**Original Article**

**Translating research into practice: adoption of endocrine diagnostic testing in cases of equine laminitis**

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**Abstract**

Research demonstrating insulin’s causal role in endocrinopathic laminitis has greatly advanced understanding of equine laminitis. However, the degree to which this knowledge has been translated into clinical practice has not been assessed. This two-part study aimed to investigate veterinary surgeons’ current diagnostic approach to laminitis, whether this had changed over time, and the impact of diagnosing an endocrinopathy on laminitis case management and outcome. Two cross-sectional online surveys of equine veterinary surgeons working within the United Kingdom were undertaken.

The first study population comprised 141 veterinary surgeons, who had graduated a median of 8 years previously. Overall, 83.6% of respondents (*n*=117/140) had changed their diagnostic approach to laminitis since graduating, primarily through increasing use of endocrine testing (88.7%; *n*=86/97). Ninety-nine percent (*n*=140/141) performed endocrine diagnostic test(s) for some or all laminitis cases at initial and/or subsequent examinations. The second study had 120 participating veterinary surgeons, ≥76% of whom considered diagnosing underlying endocrine diseases greatly influenced their laminitis case management. Where an endocrinopathy was identified, 75.0% (*n*=90/120) considered that client communication regarding laminitis was facilitated, and ≥67% considered that treating the endocrinopathy was effective in reducing laminitis recurrence. This study demonstrates successful translation of research knowledge into equine practice, with the vast majority of veterinary surgeons adopting endocrine diagnostic testing within their routine approach to laminitis cases. Respondents perceived that this change in diagnostic approach has resulted in improvements in several non-clinical and clinical healthcare outcomes, including client communication and reduction in recurrent laminitis episodes.

*Keywords*:Endocrinopathic;Evidence-based; Implementation science; Knowledge translation

**Introduction**

Equine laminitis is a painful, debilitating condition that is highly prevalent, particularly in native pony breeds (Potter et al., 2017; Pollard et al., 2019). While laminitis has been recognised for centuries, veterinary diagnosis and treatment of laminitis historically focussed on the lameness and local manifestations within the hoof, rather than on the underlying cause (Patterson-Kane et al., 2018). This focus changed fundamentally following the key discovery that hyperinsulinaemia, initiated via administration of a continuous insulin infusion, results in induction of laminitis (Asplin et al., 2007; de Laat et al., 2010). These seminal studies confirmed the long held clinical suspicion of the link between endocrine disease and laminitis (Coffman and Colles, 1983). Experimental demonstration of insulin’s causal role in endocrinopathic laminitis was supported by field studies showing a clear link between hyperinsulinaemia and naturally-occurring laminitis (Treiber et al., 2006; Karikoski et al., 2015).

While research evidence established endocrinopathic laminitis as a distinct form of laminitis, further studies identified endocrinopathic laminitis as the most common form (Karikoski et al., 2011). Endocrinopathic laminitis was reported to occur at a much greater frequency (Karikoski et al., 2011) than supporting limb laminitis (Wylie et al., 2014) or laminitis secondary to systemic inflammation or endotoxaemia, such as that reported in post-operative colic cases (Parsons et al., 2007; de la Rebière de Pouyade et al., 2009). Hyperinsulinaemia in naturally-occurring endocrinopathies was shown to be a result of insulin dysregulation, primarily associated with two endocrine conditions, pituitary pars intermedia dysfunction (PPID) and equine metabolic syndrome (EMS) (reviewed by Frank and Tadros, 2014). Knowledge creation and dissemination, through primary research publications, have resulted in a rapidly expanding literature base on endocrinopathic laminitis (reviewed by Patterson Kane et al., 2018).

Evidence-based veterinary medicine (EBVM) relies on the ability of veterinary surgeons to assimilate the best available evidence into practice and is a vital underpinning process for improvements in veterinary care. An integral part of the EBVM cycle is knowledge translation, which involves using high-quality knowledge in clinical decision making (Straus et al.,2009). Yet, despite evidence in the literature, transfer of research findings into practice is often a slow and haphazard process (Dilling et al., 2013). Translation of newly created knowledge from primary research into routine clinical practice and decision making has been identified as a major translational block impeding the efficient application of clinical science to improve human health (Sung et al., 2003).

