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Article *in* The Canadian veterinary journal. La revue veterinaire canadienne · June 2010

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Article

Prognostic indicators of poor outcome in horses with laminitis at a tertiary care hospital

James A. Orsini, Corrina Snook Parsons, Linda Capewell, Gary Smith

Abstract — This retrospective study investigated the factors associated with a poor outcome (death by euthanasia or from other causes) in horses treated for laminitis at a tertiary care hospital. Cases (n = 247) were defined as patients with laminitis that were euthanized or that died of other causes during hospitalization. Controls (n = 344) were patients with laminitis that survived to be discharged from the hospital. In the final multivariate analysis, the factors significantly associated with an increased risk for death and their respective odds ratios (OR) were as follows: Thoroughbred (OR = 1.57); racehorse (OR = 1.76); treatment with flunixin meglumine (OR = 1.76); vascular pathology (OR = 2.12); distal displacement of the third phalanx (OR = 2.68); pneumonia (OR = 2.87); and lameness of Obel grade II (OR = 2.99), grade III (OR = 9.63), or grade IV (OR = 20.48). The use of glue-on shoes significantly reduced the risk for death (OR = 0.36).

Résumé — Indicateurs d'un pronostic de mauvais résultats chez les chevaux atteints de laminite dans une clinique de soins tertiaires. Cette étude rétrospective a examiné les facteurs associés à de mauvais résultats (mort par euthanasie ou pour d'autres causes) chez les chevaux traités pour la laminite dans une clinique de soins tertiaires. Les cas (n = 247) étaient définis comme des patients atteints de la laminite qui ont été euthanasiés ou qui sont morts d'autres causes durant l'hospitalisation. Les témoins (n = 344) étaient des patients atteints de laminite qui avaient survécu au congé de la clinique. Dans l'analyse finale multicritères, les facteurs présentant une association significative avec le risque accru de mort et leurs ratios respectifs d'incidence (RI) étaient les suivants : Thoroughbred (RI = 1,57); cheval de course (RI = 1,76); traitement à la flunixin méglumine (RI = 1,76); pathologie vasculaire (RI = 2,12); déplacement distal de la troisième phalange (RI = 2,68); pneumonie (RI = 2,87); et boiterie de grade Obel II (RI = 2,99), de grade III (RI = 9,63) ou de grade IV (RI = 20,48). L'usage de fers collés réduisait significativement le risque de mort (RI = 0,36).

(Traduit par Isabelle Vallières)

Can Vet J 2010;51:623–628

Introduction

Laminitis is a potential sequela to numerous conditions in the horse (1–4). It can be a very frustrating disease, and case management often is complicated by humane, financial, and emotional considerations which at times are in direct conflict. Laminitis is not in itself a fatal disease; however, the associated pain and debility can be of such severity and duration that euthanasia ultimately is in the best interest of the patient. Even so, this decision seldom is an easy one, as there is a broad gray area in which the outcome, in terms of comfort and function, is uncertain.

The severity of pain, degree of rotation of the third phalanx (P3), and radiographic or palpatory evidence of distal displacement ("sinking") of P3 are primarily used by clinicians to determine the prognosis for clinical recovery and return to athletic function in any given case (1–5). However, the handful of epidemiological studies examining outcome in horses with laminitis have been somewhat contradictory in that regard. For example, Hunt (3) found that functional outcome was not correlated with the degree of rotation. He concluded that, while horses that develop distal displacement of P3 are more likely to die than are horses without distal displacement, neither the presence or absence of distal displacement nor the degree of P3 rotation can reliably be used to predict the outcome in a horse with laminitis (3).

Cripps and Eustace (4) similarly noted that the clinical group to which the horse was assigned — which factored in duration,

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This research was supported by the Spot Castle Fund.

gross digital pathology, and severity of lameness — was the single most important indicator of outcome, and more reliable than any radiographic findings. These studies highlight the importance of clinical assessment, particularly as it relates to severity and duration of pain, in determining outcome. Even so, reliance on radiographic findings in making treatment decisions and outcome predictions persists among clinicians. Certainly, radiographic findings are important in case assessment and management, but our experience and the aforementioned studies indicate that radiographic findings should not be the sole or even the primary deciding factor in determining outcome nor in opting for euthanasia.

