Retrospective case series of 2,602 'out-of-hours' first opinion emergencies seen by equine veterinary practitioners.

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Abstract

Background: The study aim was to describe conditions seen 'out-of-hours' in equine practice.

Methods: This was a retrospective case series of first opinion 'out-of-hours' cases seen at two equine practices between 2011-2013. Data was retrieved on case presentation, diagnostic testing, treatment administered and outcome, and diseases categorised using a systems-based coding system. A hierarchical logistic regression, formulated using a Generalised Linear Model, was used to identify clinical variables associated with a binary outcome of 'critical' cases (required hospitalisation or euthanasia or died).

Results: Data from 2,602 cases were analysed. The most common reasons for 'out-of-hours' visits were colic (35%, n=923/2,620), wounds (20%, n=511/2,620) and lameness (11%, n=288/2,620). The majority of cases required a single treatment (58%, n=1,475/2,550), 26% (n=656/2,550) needed multiple treatments, and 13%

(n=339/2,550) were euthanased. Eighteen percent (n=480/2602) of cases had a critical outcome. Increased heart rate at primary presentation was associated with critical outcome in both practices (Practice A, OR 1.07 (95%CI 1.06-1.09), Practice B OR 1.08 (95%CI 1.07-1.09; p<0.001)).

Conclusion: Colic, wounds and lameness were the most common equine 'out-of-hours' conditions; 13% of cases were euthanased. Further research is required into out-of-hours euthanasia decision-making.

Introduction

Veterinary surgeons in the UK are obliged to provide twenty-four hour care for first aid and pain relief for animals (1). Equine first opinion practices are often responsible for providing their own emergency cover, with hospitals throughout the United Kingdom for referral of cases requiring intensive medical or surgical care. Current published studies investigating 'out-of-hours' equine practice have focused on referral centre populations (2, 3). There is a lack of peer-reviewed data about 'out-of-hours' conditions seen in first opinion (primary) equine practice.

Gathering information on the most common primary equine emergency conditions, including presentation, diagnostics, treatments and outcome is important to inform practice policies, training, investment and resources, and to identify foci for owner education.

The aim of this study was to identify the conditions seen at primary assessment during 'out-of-hours' consultations in two first opinion equine practices in the United Kingdom.

The objectives of the study were:

- To categorise the type and frequency of different conditions presented for primary (first opinion) assessment outside of normal working hours.
- To describe the diagnostic tests used most commonly during 'out-of-hours' primary assessment of horses.

- To document the treatments that are frequently administered during 'out-of-hours' primary assessments.
- To evaluate the outcomes of patients seen for 'out-of-hours' primary assessment.

Methods

Study design and data collection: A convenience sample of two practices with a first opinion equine division were recruited to participate in the study. Both practices undertook their own ambulatory twenty-four hour care, providing primary care for horses requiring veterinary treatment outside of normal working hours. The first practice was an RCVS accredited equine veterinary hospital based in the South of England, whose population of horses were predominantly pleasure/competition horses. Only data from the first opinion ambulatory calls were collected. There were eight first opinion ambulatory vets conducting 'out-of-hours' visits during the period of data collection, with an additional 11 veterinary surgeons working within the hospital providing referral services. The second practice was a first opinion equine veterinary practice with hospitalisation facilities based in the Midlands, UK, which also saw predominantly pleasure/competition horses. This had eight first opinion ambulatory vets conducting 'out-of-hours' visits during the period of data collection, with two of these veterinary surgeons also working within the hospital. The practice had full diagnostic and surgical facilities and a 24hr emergency service.

Both practices provided a list of 'out-of-hours' calls, compiled using the practice management systems (PMS) (Eclipse at Practice A and Spectrum at Practice B). Inclusion criteria were cases identified via the PMS charging systems that received both an 'out-of-hours' visit and examination fee, thus forming a retrospective case series. Only cases seen outside of normal working hours (8am-5pm Monday to Friday for Practice A, and 8.30-5.30pm for Practice B) were analysed. Emergency cases seen during normal working hours were not included as these could not be consistently

identified and retrieved from the records. The cases were retrieved for three years from 1st January 2011 to 31st December 2013, organised by date. Numeric codes were assigned chronologically by date to the cases from each practice in order to anonymise the data prior to analysis.