The significant and fundamental advancements in our understanding of equine laminitis have real potential to inform decision making to improve clinical outcomes. However, equine endocrinology research will only achieve its maximal impact through successful knowledge translation leading to changes in veterinary practice for the benefit of patients. Therefore, the aims of this two-part study were firstly; to investigate current approaches to diagnosis for equids presenting with clinical signs consistent with laminitis and to evaluate research knowledge translation regarding endocrinopathic laminitis through exploring changes in diagnostic approach over time since respondents had graduated. Secondly, we aimed to determine how diagnosing an underlying endocrine disease influences management of laminitis and case outcome.

**Materials and methods**

The study was granted ethical approval by the University of Liverpool’s Committee on Research Ethics (VREC580, October 2017) and consent was obtained from all respondents prior to filling out the questionnaire (See Appendix A: Supplementary material).

*Selection of study sample*

Two separate cross-sectional surveys were undertaken using online questionnaires, for which the study populations included veterinary surgeons undertaking equine work within the UK.

*Study 1*

Veterinary surgeons attending the 56th Congress of the British Equine Veterinary Association (BEVA), 14th – 16th September 2017, in Liverpool, were invited to participate in the survey by Veterinary Postgraduate Unit staff at the University of Liverpool’s stand within the congress commercial exhibition hall. Participants completing the survey during BEVA Congress provided their responses anonymously on a supplied Apple ipad. Additionally, a link to the survey was promoted via social media, including Twitter and the Institution’s Facebook pages during November and December 2017.

*Study 2*

Veterinary surgeons attending the 58th BEVA Congress, 11th – 14th September 2019, in Birmingham, were invited to participate in the second survey as described for Study 1. Additionally, a link to the questionnaire was promoted via the Institution’s Facebook pages during October 2019 and January 2020.

*Questionnaire Design*

The self-administered online questionnaires were designed using an online survey tool (Kwiksurveys[[1]](#footnote-1)). No personal data were collected, and participants were asked to provide informed consent at the start of the questionnaires. The questionnaires for both surveys included a short introduction section, which described the aim and inclusion criteria for the study.

*Study 1*

The questionnaire requested basic information regarding the participant and their current veterinary role. Six further questions pertained to participants’ current approach to diagnosis in horses/ponies presenting with clinical signs consistent with laminitis and any changes in diagnostic approach since respondents had graduated (See Appendix A: Supplementary material). The majority of questions were closed end style, with drop down response options or tick boxes. For questions that had an “other” option, respondents were asked to provide further details where this was selected. Finally, an open text format question was used for respondents to describe how their diagnostic approach to laminitis had changed since graduating.

*Study 2*

The second questionnaire requested the same basic information regarding the participant and their current role. As this questionnaire requested information on respondents’ perceptions regarding management of cases of endocrinopathic laminitis, a screening question about endocrine diagnostic testing was included. Skip logic was then used to direct respondents who reported that they never use endocrine tests in laminitis cases to finish the survey at this stage. Eight further questions pertained to participants’ current approach to management of laminitis and their perceptions of any effect that increasing use of endocrine testing has had on laminitis case management or outcome. The majority of questions were visual analogue scale (VAS) style, where respondents used a slider bar to select a value on the scale from 0 – 10 (See Appendix A: Supplementary material).

*Data Analysis*

Data from the survey were exported directly from Kwiksurveys in Microsoft Excel spreadsheets. Statistical analyses were performed using commercial statistical software (SPSS versions 24 and 25). Responses to open-ended questions were categorised manually for analysis. Data from the questionnaire responses were described as medians with inter-quartile ranges (IQR) for continuous data and as proportions for categorical data. Mode responses for VAS questions in study 2 were also reported. Where appropriate, Pearson chi-squared or Fisher’s exact tests were used to assess associations between categorical variables. Mann-Whitney U tests were used to evaluate differences between median values of the number of years since graduation and change in diagnostic approach to laminitis cases since graduation (binary, yes/no). The same test was also used to compare number of years since graduation between the study populations for each of the two surveys. The critical probability for all analyses was set at 0.05.