The purpose of our study was to examine, in more detail, the clinical circumstances associated with a poor outcome (death, whether by euthanasia or from other causes) in a large group of horses treated for laminitis at our tertiary care hospital. Identifying significant risk factors for a poor outcome and providing odds ratios for each, we believe, will aid the clinician in decision-making and client communications.

Materials and methods

Study design

This retrospective study used an unmatched case-control design. Data were obtained from medical records at the George D. Widener Hospital for Large Animals, University of Pennsylvania School of Veterinary Medicine, between 1986 and 2003.

Source population

Records were retrieved by searching the hospital database for all equine patients that had had a diagnosis of laminitis. Included were horses with a presenting complaint of laminitis that were hospitalized for treatment of laminitis, and horses that presented to the hospital for any other reason and developed laminitis during their period of hospitalization.

A diagnosis of acute laminitis was based on clinical findings which included characteristic stance or posture, characteristic lameness, digital pulses of increased intensity, and increased hoof wall temperature. The diagnosis of laminitis was supported radiographically in horses surviving beyond the acute stage of disease if rotation and/or distal displacement of P3 were seen in animals with clinical signs suggestive of laminitis.

Severity of lameness was rated according to Obel grade (5). With Obel grade I, the horse does not appear lame at the walk but has a somewhat stilted gait at the trot; the horse intermittently shifts its weight from foot to foot while standing still. A horse with Obel grade II lameness is willing to walk but has the characteristic camped-out posture of a laminitic horse; these horses will allow the affected feet to be picked up. In contrast, a horse with Obel grade III lameness is reluctant to move and resists attempts to pick up its feet. A horse with Obel grade IV lameness is extremely reluctant to move and is often recumbent.

Acute, subacute, and chronic cases of laminitis were all included in the analysis, as long as the animal was treated for laminitis at the hospital and complete treatment data and outcome were available. Records with incomplete treatment information or outcome were excluded. A *case* was defined as a patient with laminitis that was euthanized or died of other causes during hospitalization. A *control* was defined as a patient with laminitis that survived to be discharged from the hospital.

Exposures of interest

Exposures of interest gleaned from the medical records were grouped into the following categories: signalment (breed, sex, age); use (racing, show, breeding); Obel grade of lameness (I = stilted trot, II = lameness when walking, III = moves reluctantly, IV = often recumbent); management history (excess lush grass intake, excess cold water intake, carbohydrate overload, exercised on hard surface, stabled on black walnut wood shavings); associated features (rotation of P3, distal displacement of P3, thickened dorsal laminae, pedal osteitis, solar abscesses, contralateral limb lameness); other conditions and signs (medically treated colic, surgically treated colic, retained placenta/metritis, vascular pathology, hypothyroidism, pituitary adenoma, pneumonia, diarrhea, obesity, positive *Salmonella* culture); and procedures and treatments [deep digital flexor tenotomy, hoof wall resection, glue-on shoes, lily pads, phenylbutazone, flunixin meglumine, aspirin, isoxsuprine, dimethyl sulfoxide (DMSO), acepromazine, pentoxifylline, J5 antiendotoxin plasma, heparin, topical nitroglycerine, intravenous lidocaine].

Vascular pathology included phlebitis, thrombophlebitis, and septic thrombophlebitis/abscessation which were consequences of intravenous catheter placement and maintenance for intravenous administration of drugs and fluids. The diagnosis was confirmed on ultrasonographic examination of the affected jugular vein(s), followed by aseptic aspiration of any hypoechoic areas that were suspected to be foci of infection.

Statistical analysis

Data were analyzed using the statistical software available in STATA (Stata Statistical Software: Release 7.0, 2001; Stata Corp., College Station, Texas, USA). A preliminary univariate screen of all exposures was undertaken to select those that would be included in the final multivariate analysis. Additional analysis used the format of Hosmer and Lemeshow (6).