The collection of data was carried out over a one-year period by one researcher (A. Bowden). Cases were excluded only if the electronic record was missing. When there were multiple appointments for one animal for the same condition in the same 'out-of-hours' period, only the initial visit was recorded, and data from subsequent visits was only analysed to determine the outcome (e.g. euthanasia or required multiple treatments). In instances where one animal received two 'out-of-hours' visits for different, unrelated conditions, two recording forms were completed. If a second visit was deemed to be a complication of the primary presenting condition, it was recorded as such on the initial form in the complications section. If an animal presented with more than one condition at a single visit, the data capture method incorporated multiple morbidities within one form.

A bespoke data capture form (Supplementary item 1) was developed based around the expected key elements of a consultation. This was piloted and amended before the final data collection. The main sections were: signalment and history, presentation and clinical signs, diagnostic approach, treatment administered, and outcome. A data capture form with editable fields was developed in Microsoft Word 2013, then converted to an electronic data capture system using Adobe Acrobat XI (Acrobat XI, Adobe Systems Inc., San Jose, CA). The forms were populated offline in Adobe Reader (Adobe Systems Inc., San Jose, CA) and saved as Portable Document Format (PDF) files (Supplementary Item 1).

For clinical parameters, tachycardia was defined as heart rate over 44 beats per minute, or a statement of tachycardia in the clinical records; increased respiratory rate was defined as a respiratory rate over 12 breaths per minute or a statement of increased or rapid breathing in the clinical records; pyrexia was defined as a rectal temperature over 38.2^{o}C (consistent with the values used by the practices) or a

statement of pyrexia in the clinical records. Diseases were categorised by body system primarily prior to subcategorization into disease/ condition subtypes. A list of categories (Supplementary Item 2) were devised by the main researcher (A. Bowden) for each body system and these were reviewed by the research group (A. Bowden, S. Freeman, J. Burford and L. Curtis) for comprehensiveness. Conditions that did not fit predetermined categorieswere entered as free text, and then categorised retrospectively during the analysis stages of the research (Supplementary Item 3). Horse breeds were categorised into groups for analysis.

Case outcomes within the dataset were subject to binary retrospective classification of 'critical' or 'not critical'. 'Critical' outcomes were defined as outcomes that were fatal (death or euthanasia), or required critical care for resolution of the condition (hospitalisation for intensive medical treatment or surgery). Conversely, 'non-critical' cases outcomes had conditions that resolved with treatment and no requirement for referral or hospitalisation.

Data analysis: After data collection, the completed Portable Document Format (PDF) files were converted into Forms Data Format (.fdf) to allow data extraction by the software into a Comma Separated Value (.csv) file readable by Microsoft Excel (2013). The data for the two practices were kept separate at all stages of data collection to ensure reliable comparison between them. Data were cleaned by category in a stepwise manner to ensure validity and to allow identification of any discrepancies or inconsistencies within the data itself. Free text data were sorted and compiled into discrete categories where possible. Data were then entered into a statistical software package (SPSS Statistics Version 24, IBM Corporation, 2012) for further analysis. Continuous variables were subject to descriptive statistics including mean, mode, median and range, and percentage frequencies were calculated for all categorical data. Mean was used as the reported summary statistic where visual assessment of the data approximated a normal distribution.

Univariable screening for association of parameters with the 'critical' outcome was performed using a single level binary logistic regression model. In addition,

biologically plausible interaction terms were investigated. Variables showing evidence of association ($p<0.2$) were further evaluated in a multivariable model.

A hierarchical model was built whereby variables were each nested within practice (defined as A and B) using a generalised linear model with a logit link function, thus this acted as a logistic regression. Variables were added into the model in a forwards step-wise fashion. The model was evaluated using the log likelihood parameter, and the Akaike Information Criterion (AIC) was used to assess goodness of fit. Manual calculation of the likelihood ratio test statistic (LRTS) of the two models was used to assess the effect of adding a further variable into the model. The new model was accepted where $p<0.05$ for the LRTS.

Results

During the period from 1st January 2011 to 31st December 2013 inclusive, 1,729 cases were seen outside of normal working hours for Practice A, whilst Practice B attended 873 cases. The number of cases attended per year was consistent for each practice. The distribution of the age and gender of horses was similar for both practices: the mean age was 13.7 years for Practice A (SD $\pm$ 8.5, range 0-40) and 13.8 years for Practice B (SD $\pm$8.7, range 0-44). Gender of the patient was recorded in 82% of records for Practice A (n=1,422/1,729) and 88% for Practice B (n=768/873). Geldings were most common (52%; n=746/1,422 Practice A, 55%; n=424/768 Practice B) followed by mares or fillies (44%; n=626/1,422 Practice A, 41%; n=319/768 Practice B), and stallions or colts (4%; n=50/1,422 Practice A, 3%; n=25/768 Practice B). There were 80 breeds/ types of horse recorded across the two practices.