**Results**

*Description of study population*

*Study 1*

One hundred and forty one veterinary surgeons meeting study inclusion criteria submitted useable questionnaires. Of these, 60 (42.6%) were completed during BEVA Congress 2017; the remaining 81 (57.4%) were submitted online between 17th November 2017 and 19th January 2018. Sixteen additional responses that did not meet participant inclusion criteria were excluded from analysis. A further 12 partially completed questionnaires, where respondents that met study inclusion criteria had provided responses to only the first section of the questionnaire (about the location of their undergraduate training and their current role) but no response to any questions about diagnostic approach to laminitis, were also excluded from analysis. Comparison between responders and partially completed excluded responses found no significant difference between the number of years since graduation (*P*=0.16), region from which they graduated with their veterinary degree (*P*=0.31) or current role (*P*=0.26).

For a low number of individual questions, there were small amounts of missing data; therefore, the denominator for all results was 141 unless otherwise stated. Respondents had graduated from their primary veterinary degree a median of 8 years previously (IQR 3 – 16.75 years; range 0 – 45 years) (Table 1). The vast majority of respondents had undertaken their veterinary degree in a veterinary school within the UK or Ireland (88.6%; *n*=124/140), with a further 9.3% of respondents (*n*=13/140) graduating from a veterinary school within a European Union (EU) country, and 2.1% (*n*=3/140) graduating from an institution in a non-EU country. The majority of respondents’ current employment was in a solely equine clinical veterinary role, with 46.1% (*n*=65) working in a 100% equine first opinion/ambulatory practice and a further 21.3% (*n*=30) working in a 100% equine role that combined equine first opinion/ambulatory practice and referral hospital (Table 1).

*Study 2*

A total of 120 veterinary surgeons meeting inclusion criteria submitted useable questionnaires for the second study. Of these, 58 (48.3%) were completed during BEVA Congress 2019; the remaining 62 (51.7%) were submitted online between 2nd October 2019 and 4th February 2020. A further nine responses that did not meet participant inclusion criteria were excluded from analysis, and one additional response was excluded from data analysis, where the respondent indicated that they never performed endocrine testing in any laminitis cases.

Respondents had graduated from their primary veterinary degree a median of 10 years previously (IQR 4.25 – 18.0 years; range 0 – 49 years), which was not significantly different from the population for study 1 (*P=*0.21). The vast majority of respondents had undertaken their veterinary degree in a veterinary school within the UK or Ireland (90.8%; *n*=109/120). A further 6.7% (*n*=8/120) had undertaken their veterinary degree within an EU country, and 2.5% (*n*=3/120) had graduated from an institution in a non-EU country, which was not significantly different from the population for study 1 (*P=*0.75). The majority of respondents’ current employment was in an equine clinical veterinary role, with no significant difference from the population for study 1 (Table 1).

*Study 1: Current approach to laminitis cases*

Respondents were asked to estimate, on average, how many cases of laminitis they attended per week during the month(s) in which they observed the highest frequency of laminitis ('peak season') in their current role. Twenty-eight percent of respondents (*n*=40) estimated that they attended <1 laminitis case per week during the month(s) of highest laminitis frequency, 36.2% (*n*=51) estimated that they attended approximately 1 laminitis case per week and the remaining 35.5% of respondents (*n*=50) estimated that they attended >1 laminitis case per week.

From a list of diagnostic techniques and laboratory tests, respondents were asked to indicate the frequency with which they would perform each, both at the first examination and on subsequent re-examination(s), when presented with an equid with a clinical suspicion of laminitis, but no signs of systemic illness or pyrexia. All respondents (100%; *n*=141) performed a clinical examination (e.g. assessment of digital pulses, stance, assessment of lameness, response to hoof testers, etc.) in all cases of suspected laminitis on their first examination. For the first examination of suspected laminitis cases, respondents performed measurement of basal adrenocorticotrophic hormone (ACTH) more frequently than basal insulin (Table 2). Overall, 86.5% (*n*=122/141) utilised ACTH measurement at first examination (for some (75.9%; *n*=107/141) or all (10.6%; *n*=15/141) cases) and 41.4% (*n*=58/140) utilised non-fasted basal insulin (for some (37.9%; *n*=53/140) or all (3.6%; *n*=5/140) cases) (Table 2). In free text responses, other diagnostic tests/procedures performed by respondents in some or all suspected laminitis cases at first examination included measurement of adiponectin concentration (*n*=5), body condition scoring (*n*=2), accurate bodyweight measurement with a weighbridge or weight estimation (both *n*=1), and palmar digital nerve block (*n*=1).