Univariate analysis. Odds ratios were used to measure the association between each independent categorical variable and the outcome of interest (death). The significance of each association was assessed using the Pearson's chi-squared (χ^2) statistic. The association between age (the only continuous variable) and death was evaluated using Student's *t*-test to compare means. The association was then re-examined using odds ratios (OR) after grouping the age data into 5 levels ($<$ 3 y, 3–5 y, 6–10 y, 11–15 y, $>$ 15 y). Owing to the multiple categories of Obel grades, we treated this variable similarly to age. All exposures associated with death in the univariate analysis at $P < 0.20$ were selected for inclusion in the multivariate logistic regression analysis. The value, $P < 0.2$, was selected to avoid a too rigorous initial selection among variables (6,7).

Multivariate analysis. The components of the multivariate model were determined by a combination of purposeful backwards model selection and an automated stepwise backwards model selection process. The order in which the contribution of an independent variable was evaluated in the

purposeful selection procedure was based upon an examination of the Wald statistic for that variable. Variables with a Wald statistic that was substantially < 2 were evaluated first. After selection and removal of the variable, the new model was compared with the old model using the likelihood chi-squared ratio (LCSR) test. Multivariate model analyses are used in this kind of case control study because of their ability to tease out the individual contribution for any given risk factor independently of all other tested factors.

Following the recommendations of Hosmer and Lemeshow (7), a variable was permanently excluded from the model if the *P*-value for the LCSR was > 0.15, unless its removal caused a $> 50\%$ alteration in the magnitude of the ORs for the remaining variables. We also considered removing variables when the interval estimates for their odds ratios were very large.

Finally, clinically plausible interaction terms were defined and included in the main effect model. Individual interaction terms were examined in step-wise fashion and deleted or retained using the criteria already stated. Model performance was evaluated using the Pearson's X^2 test as a summary statistic of goodness of fit ("calibration" *sensu*) (6,7) and the area under the receiver-operator curve as a summary statistic of discriminating power. The use of the Pearson's X^2 test was justified because the number of covariate patterns was small compared with the number of observations. We were particularly interested in the area under the receiver-operator curve, given that we were seeking prognostic indicators of death.

As shown in Table 1, 23 independent variables satisfied the criteria for inclusion in the initial multivariate model. All variables were looked at and those with $P < 0.2$ were selected for inclusion in the multivariate analysis. Age was not retained, as univariate analysis revealed $P > 0.3$ for all age categories, and preliminary multivariate analysis revealed no evidence that age was a confounding variable. Because of the large number of variables that met the initial screening criteria, 5 multivariate exploratory models were developed, each based upon one of the main categories of exposure (signalment, initial Obel grade, associated features, other conditions and signs, procedures and treatments). The variables identified as making substantial contributions in each of the exploratory models were then pooled and used to develop the final main effects model (8).

Table 1. Results of univariate analysis of data from 591 horses with laminitis, showing the association between several independent variables and the outcome of interest (euthanasia or death from other causes)

Variable	Odds ratio	95% CI	*P*-value
Age (years)			
< 3	1.00		
3–5	0.97	0.53–1.70	0.94
6–10	1.06	0.61–1.86	0.83
11–15	1.17	0.64–2.13	0.61
> 15	0.71	0.36–1.38	0.31
Sex			
Gelding or mare	1.00		
Stallion	1.93	1.26–2.94	0.002
USE			
Show or breeding	1.00		
Racing[a]	2.87	1.98–3.15	< 0.001
Breed			
Quarter horse or other	1.00		
Standardbred	2.55	1.50–4.35	0.003
Thoroughbred[a]	2.18	1.51–3.15	< 0.001
Associated conditions			
Rotation of P3	0.65	0.45–0.94	0.02
Distal displacement of P3[a]	3.28	2.25–4.76	< 0.001
Pedal osteitis	0.46	0.26–0.81	0.006
Contralateral limb lameness	1.80	1.11–2.93	0.016
Other conditions			
Medically treated colic	2.20	1.22–3.94	0.007
Vascular[a] pathology (thrombophlebitis/ coagulopathy and septic thrombophlebitis)	3.24	1.88–6.63	< 0.001
Diarrhea	2.65	1.70–4.12	< 0.001
Positive test for *Salmonella*	3.76	1.31–10.75	0.008
Pneumonia[a]	3.25	1.54–6.81	0.001
Obel grade			
Grade I[a]	1.00		
Grade II[a]	3.90	1.96–7.74	< 0.001
Grade III[a]	13.38	6.31–28.38	< 0.001
Grade IV[a]	27.07	10.93–67.05	< 0.001
Procedures and treatments			
Glue-on shoes[a]	0.35	0.19–0.65	0.0004
Lily pads	1.81	1.26–2.62	0.0012
Flunixin meglumine[a]	2.97	2.02–4.34	< 0.001
Aspirin	2.22	1.26–3.90	0.0042
DMSO	2.57	1.33–4.99	0.004
Acepromazine	2.36	1.56–3.58	< 0.001
Pentoxifylline	2.74	1.20–6.29	0.013
J5 antiendotoxin plasma	2.30	1.20–4.43	0.01
Heparin	8.71	1.90–39.89	0.0008

