based study is needed to address this.

Treatment of acute laminitis is seen as a medical emergency as the best results are obtained when intensive treatment is instituted with the first several hours of the appearance of the 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 in cases of chronic laminitis (Hunt and others 1991) rather than the effect of medical treatments employed in the acute laminitic case which was the focus of this study. In this study, and our 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.

Whether vasodilator or vasoconstrictor therapy should be employed in the treatment of acute laminitis remains unclear but the current evidence tends to support the former strategy. ACP is a phenothiazine sedative and an α-adrenergic antagonist that may be beneficial in the treatment of the vasoconstriction that is thought by some to accompany acute 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 acute or chronic 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 the current study. Previous studies on the effects of the vasodilator nitroglycerine in the equine digit have produced conflicting data (Gilhooly and others 2005; Hinckley and others 1996; Hoff and others 2002). Vasoconstrictor therapy in the form of cryotherapy is advocated by some as, when applied to one foot, it markedly reduced the severity of acute laminitis in an experimental carbohydrate overload model (van Eps and Pollitt 2004). Cold hosing was employed in the minority of cases in the present study and thus, although cold hosing was associated with a poorer outcome in the mild sub-group, 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 the non steroidal anti-inflammatory drugs (NSAIDs). NSAIDs are

also thought to be beneficial in the treatment of acute laminitis due to their anti-inflammatory and anti-thrombotic effects. Suxibuzone (Sux) is very rapidly transformed in the horse following oral or intravenous administration into its main active metabolites, phenylbutazone (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 be compared in one study previously. Ketoprofen and phenylbutazone (PBZ) were compared in 7 horses with chronic laminitis; ketoprofen at the dosage rate of 1.65 times the recommended therapeutic dose was more potent than phenylbutazone 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 principle objectives of supportive therapy are to prevent further laminar injury by reducing the stresses on the laminae most at risk of secondary mechanical injury and to prevent compression of the circumflex artery and solar plexus (Parks and others 1999). Achieving these objectives generally contributes significantly to pain relief. As the maximal stresses within the laminae are associated with the horse moving, box rest is advisable for all horses (Parks and others 1999). Whilst exercise indirectly increases blood flow through the foot (Stashak 1987), 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). 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 (Eustace and Caldwell 1989; Goetz 1987, 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 supports were rarely used. The severity of the laminitis appeared to influence 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.

Several studies have previously attempted to improve the accuracy for determining the 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^{o} 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 both acute and chronic cases and those not just 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 which was studied. Outcome was successful in 100% of laminitis cases, 81% of acute founder, 20% of sinker and 79% of chronic founder cases. In the present study, 95% of laminitis cases, 100% of acute and chronic founder cases and none of the sinker cases survived; and acute and chronic founder were significantly associated with survival. However, there were only 4 cases of acute founder, 5 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% of animals with mild laminitis (grades 0-3) and 48.8% with severe laminitis (grades 4-5).

Certain individual animals appear predisposed to the development of chronic pasture-associated laminitis and in the present study 43% of animals had a history of previous laminitis. This figure is similar to the single previous report documenting the recurrent nature of the disease in which 35% of animals had repeated episodes (Katz 2004). Of the animals with mild laminitis, 52.6% had previously had laminitis compared with only 16.1% 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 compared to an animal which has not had laminitis previously. Nevertheless, whether or not the animal was ridden again was significantly associated with whether or not it had previously experienced laminitis. The odds of an animal, without previous laminitis, being ridden again by the end of the study were 2.59 times greater than that of an animal with previous laminitis. This may be due to the laminar damage cause by repeated episodes of the disease.

In conclusion, the majority of animals with acute pasture-associated laminitis were overweight or obese, and a higher BMI tended to be associated with severe laminitis whilst optimal body condition was associated with survival. The commonest 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% of animals were alive, with lower body weight, optimal body condition, mild rather than severe laminitis and acute/chronic founder 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, this 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 and/or foreign populations.

Welfare message for horse and pony owners:

Overweight animals that develop laminitis tend to have more severe signs than those of optimal weight. When laminitis does occur, overweight animals are more likely to die of the disease than their thinner counterparts.

Welfare & Scientific message for practising veterinarians

Treatment choices are driven by the severity of signs but including ACP in the treatment regimen tends to improve survival. Veterinarians should continue to educate their clients on the danger of severe and fatal laminitis that is associated with excessive body condition in horses and ponies.

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