Respondents reported performing dynamic tests of ACTH or insulin more frequently at re-examination compared to first examination (Table 2). In free text responses, other diagnostic tests/procedures performed by respondents in some or all laminitis cases at re-examination(s) included measurement of adiponectin concentration (*n*=1), weight estimation (*n*=2), body condition scoring (*n*=1), assessment of neck crest thickness (*n*=1), accurate bodyweight measurement (*n*=1), palmar digital nerve block (*n*=1), and venography (*n*=1).

Overall, 99.3% of respondents (*n*=140/141) reported undertaking some form of endocrine testing (including basal and dynamic tests for ACTH, insulin, or both) for some laminitis cases at initial and/or subsequent examinations. Including both the initial examination and re-examination(s), 99.3% of respondents (*n*=135/136) performed basal and/or dynamic tests for ACTH, while 93.8% of respondents (*n*=122/130) reported performing some form of insulin testing, for at least some suspected laminitis cases.

*Change in diagnostic approach to laminitis cases*

Overall, 83.6% of respondents (*n*=117/140) reported that their diagnostic approach to laminitis cases had changed since they graduated, with the remaining 16.4% (*n*=23/140) reporting that they had not changed their diagnostic approach. Of the 117 veterinary surgeons whose diagnostic approach to laminitis had changed since graduation, 97 volunteered a description of what aspect(s) of their approach had altered (See Appendix A: Supplementary material). The most frequently reported change in diagnostic approach was increased use of endocrine testing for PPID and/or EMS or insulin dysregulation (ID) (88.7%; *n*=86/97). For example, in free text responses participants reported: *“Always looking for an endocrine aetiology”; “Routine testing for endocrinopathy on nearly all cases”; “Endocrinology testing plays a main role”; “Now looking for a cause - most frequently EMS/PPID”* and *“Cushing’s testing is discussed more as it was not when I was at university”* (See Appendix A: Supplementary material). Differences in utilisation of radiography were the next most frequently reported change in diagnostic approach (14.4%; *n*=14/97). These included increased use of radiography in laminitis cases (largely attributed to improvements in radiographic equipment such as availability of portable machines and ease of use of digital radiography), radiographing earlier in the course of disease, and obtaining dorsopalmar views in addition to lateromedial views (See Appendix A: Supplementary material).

When asked to indicate, from a list provided, which factors or activities had influenced their change in diagnostic approach to laminitis, the most frequently reported influencing factors were personal experience, research or evidence-based veterinary medicine, and Continuing Professional Development (CPD) activities/events (Table 3).

Time since graduation was associated with change in diagnostic approach to laminitis: veterinary surgeons who reported changing their diagnostic approach had been qualified for a median of 10 years (IQR 5 – 18 years) compared to a median of 2 years (IQR 1 – 4 years) for those who reported no change in their approach to laminitis (*P*<0.001). There was no association between region from which respondents graduated (UK or Ireland; EU country or non-EU country) and change in diagnostic approach to laminitis (*P*=0.69). There was also no association between the estimated number of laminitis cases attended per week during the month(s) of highest laminitis frequency in the respondents’ current role and change in diagnostic approach (*P*=0.24). Current role was associated with change in diagnostic approach (*P*=0.05): only 58.8% of respondents working within a mixed practice (*n*=10/17) reported changing their approach to laminitis compared to 86.2% working in 100% equine first opinion practice (*n*=56/65), 87.8% working in 100% equine referral hospital +/- first opinion (*n*=43/49) and 88.9% working in academia, research, or equine industry (*n*=8/9).

*Study 2: management of endocrinopathic laminitis*

Overall, 60.8% of respondents (*n*=73/120) reported performing some form of endocrine testing for all cases that they attended with a clinical suspicion of laminitis, but no signs of systemic illness or pyrexia. The remaining 39.2% of respondents (*n*=47/120) reported performing endocrine testing in some laminitis cases.