CI — confidence interval; P3 — third phalanx; DMSO — dimethyl sulfoxide (administered intravenously); [a] — variables that were included in the multivariate analysis.

Covariate patterns. Having calculated the summary statistics for goodness of fit for our final model, we then explored the assumption that the contribution of each covariate pattern to the summary statistics was both unsystematic and small, relative to the error structure of the model. We calculated 3 diagnostic statistics for each covariate pattern: the change in the Pearson chi-squared test statistic (χ^2) and in the deviance (D) following the deletion of the covariate pattern, and the Prebigon influence statistic (β). Covariate patterns were examined more thoroughly if the corresponding value $\gamma\chi^2$ or (D) exceeded 4 or if β exceeded 1 (7).

The next step was to remove covariate patterns with extreme values of χ^2, D or β from the model to see if this would result in large changes in the newly calculated odds ratios ($> 50\%$) or the summary statistics for goodness of fit. If this was the case, then the details for suspect covariate patterns were examined to see if there was any clinical justification for removing these groups of patients from the analysis.

Results

Descriptive statistics

There were 591 horses in the source population: 247 cases [of which 234 (95%) were euthanized and 13 (5%) died of other causes] and 344 controls, for a control–case ratio of 1.4:1 and an overall mortality rate of 41.8%. The median age was 7 y and the average age was 8.5 y; the oldest patient was 31 y. Gender distribution was as follows: 46% mares, 35.5% geldings, and 18.5% stallions. Regarding use, 31.3% were race horses, 49.8%

were show horses, and 11.2% were kept for breeding purposes; the horse's use was not recorded for the remaining 7.7% of patients. Breed distribution was as follows: 42% Thoroughbreds, 13% Standardbreds, 9% Quarter horses, and 36% mixed or undetermined breed.

Obel grades were recorded for 491 horses in the source population. The breakdown was as follows: 31% with Obel grade I (16 cases, 136 controls); 21.5% with Obel grade II (33 cases, 72 controls); 24.5% with Obel grade III (74 cases, 47 controls); and 23% with Obel grade IV (86 cases; 27 controls). As shown in Figure 1, there was a highly significant association between Obel grade and the probability of death (Pearson's chi-squared test of association = 130, df = 3, $P < 0.001$).

Multivariate analysis

The results of the final multivariate analysis are shown in Table 2. The final model was based upon 491 observations, and there were no significant interaction terms. The Pearson chi-squared statistic for goodness of fit was 137.72 (df = 30, $P = 0.31$), and the area under the receiver-operator curve was 0.86 (indicating "excellent" discrimination) (6,7).

Covariate analysis

Examination of the diagnostic statistics revealed 3 covariate patterns with extreme values. Re-estimating the model parameters and goodness of fit statistics after deletion of these covariate patterns resulted in large changes in calculated odds ratios and goodness of fit statistics in only 1 case. This covariate pattern comprised 3 race horses with vascular pathology (phlebitis/thrombophlebitis) and Obel grade I lameness. All 3 patients were treated with flunixin meglumine and all 3 patients died before discharge (2 were euthanized, 1 died of other causes).