Of the 1,729 cases seen for Practice A, 1,707 presented with one condition at the visit, 46 presented with two separate conditions, whilst four presented with three conditions at the same visit. Twenty two cases had no recorded presenting complaint, which resulted in 1,757 separate conditions seen for primary assessment at Practice A. Of the 873 cases seen by Practice B, 823 presented with one condition at the visit, 40 presented with two conditions, whilst 50 had no recorded presenting

complaint. There were therefore 863 conditions seen for primary assessment for Practice B.

The most common presenting complaints (Figure 1) for both practices over the three year period were colic (35% both practices, n=619/1,757 Practice A; n=304/863 Practice B), wounds (19%, n=342/1,757 Practice A; 20%, n=169/863 Practice B) and lameness (10%, n=178/1,757 Practice A; 13%, n=110/863 Practice B). Other common presenting conditions at both practices were respiratory distress (3%, n=60/1,757 Practice A; 2%, n=17/863 Practice B) and undefined eye problems (3% both practices, n=52/1,757 Practice A; n=26/863 Practice B). Laminitis was responsible for 4% (n=35/863) of presentations 'out-of-hours' at Practice B (2% Practice A n=30/1,757) whereas oesophageal obstruction accounted for 3% (n=60/1,757) of the total 'out-of-hours' caseload of Practice A (1% Practive B n=9/863). The remaining 24% and 22% of the caseloads of Practice A and B were comprised of 48 and 49 different conditions, respectively (Supplementary Item 3). The results were consistent when the data were considered annually, with no skew identified for any individual year for either practice.

The most frequent diagnostic tests undertaken outside of normal working hours were rectal examination (35%, n=611/1,729 Practice A; 19%, n=163/873 Practice B) and nasogastric intubation (11%, n=194/1,729 Practice A; 7%, n=63/873 Practice B). Blood sampling was performed in 8% of cases at Practice A (n=140/1,729) and 7% at Practice B (n=63/873).

Sedation was administered in 55% (n=956/1,729) of cases at Practice A and 23% (n=201/873) at Practice B. The most common treatments used at both practices were analgesics and antimicrobials. Analgesics were used in 73% (n=1,254/1,729) of cases at Practice A and 78% (n=683/873) at Practice B whilst antimicrobials were given in 29% (n=496/1,729) of cases at Practice A and 38% (n=328/863) of cases at Practice B. There were multiple antimicrobial or antimicrobial combinations given at both practices (24 at Practice A and 27 at Practice B). The most common antimicrobials administered were potentiated sulphonamides (TMPS) (61%, n=305/496 Practice A;

54%, n=178/328 Practice B), followed by penicillin (13%, n=64/496 Practice A; 19%, n=63/328 Practice B) and a combination of penicillin and gentamicin (6%, n=28/496 Practice A; 11%, n=37/328 Practice B). Thirty nine different combinations of antimicrobials were given in the remaining cases (20%, n=99/496 Practice A; 15%, n=50/328 Practice B).

There were 1,705 cases with a recorded outcome for Practice A and 845 for Practice B. The outcomes of cases attended by both practices were consistent over the three year period. The majority of cases resolved with a single treatment (58%, n=995/1,705 Practice A; 57%, n=480/845 Practice B), although it was also common that multiple treatments were required for resolution of the condition (25%, n=421/1,705 Practice A; 28%, n=235/845 Practice B). Approximately 13% of cases were euthanased (n=225/1,705 Practice A; n=114/845 Practice B) over the three year period (range 11.3%-16.2% when each year was analysed individually).

The 1,729 and 873 'out-of-hours' cases at Practices A and B respectively were categorised into critical and non-critical outcomes. There were critical outcomes (euthanased, died, required surgery or hospitalisation) for 19% (n=322/1,729) of the total 'out-of-hours' population in Practice A and 18.% (n=158/873) in Practice B. The majority of these had a fatal outcome (75%; n=360/480) (Figure 2). Recording of clinical data was notably different dependant on the outcome of the individual case. Definitive diagnosis data were not recorded for 34% (n=122/360) of cases with a fatal outcome, and clinical notes in fatal cases were often non-specific.