A mode VAS score of 7/10 indicated that respondents considered concurrent treatment of an underlying endocrinopathy to have a beneficial effect in reducing the time taken to achieve a clinical improvement in acute episodes of laminitis (based on duration of veterinary treatment) (Table 4). The majority of respondents reported that diagnosing an endocrine disorder contributed considerably to their management of laminitis cases over the longer term, particularly for EMS/ID (Table 4). Seventy-five percent of respondents considered that diagnosing an underlying endocrine disorder was very valuable (VAS score ≥8/10) for client communication, facilitating provision of advice regarding laminitis treatment and prognosis (Table 4). Respondents perceived that treatment of endocrine disorders can effectively reduce the recurrence of acute laminitis in affected animals, and that overall case outcome was improved in equids diagnosed with an endocrine disorder (Table 4).

**Discussion**

This two-part study represents the first publication dedicated specifically to documenting translational research in equine medicine, evaluating the implementation of research knowledge into everyday practice and diagnostic decision making for laminitis. The key finding of the first survey was that almost 90% of participating veterinary surgeons reported approaching laminitis cases differently compared to when they first graduated, with the most commonly reported difference being the integration of diagnostic investigation for an underlying endocrinopathic disorder. These results support translation of research findings of endocrinopathic laminitis as a distinct form of laminitis and demonstrate a move away from considering the hooves and resultant lameness as the primary problem.

In the medical literature, the lag between research findings and implementation into practice (the research-practice or evidence-practice gap) is frequently well over a decade (Dilling et al., 2013) and knowledge transfer is often incomplete (Green, 2014). In contrast, our results show a relatively complete and rapid translation of research findings into clinical practice. Major changes in the scientific understanding of endocrinopathic laminitis occurred predominantly from 2006-2014 (Patterson Kane et al., 2018). The majority of respondents surveyed in 2017 reported having changed their practice since graduating, with these respondents having been graduated for longer (median 10 years) than those who had not changed their approach to laminitis (median 2 years). With 99% of all respondents utilising endocrine testing for some or all of their laminitis cases, these results imply that recent graduates were already including diagnostic testing for endocrine disease as part of case management for laminitis. This likely reflects the use of research-connected teaching and increasing focus on EBVM (Dean et al., 2017) within the veterinary undergraduate curriculum.

Laminitis was a frequently encountered disorder, with 72% respondents seeing a case one or more times every week during the time(s) of year that they recognised highest laminitis incidence. It is also a disorder that can have devastating consequences for the animal and their owners, with a high recurrence rate (de Laat et al., 2019), affecting animals for a number of years after initial diagnosis (Welsh et al., 2016). Moreover, laminitis is associated with increased risk of mortality (Welsh et al., 2016). Knowledge translation may be more efficient where the topic represents a major concern for practitioners. This has been demonstrated for antibiotic awareness in physicians, where even prior to a national antibiotic awareness campaign, high levels of physician knowledge regarding antibiotic use and antimicrobial resistance have been reported (Smith et al., 2017). The fact that laminitis is a serious and frequently encountered condition could be a reason for the rapid translation of research into practice identified in this study.

The factors most frequently associated with respondents’ change in practice were personal experience, research findings or EBVM and continuing professional development/continuing education activities. A nationwide laminitis disease awareness initiative, launched in 2012, which offered free laboratory testing (for basal ACTH) is likely to have increased horse owner awareness of endocrinopathic laminitis. It is probable that this increased owner awareness would subsequently lead to increased expectation of endocrine testing in laminitis cases, yet marketing and free laboratory testing schemes were less frequently reported by respondents to have influenced a change in their practice (Table 3). Respondents from 100% equine practices (including first opinion, referral and academia) were all more likely to have changed practice since graduation than respondents from mixed practice. These findings mirror those from surveys of general practitioners (Cranney et al., 2001). Reasons for this were not investigated, but those involved in translation of evidence into practice should pay particular attention to mixed practitioners. Unlike the difference between 100% equine practices and mixed practices, vets who graduated from other countries were not different from UK and Ireland graduates in whether they had changed their diagnostic approach to laminitis cases, although there were very small numbers of respondents. This finding supports an international change in practice, at least in the sample of respondents in this study.