Removing these patients resulted in a marked increase in the goodness of fit (Pearson chi-squared = 128.45, df = 29, $P = 0.50$) but no improvement in the model's ability to discriminate between patients that died and those that did not (area under the receiver-operator curve = 0.86). There was thus no clinical justification for excluding these 3 horses in this covariate pattern, and the results presented in Table 2 include the contribution of these patients.

Obel grade

The odds of death in a horse with laminitis and an Obel grade of II were 3 times greater than the odds for a similar horse (with respect to the other covariates in the model) with an Obel grade of I (Table 2). The likelihood of a poor outcome increased with the severity of lameness: the odds of death in laminitis patients with Obel grades of III or IV were respectively 9.6 and 20.5 times greater than the odds for a similar horse with an Obel grade of I. Indeed, the Obel grade alone provided a model with reduced but still excellent ability to discriminate (area under the receiver-operator curve = 0.80).

Other risk factors

Thoroughbreds and race horses with laminitis were the 2 breed/occupation groups at greatest risk for death (OR = 1.57 and 1.76, respectively; Table 2). Patients with pneumonia, distal displacement of P3, or vascular pathology were 2–3 times more likely to die than horses without these conditions. The odds of death in a laminitis patient treated with flunixin meglumine were almost 2 times greater than the odds for a horse not treated with flunixin. Glue-on shoes appeared to be protective: the odds of death in a laminitis patient with glue-on shoes were approximately 1/3 of that for a patient in which glue-on shoes were not used. The odds ratio for glue-on shoes was 0.36, with a confidence interval (CI) of 0.16–0.78.

Table 2. Results of the final multivariate analysis of data from 491 horses with laminitis, comparing cases (horses with laminitis that died or were euthanized) with controls (horses with laminitis that were discharged from the hospital) for 11 independent variables identified by univariate analysis

Variable	Cases *(n)*	Controls *(n)*	Adjusted OR	95% CI
Obel grade				
Grade I	16	136	1.00	
Grade II	33	72	2.99	1.45–6.14
Grade III	74	47	9.63	4.80–19.32
Grade IV	86	27	20.48	9.98–42.02
Thoroughbred				
No	109	188	1.00	
Yes	100	94	1.57	0.96–2.57
Race horse				
No	111	216	1.00	
Yes	98	66	1.76	1.03–2.99
Distal displacement of P3				
No	98	226	1.00	
Yes	111	56	2.68	1.65–4.39
Pneumonia				
No	188	273	1.00	
Yes	21	9	2.87	1.05–7.82
Vascular abnormality				
No	171	262	1.00	
Yes	38	20	2.12	1.02–4.41
Flunixin meglumine				
No	114	231	1.00	
Yes	95	51	1.76	1.05–2.96
Glue-on shoes				
No	195	232	1.00	
Yes	14	50	0.36	0.16–0.78

n — number of horses in that group; OR — odds ratio; CI — confidence interval; P3 — third phalanx.

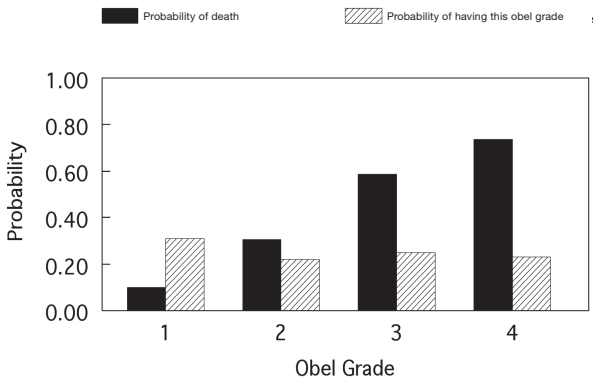

Figure 1. Results of a Pearson's chi-squared test of association for Obel grade and probability of death in 491 horses with laminitis.