The horses that were categorised as having critical outcomes (Figure 3) most commonly presented with colic (44%, n=140/322 at Practice A and 42%, n=67/158 at Practice B), followed by recumbency without clinical signs of other conditions (such as colic) (8%; n=25/322 at Practice A, 3%; n=4/158 at Practice B), limb wounds with no initial obvious synovial involvement (8%, n=24/322 at Practice A, 14%; n=22/158 at Practice B), or lameness with an unknown cause (7%, n=23/322 at Practice A, 9%; n=14/158 at Practice B).

Following univariable analysis (not shown), all variables with evidence of association with the dependent variable ('critical') were evaluated in a forwards stepwise fashion. The only variable that was included in the final model was heart rate which showed a positive relationship, with higher heart rates being associated with an increased likelihood of a critical outcome, with the effect almost identical for both practices (Table 1, $p<0.001$). Temperature also showed strong association with the outcome; however, inclusion of this variable in the model did not improve model fit as assessed by the Likelihood Ratio Test Statistic and showed an increase in the AIC (255 vs 221 without temperature). Temperature was only recorded in 393 cases compared to 1,123 records for heart rate.

Table 1: Multivariable model for clinical variables (history, signalment and clinical presentation) from 1,123 records where heart rate was recorded at primary assessment 'out-of-hours' at two practices over a three year period (2011-2013). Cases were categorised as critical or not critical on the basis of case outcome.

Variable	**Exp(B)**	**95% CI**	**p value**
Intercept	0.01	0.01-0.03	**<0.001**
Heart rate (Practice A)	1.07	1.06-1.09	**<0.001**
Heart rate (Practice B)	1.08	1.07-1.09	**<0.001**

Discussion

This is the first study to investigate cases seen at primary presentation outside of normal working hours in equine veterinary practice. The most common reasons for veterinary attendance at both practices were colic (abdominal pain), wounds or lameness. A significant number of horses seen 'out-of-hours' had critical outcomes (euthanased, died, required surgery or intensive treatment within a hospital) (18%; n=480/2,602), many of which were associated with colic (43%; n=207/480). Recording of data in clinical records of fatal cases was often incomplete.

There are some limitations of the study design and methodology. Data were collected on all conditions seen outside of normal working hours only, rather than emergency conditions specifically. Emergency conditions can happen on any day, at any time, and therefore any 'emergency' conditions that occurred during working hours were not included in the study. Identification of the emergency caseload was not possible with a retrospective study design however the 'out-of-hours' subset of cases assessed in primary care practice is more likely to be comprised of emergency conditions due to the increased costs attributed to it (4, 5). The study used a retrospective case series methodology; an inherent weakness being variations and missing data as the collection was not planned and controlled (6). A prospective study may have allowed for a more complete dataset; however, this was not feasible within the constraints of the project, and would have presented its own challenges, such as compliance. Compliance is potentially more challenging where multiple vets are involved, and considering the time and practical constraints of emergency practice. Furthermore, prospective studies may induce bias with over-reporting of more interesting or memorable cases (6, 7).

The recording of data within electronic medical records are not always accurate or consistent (8) and it was evident when examining the case records that there was variation in clinical record keeping between practitioners. Additionally, there were differences in individual practitioner recording, particularly when there had been multiple cases attended in the same 'out-of-hours' period. Some records were more detailed, whereas others only contained what were considered the most important findings of the examination. Furthermore, individual clinicians may have different interpretations as part of their own clinical judgement and therefore there could be different representations of the same case (9, 10).

The sampling frame of two practices also had advantages and disadvantages. Whilst it allowed for comparisons to be drawn between the two practices, it could be argued that using two practices was not enough to draw any significant conclusions that are transferrable to the wider equine veterinary profession. Using two practices improved the validity of the results, especially as the out-of-hours caseload was remarkably similar. As mentioned, this was the first study to investigate the 'out-of-hours' caseload of primary care

equine veterinary work and therefore a greater depth of investigation on a smaller dataset provides a useful starting point on which to develop and base future investigations.

This study describes the frequency of conditions seen 'out-of-hours' in two practices however these results do not describe the prevalence of different conditions within primary care equine veterinary practice as a whole. Colic was the most common condition attended, consistent with the findings of another study, which reported veterinary practitioners' opinions of commonly attended conditions in the United States of America (11). The methodology used by Traub-Dargatz and others was that veterinarians nominated the conditions seen, rather than recording their specific caseloads, and may be subject to recall bias. The current study highlights the importance of colic 'out-of-hours' in particular, which alone accounts for over a third of the conditions seen in both these UK practices. Colic was previously reported as a major cause of death in the horse (12, 13), and this current study adds to this evidence, as horses with colic comprised a large proportion of the critical outcomes and mortalities in the study population.