The predominant endocrine testing was ACTH testing (basal or dynamic) for the diagnosis of PPID, with over 90% of vets responding that they would consider it for some or all of their cases on the first visit. However, on re-examination, over 90% of respondents also chose basal and dynamic tests for insulin dysregulation. Basal or dynamic ACTH testing is the diagnostic test of choice for diagnosis of PPID (Durham et al., 2014), while tests of insulin dysregulation are required to diagnose EMS (Durham et al., 2019). Recent studies have demonstrated that amongst PPID cases, the risk of laminitis is associated with insulin dysregulation (Karikoski et al. 2015, 2016), and the severity of basal hyperinsulinaemia is positively associated with the severity of laminitis (Tadros et al., 2019). The fact that most veterinary surgeons are choosing to test both at some point in the management of cases of laminitis supports translation of these more recent findings. However, the small proportion of respondents reporting that they never performed basal or dynamic tests for insulin, and the lower proportions of respondents testing insulin in all laminitis cases (compared to ACTH) highlights an area where knowledge transfer could be improved.

Due to the anonymous nature of the online questionnaires and promotion via social media, it was not possible to compare characteristics of respondents with non-responders, nor calculate a response rate. Selection bias could have influenced both parts of this study, with volunteer bias meaning that respondents for both surveys were likely to be those with an interest in laminitis. Further, with just under half of the responses for each survey comprising delegates attending the national equine conference (BEVA), it is probable that the study populations for both surveys included a considerable proportion of veterinary surgeons more likely to practice evidence-based veterinary medicine and to change their practice, compared to the equine veterinary profession as a whole.

The primary reason for striving for effective translation of research evidence to practice is to improve patient care and case outcomes (Lavis et al., 2003; Glasziou and Haynes, 2005). The key finding of the second survey was that respondents indicated that diagnosis of an underlying endocrinopathic disorder had a positive effect on case outcome. Furthermore, diagnosis of an endocrinopathy was reported as valuable for client communication, facilitating provision of advice regarding laminitis treatment, prevention and prognosis. The reported positive effect of diagnosis of an endocrine disorder on case management was greater for influencing long-term management, prevention of future laminitis episodes, and overall outcome rather than in the acute occurrence of laminitis. This fits with both PPID and EMS being chronic conditions, associated with lifelong management (Durham et al. 2014, 2019). The relatively low proportion of respondents (≤40%) considering concurrent treatment of PPID or EMS to have marked beneficial effect on reducing duration of the acute laminitis episode is not unexpected. While histological evidence of lamellar stretching can occur after as little as 6 hours of hyperinsulinemia (de Laat et al., 2013), improvement in Obel grade associated with reduction in insulin concentration has been reported in clinical cases over a much longer period (mean 8 months), following dietary and exercise management (Walsh et al., 2009).

**Conclusions**

The results of this study demonstrate rapid translation of research knowledge into equine practice, with the vast majority of respondents indicating that they have adopted endocrine diagnostic testing within their routine approach to laminitis cases. Integration of research evidence into clinical practice resulted in respondents recognising improvements in several non-clinical aspects of healthcare provision and clinical outcomes. Veterinary surgeons perceive that diagnosing and treating underlying endocrine disease in equids affected by laminitis facilitates client communication, aids reduction of recurrent laminitis episodes, and improves overall case outcome.

**Conflict of interest statement**

None of the authors has any other financial or personal relationships that could inappropriately influence or bias the content of the paper.

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**Appendix: Supplementary material**

Supplementary data associated with this article can be found, in the online version, at doi: …

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**Table 1**

Distribution of time since graduating from their primary veterinary degree and type of role currently undertaken in two separate online surveys of veterinary surgeons undertaking equine work within the United Kingdom.