Discussion

The prognostic factors of importance that are variously cited for horses with laminitis include the degree of rotation of P3 (1,4), body weight in horses with distal displacement of P3 (2), clinical grade of laminitis (which primarily includes the severity of lameness) (3,4,9), clinical category of laminitis (which encompasses both severity and chronicity) (4), founder distance (vertical distance from the top of the dorsal hoof wall to the top of the extensor process of P3) (4), presence of solar prolapse (4), and the number of feet affected (4,9). Clinicians may also use the duration of lameness, speed of progression to severe lameness, prior episodes of laminitis, concurrent disease processes, and owner commitment to treatment when determining the prognosis in a given case (10).

The goal of our study was to further clarify the risk factors for a poor outcome (nonsurvival) in hospitalized horses with laminitis, and thereby guide clinicians in making decisions when treating these patients. As it was a retrospective study, it was not possible for us to evaluate the rationale for euthanasia, in particular whether laminitis was the primary reason for euthanasia, and what contribution humane, economic, and emotional considerations made in each case.

Some of our findings were expected and reiterated those of previous reports (3,4). They included an increased risk for death in Thoroughbreds, racehorses, sinkers, and horses with an illness that involved a systemic inflammatory response (such as, pneumonia). Also not unexpected was an increased risk for death in laminitic horses with severe lameness. Of all the variables evaluated in our analyses, by far the one most highly associated with outcome was the severity of the lameness. In fact, Obel grade was the single best indicator of outcome.

The association was particularly strong for horses with Obel grade III or IV lameness, which were approximately 10 and 20 times, respectively, more likely to die than were horses with Obel grade I lameness. This association likely reflects the humane aspects of managing severe laminitis as much as it does the severity of the disease process and thus the likelihood of a satisfactory outcome in very painful cases. It is difficult to justify continued treatment in a horse with Obel grade IV lameness when one cannot say for certain that comfort and some degree of normal function will be restored in a reasonable period of time.

These findings are consistent with those of Hunt (3) and of Cripps and Eustace (4), who each showed a clear correlation between the severity of lameness and outcome. In essence, the more severe the lameness, the less likely it was that the horse would survive and return to athletic function. In addition to humane considerations, this latter aspect may, in part, be indicative of the economic realities of managing athletic horses that have potentially performance-limiting or career-ending diseases. For example, in our clinical experience, race horses given a poor prognosis for return to racing and with only average potential value as breeding animals often are euthanized, for economic rather than medical/humane reasons.

Of some surprise was the increased risk for death in horses with vascular pathology (phlebitis, aseptic or septic thrombophlebitis). With the possible exception of septic thrombophlebitis, these vascular conditions are not considered to carry an inherently high risk for death. It is possible that phlebitis may increase the risk for thromboembolic events in the digital microvasculature, which could worsen the prognosis for recovery from laminitis. An equally plausible explanation, though, is that these vascular problems developed as a complication of treatment for concurrent systemic disease states (intravenous catheterization and administration of medications, fluids, hyperalimentation), and it was the concurrent disease which increased the risk for death in these patients.

Also of interest was the increased risk for death in horses treated with flunixin meglumine. The most likely reason for this finding is that the horses that received flunixin typically had severe concurrent diseases (for example, endotoxemia, severe diarrhea, pneumonia) which, in themselves, were potential risk factors for laminitis and also for death. Thus, a higher percentage of critically ill cases were treated with flunixin, which biased the results. It seems unlikely that the drug itself would have increased the risk for death/euthanasia when other NSAIDs (phenylbutazone, aspirin, DMSO) did not. Even so, this finding is somewhat sobering, in that it seems to suggest that flunixin has a limited protective effect, in terms of avoiding a poor outcome, in such cases.

The protective influence of glue-on shoes was an interesting and useful finding. The use of glue-on shoes in laminitic horses has been documented in the veterinary literature (11), although no critical evaluation of their use has been published before. Proponents of glue-on shoeing technology consider it a means to atraumatically provide support to the laminitic foot. In addition, by allowing the farrier and clinician to adjust the angle of the shoe relative to the weight-bearing surface of the hoof, the normal orientation of P3 relative to the rest of the digit and to the ground surface can be restored, thus relieving compression on the solar corium and tension on the dorsal laminar corium. As a result, the horse is more comfortable, and the presumption is that blood flow to those compromised areas is improved (11).