The data from both practices were very similar in terms of patient demographics, conditions presented and outcomes, but there were differences in use of diagnostic tests and treatments, which will reflect individual clinician preference or approaches used in each practice. The diagnostic tests that were most frequently used 'out-of-hours' were rectal examination and nasogastric intubation, which reflects the high proportion of colic cases in this study (14, 15) . Sedation was commonly administered 'out-of-hours', however the reason for use was often not recorded in the clinical notes. Sedation and also spasmolytic agents (used in 10% of cases) can be utilised to facilitate diagnostic testing or can be administered for their therapeutic properties as a treatment in cases of colic (16, 17). Analgesics were the most common treatment administered which is consistent with other studies (15, 17). The rationale for the use of different treatments and classes of drugs would need to be investigated further, as there are a range of factors which may affect decision-making for individual cases.

The outcomes of cases attended by both practices in the study were similar. The majority of cases resolved with a single treatment (58%), but a significant number (18%) had critical outcomes, requiring referral, euthanasia or resulted in death. The single variable associated

with critical outcomes in the multivariate model was increased heart rate. This may reflect the high proportion of horses with colic, consistent with a previous study of factors associated with critical cases of colic (15).

Approximately 13% of animals attended outside of normal working hours were euthanased. These results are similar to another study that investigated mortality in geriatric horses (13). The study by Ireland and others (13) reported that mortality rate in geriatric horses was 11% overall, and that the majority (94%) of horses were euthanased (n=111/118), with only seven animals found dead or dying. It also reported that lameness and colic were the most common reasons for performing euthanasia in geriatric horses; these were also two of the three most common conditions attended 'out-of-hours' in this study.

This study has highlighted that a significant number of horses seen 'out-of-hours' have critical outcomes (18%), the majority of which were euthanased. This is potentially an important welfare consideration and requires further investigation. Late or delayed decisions on euthanasia is a major welfare concern, where the owners find the decision difficult and may delay until the horse becomes severely ill or has its welfare compromised (18). This study highlights the large number of horses requiring euthanasia 'out-of-hours', but the retrospective nature of the study meant that it could not be determined whether these were the result of an acute morbidity or a sudden deterioration of a pre-existing condition.

There is a lack of research on factors that affect out-of-hours decision-making in critical cases from both horse owner and veterinary perspectives. This is relevant both in terms of identifying health and welfare problems in the horse, ensuring there are resources and materials to support clients in decision-making, informing the training of veterinary students and new graduates, and providing appropriate educational materials and support for veterinary surgeons involved in 'out-of-hours' calls. The latter is particularly pertinent given that provision of twenty-four hour care is a requirement of the governing body of the profession in the United Kingdom and adequate support is integral to ensuring the welfare of equine veterinary surgeons. In an ambulatory setting, the veterinary surgeon may be isolated in potentially dangerous situations where the diagnostic tests and treatments administered leave the practitioner exposed to an increased risk of injury (19, 20).

This study has documented the types and frequencies of conditions seen 'out-of-hours' in equine practice. Colic, wounds and lameness were the most common conditions seen 'out-of-hours', and almost 1 in 5 cases (18%) attended 'out-of-hours' had critical outcomes. Most of the critical cases (71%) were euthanased, and these represent a population with potentially significant welfare implications. Factors affecting decision making in critical cases, particularly with respect to euthanasia, need further investigation from both an owner and veterinary perspective to evaluate why these are presenting as emergencies, and whether decisions are timely and appropriate. Further research is also needed to ensure that there is appropriate support for both horse owners and veterinary practitioners, who will be making difficult and potentially traumatic decisions outside of normal working hours.

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Figure Legends:

Figure 1: The presenting complaints of 2,602 horses that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

Figure 2: Outcomes of 480 critical cases (cases that were euthanased, died, or required surgery or hospitalisation) that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

Figure 3: The presenting conditions of critical cases (n=322/1,729 at Practice A, n=158/873 at Practice B) that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

Supplementary item legends

Supplementary Item 1. Data capture form for collating data from practice records for horses that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

Supplementary Item 2. Categories for presenting complaints and definitive diagnosis used in the data capture form for horses that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

Supplementary Item 3. Other conditions seen in 2,602 horses that were attended for primary assessment 'out-of-hours' at two practices over a three year period (2011-2013).

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