|  |  |  |  |
| --- | --- | --- | --- |
| **Number of years since graduation**  | **Study 1 (*n*=140)** | **Study 2 (*n*=120)** | **aChi square *P* value** |
| **Frequency** | **Percent** | **Frequency** | **Percent** |
| 0 – 4 years | 48 | 34.3 | 30 | 25.0 | 0.35 |
| 5 – 9 years | 27 | 19.3 | 28 | 23.3 |
| 10 – 14 years | 25 | 17.9 | 23 | 19.2 |
| 15 – 19 years | 17 | 12.1 | 15 | 12.5 |
| 20 – 24 years | 7 | 5.0 | 14 | 11.7 |
| 25 – 29 years | 6 | 4.3 | 3 | 2.5 |
| ≥30 years | 10 | 7.1 | 7 | 5.8 |
| **Description of current role**  | **Study 1 (*n*=141)** | **Study 2 (*n*=120)** | **aFisher’s exact *P* value** |
| **Frequency** | **Percent** | **Frequency** | **Percent** |
| 100% equine - first opinion only | 65 | 46.1 | 63 | 52.5 | 0.20 |
| 100% equine - first opinion and referral | 30 | 21.3 | 31 | 25.8 |
| 100% equine - referral hospital | 19 | 13.5 | 11 | 9.2 |
| Mixed practice ≥50% equine | 9 | 6.4 | 8 | 6.7 |
| Mixed practice <50% equine | 9 | 6.4 | 2 | 1.7 |
| Equine charity  | 0 | 0 | 2 | 1.7 |
| Equine pharmaceutical/industry | 5 | 3.5 | 2 | 1.7 |
| Academia/research | 4 | 2.8 | 1 | 0.8 |

a*P* values for comparison between populations for studies 1 and 2

**Table 2**

Frequency with which respondents undertake selected diagnostic procedures and laboratory tests when presented with an equid exhibiting lameness, with a clinical suspicion of laminitis, but no signs of systemic illness or pyrexia at i) first examination and ii) subsequent re-examination(s) in an online survey of veterinary surgeons (*n=*141) undertaking equine work within the United Kingdom.

|  |  |
| --- | --- |
| **Diagnostic procedure/test at first examination**  | **Frequency (%) at first examination** |
| Never at first examination | Some cases at first examination | All cases at first examination |
| Clinical examination (*n*=141) | 0 (0%) | 0 (0%) | 141 (100%) |
| Radiography (*n*=141) | 48 (34.0%) | 87 (61.7%) | 6 (4.3%) |
| Haematology and biochemistry (*n*=140) | 79 (56.4%) | 58 (41.4%) | 3 (2.1%) |
| Basal ACTH (*n*=141) | 19 (13.5%) | 107 (75.9%) | 15 (10.6%) |
| Dynamic ACTH (e.g. TRH stimulation test) (*n*=140) | 134 (95.7%) | 6 (4.3%) | 0 (0%) |
| **Any test of ACTH (basal and/or dynamic test)** (*n*=141) | **18 (12.8%)** | **123 (87.2%)** |
| Fasted basal insulin (*n*=138) | 118 (85.5%) | 20 (14.5%) | 0 (0%) |
| Non-fasted basal insulin (*n*=140) | 82 (58.6%) | 53 (37.9%) | 5 (3.6%) |
| Dynamic insulin (e.g. oral sugar or glucose test) (*n*=138) | 125 (90.6%) | 13 (9.4%) | 0 (0%) |
| **Any test of insulin (basal and/or dynamic test)** (*n*=141) | **73 (51.8%)** | **68 (48.2%)**  |
| **Diagnostic procedure/test at re-examination(s)** | **Frequency (%) at re-examination(s)** |
| Never at re-examination | Some cases at re-examination | All cases at re-examination |
| Clinical examination (*n*=138) | 0 (0%) | 3 (2.2%) | 135 (97.8%) |
| Radiography (*n*=141) | 1 (0.7%) | 125 (88.7%) | 15 (10.6%) |
| Haematology and biochemistry (*n*=141) | 60 (42.6%) | 76 (53.9%) | 5 (3.5%) |
| Basal ACTH (*n*=138) | 4 (2.9%) | 109 (79.0%) | 25 (18.1%) |
| Dynamic ACTH (e.g. TRH stimulation test) (*n*=139) | 46 (33.1%) | 92 (66.2%) | 1 (0.7%) |
| **Any test of ACTH (basal and/or dynamic test)** (*n*=141) | **2 (1.4%)** | **139 (98.6%)** |
| Fasted basal insulin (*n*=139) | 42 (30.2%) | 92 (66.2%) | 5 (3.6%) |
| Non-fasted basal insulin (*n*=138) | 59 (42.8%) | 76 (55.1%) | 3 (2.2%) |
| Dynamic insulin (e.g. oral sugar or glucose test) (*n*=140) | 28 (20.0%) | 105 (75.0%) | 7 (5.0%) |
| **Any test of insulin (basal and/or dynamic test)** (*n*=141) | **8 (5.7%)** | **133 (94.3%)**  |