Furthermore, glue-on shoe technology allows one to create a larger weight-bearing surface, which improves the biomechanics of the foot by reducing the concentration of load in the toe region. It also provides some additional protection to the sole and the underlying third phalanx. Sole protection can be further enhanced by placing any of several urethane packing materials between the sole and the weight-bearing surface of the shoe. In an informal survey of 19 horses with chronic laminitis that were shod with glue-on shoes, the lameness improved in all cases and none of the horses were euthanized (11).

In summary, the severity of lameness was the single most important prognostic indicator in hospitalized horses with laminitis. Notably, the presence of distal displacement of P3 ("sinking") was the only radiographic finding significantly associated with a poor outcome. Predictably, the risk for death was greater in Thoroughbreds, race horses, and horses with an illness that caused a systemic inflammatory response (such as, pneumonia). Flunixin meglumine did not appear to be protective in terms of a poor outcome. In contrast, the use of glue-on shoes significantly reduced the risk for death. CVJ

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Answers to Quiz Corner
Les réponses du test éclair

1. **b)** *Bordetella bronchiseptica* causes pneumonia and septicemia in guinea pigs.
b) *Bordetella bronchiseptica* cause une pneumonie et une septicémie chez le cobaye domestique.

2. **d)** Recent studies have failed to confirm the value of pyloroplasty in preventing recurrence of gastric dilation-torsion.
d) Les études récentes n'ont pas réussi à démontrer la valeur de la pyloroplastie pour prévenir la récurrence de la dilatation/torsion gastrique.

3. **b)** Aging of the lens results in dehydration and hardening or sclerosis of the lens nucleus.
b) Le vieillissement du cristallin conduit à la déshydratation et au durcissement ou à la sclérose du noyau du cristallin.

4. **b)** Transfer only occurs within the first few hours after nursing, until the gut "closes" to antibody uptake.
b) La transmission se produit seulement durant les quelques premières heures après l'allaitement, jusqu'à ce que l'intestin ne soit plus « réceptif » à l'apport des anticorps.

5. **c)** Hypertonic enemas should never be administered to cats or small dogs, especially if the animal is obstipated. These can kill the animal by fluid and electrolyte shifts.
c) Les lavements hypertoniques ne devraient jamais être administrés aux chats et aux petits chiens, spécialement si l'animal est constipé. Ils peuvent tuer l'animal par échanges de liquide et d'électrolytes.

6. **b)** Association of nasal discharge with nursing in a neonate is essentially pathognomonic for cleft palate. Persistent dorsal displacement of the soft palate can be associated with coughing and nasal discharge containing food material in some horses. Intermittent dorsal displacement of the soft palate causes exercise intolerance in racehorses; clinical signs of the condition are usually absent at rest.
b) L'association d'un écoulement nasal avec l'allaitement chez un nouveau-né est essentiellement pathognomonique d'une fente palatine. La persistance d'un déplacement dorsal du palais mou peut être associée à de la toux et à un écoulement nasal renfermant de la nourriture chez certains chevaux. Le déplacement dorsal intermittent du palais mou cause une intolérance à l'effort chez les chevaux de course; les signes cliniques de la condition sont habituellement absents au repos.

7. **a)** The most common congenital cardiac defect in foals is ventricular septal defect.
a) Le défaut cardiaque congénital le plus commun chez le poulain est la communication interventriculaire.

8. **b)** Blackleg is most consistent with the described signs.
b) Le charbon symptomatique est plus compatible avec les signes décrits.

9. **d)** This painful skin condition causes pigs to walk gingerly. They arch their backs suddenly and then sink to the ground on their briskets.
d) Cette affection cutanée douloureuse fait en sorte que les porcs se déplacent avec précaution. Ils arquent le dos soudainement puis tombent par terre sur le sternum.

10. **b)** Over a period of weeks the mare may gradually accept the foal.
b) La jument peut graduellement accepter le poulain au cours d'une période de quelques semaines.