**Table 3**

Factors influencing changes in diagnostic approach to laminitis cases in an online survey of veterinary surgeons undertaking equine work within the United Kingdom.

|  |  |  |
| --- | --- | --- |
| **Factor influencing change in diagnostic approach to laminitis since graduation (*n*=117)**  | **Frequency** | **Percent** |
| Personal experience | 86 | 73.5 |
| Research or evidence-based medicine | 82 | 70.1 |
| Continuing Professional Development (CPD) activities | 80 | 68.4 |
| Expert opinion  | 71 | 60.7 |
| Disease awareness initiatives (e.g. free laboratory testing schemes) or marketing | 67 | 57.3 |
| Practice policy  | 19 | 16.2 |

**Table 4**

Respondents’ perceived effect of endocrine disorders on case management and outcome for laminitis in an online survey of veterinary surgeons (*n=*120) undertaking equine work within the United Kingdom.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Respondents’ perceived effect of endocrine disorders on case management and outcome for laminitis (*n*=120)** | **Median score** | **Interquartile range**  | **Mode score** | **Percentage of respondents scoring ≥8/10** |
| **Effect of** **concurrent treatment of PPID on the time taken to achieve a clinical improvement in acute episodes of laminitis**0 = significant increase in time to clinical improvement of acute laminitis where concurrently treating PPID10 = significant decrease in time to clinical improvement of acute laminitis where concurrently treating PPID  | 7 | 5 – 8  | 7 | 31.7% |
| **Effect of** **concurrent treatment of EMS/ID on the time taken to achieve a clinical improvement in acute episodes of laminitis** 0 = significant increase in time to clinical improvement of acute laminitis where concurrently treating EMS/ID10 = significant decrease in time to clinical improvement of acute laminitis where concurrently treating EMS/ID | 7 | 6 – 8  | 7 | 40.0% |
| ​**To what extent does a diagnosis of PPID guide your medium to long-term management of laminitis?**0 = diagnosis of PPID does not guide medium/long-term management of laminitis cases at all 10 = diagnosis of PPID guides my medium/long-term management of laminitis cases to a great extent | 8 | 8 – 10  | 8 | 75.8% |
| ​**To what extent does a diagnosis of EMS/ID guide your medium to long-term management of laminitis?**0 = diagnosis of EMS/ID does not guide medium/long-term management of laminitis cases at all 10 = diagnosis of EMS/ID guides my medium/long-term management of laminitis cases to a great extent | 9 | 8 – 10  | 10 | 80.0% |
| **How does diagnosing an underlying endocrine disorder** **influence your client communication regarding advice on laminitis management, treatment options and prognosis?**0 = identifying an underlying endocrine disorder makes it much more difficult for me to advise owners 10 = identifying an underlying endocrine disorder makes it much easier for me to advise owners  | 9 | 7.25 – 10  | 10 | 75.0% |
| On average, **to what degree do you consider treatment of PPID aids prevention of further laminitis episodes** in affected animals?0 = not at all effective in reducing laminitis recurrence 10 = highly effective in reducing laminitis recurrence | 8 | 7 – 9  | 8 | 66.7% |
| On average, **to what degree do you consider treatment of EMS/ID aids prevention of further laminitis episodes** in affected animals?0 = not at all effective in reducing laminitis recurrence 10 = highly effective in reducing laminitis recurrence | 8 | 7 – 9  | 8 | 67.5% |
| On average, **what effect do you consider** **diagnosing an endocrine disorder has on overall case outcome**, compared to managing cases of laminitis without identifying any underlying cause(s)? ​0 = much poorer case outcome for laminitis when endocrine disorder diagnosed 10 = greatly improved case outcome for laminitis when endocrine disorder diagnosed | 8 | 7 – 9  | 8 | 65.0% |

1. See: Kwiksurveys. [www.kwiksurveys.com](http://www.kwiksurveys.com) (Accessed 30 September, 2020) [↑](#footnote-ref-1)