Maximising the impact of evidence-based medicine on equine health and welfare

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Abstract

Evidence-based veterinary medicine (EVM) has the potential to improve welfare of equine patients in primary care practice by ensuring that decision making at the point of care is underpinned by credible research. Patient focussed care requires consideration of a combination of evidence, veterinary judgement, experience and owner associated variables to ensure the best possible outcomes for the animal, whilst maximising the impact of EVM on equine health and welfare. A holistic approach to development and implementation of EVM, that involves horse owners, other equine stakeholders and veterinary surgeons, will ensure that all parties involved in decision making on behalf of equine patients are engaged in evidence-based decisions.

The central aim of the thesis was to determine how advances in evidence-based veterinary medicine had the potential to achieve the greatest impact on equine health and welfare. The objectives were to:

- Review methods of implementing evidence-based medicine in clinical practice and determine their suitability for veterinary medicine.
- Describe the prevalence and outcome of conditions seen for ‘out of hours’ primary assessment in equine practice.
- Investigate horse owner perception, understanding and approach to the most common emergency conditions.
- Identify paucities in the knowledge and resources available to equine owners and highlight the information required to implement and facilitate evidence-based decision making.
- Use an evidence-based approach to develop and disseminate an educational resource for horse owners to improve understanding of an emergency condition and equine welfare associated with that specific disease.

The first section of the thesis aimed to identify a common emergency condition with a major welfare impact, which would become a focus for

research in subsequent studies. A combination of methods were used in these chapters including a retrospective case study of ‘out of hours’ case records from two practices over a three year period, and a mixed methods online survey of opinions and experiences of equine yard owners. In the retrospective case study, colic (abdominal pain) was the most common condition seen as an ‘out of hours’ emergency at both veterinary practices, accounting for approximately a third of the ‘out of hours’ caseload. The three most common reasons for ‘out of hours’ visits for both practices were colic (35%), wounds (20%) and lameness (11%). The majority of cases seen ‘out of hours’ required a single treatment for resolution of the presenting problem (58%), whilst 26% needed multiple treatments.

An online survey consisting of open and closed questions was distributed to UK livery yard owners. The survey investigated participants’ demographics and experiences, their opinion of the most common emergency conditions in the horse, and decision-making in emergency situations. Descriptive analysis of data included frequency ranking and categorisation of free text responses. There were 104 survey participants. The majority had kept horses for more than ten years (97%), and had previous experience of emergency conditions (99%), predominantly of colic (96%) and wounds (92%). Participants considered that the most common emergency conditions were colic (98%), wounds (49%) and fractures (22%), and the most concerning conditions were colic (94%), lameness (36%) and wounds (21%). Factors important in emergency decision making were: degree of pain, likelihood of condition resolving, and severity of disease. The results of these studies provided the impetus for using colic as the focus for the next phases of work within this thesis.

The second section of the thesis investigated veterinary practitioners’ and horse owners’ approaches to horses with abdominal pain, with the aim of identifying where knowledge or resources were good or were variable or lacking. The subset of horses with abdominal pain from the ‘out of hours’ retrospective case series were explored to describe how these animals presented to veterinary surgeons, how they were diagnosed, treated and the outcomes. The clinical signs associated with a ‘critical’ outcome of colic were

determined using univariate logistic regression. In the retrospective case series, 941 cases presented with signs of abdominal pain; 23.9% (n=225/941) cases were categorised as ‘critical’, and 18% (n=168/941) were euthanased. Fifteen variables from the case presentation significantly correlated with a critical case ($p<0.01$) and were therefore incorporated into the multivariate model. The final multivariable model included three variables significantly associated with the likelihood of a case being classified as ‘critical’: increased heart rate ($p<0.01$), abnormal mucous membrane colour ($p<0.01$) and absence of borborygmi in at least one quadrant ($p<0.01$). These were considered to be essential clinical parameters associated with the differentiation of critical cases of colic, and therefore should be included in the veterinary assessment of the condition. To investigate horse owners’ opinions and experiences, a mixed methods survey was distributed to investigate owner knowledge, experience and approaches to colic through open and closed questions and clinical scenarios. The survey also aimed to highlight knowledge and resource gaps that may affect the welfare and outcomes of horses with abdominal pain. The horse owner survey identified that owners had variable and often limited knowledge of colic and were frequently poor at recognising some of the clinical and behavioural manifestations of the condition. This study also identified the need for an all-encompassing educational resource for horse owners underpinned by scientific evidence in an accessible and functional format.

Developing evidence-based resources for veterinary practitioners and horse owners was beyond the scope of what could be achieved within this thesis. Educational colic resources for horse owners (‘REACT’) were collaboratively developed and disseminated by Nottingham Equine Colic Project (including the author of the thesis) and The British Horse Society. Current evidence and literature on methods of incorporating evidence into clinical decision making were reviewed within the thesis, specifically accounting for the difficulties faced in veterinary medicine. Future work is needed to develop evidence-based resources on colic for veterinary surgeons to ensure that scientifically underpinned decisions are made at the point of care.

The work contained within this thesis highlighted the importance of the owner in the recognition of disease and instigation of veterinary intervention. It is crucial that both equine owners and veterinary surgeons are considered in equal measure when investigating decision making on behalf of a horse. Owners are the gatekeepers of animal care and welfare and therefore there is a requirement that they are included in research and the development of educational material. Veterinary directed studies are commonplace, however the benefits of such research are questionable if the horse owner does not present their animal for veterinary attention. The legacy of this study will likely be the inclusion of horse owners in the development of evidence-based educational campaigns.

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I would like to dedicate this thesis to my dad for teaching me that anything is achievable with hard work and determination.

“Strength doesn't come from what you can do. It comes from overcoming the things you once thought you couldn't.”

— Rikki Rogers

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Chapter 1 Introduction

Veterinary surgeons in the United Kingdom are governed by the Royal College of Veterinary Surgeons (RCVS). As the regulatory body, they are responsible for upholding the ethical and clinical responsibilities of the veterinary profession that are contained within the Codes of Professional conduct (RCVS, 2017c). The principal role of veterinary surgeons is to ensure the welfare of animals through the provision of appropriate care to prevent and treat disease. There are 29,407 veterinary surgeons registered with the RCVS (RCVS, 2016) with 22,009 categorised as UK practicing. There are 2,975 RCVS accredited practice premises within the UK with 138 of these described as providing care for equine patients: 114 are equine general practices and 24 are equine veterinary hospitals (RCVS, 2016).

Equine practice can be split into three main categories: hospital based equine practice, clinic based equine practice and ambulatory equine work (Mayes, 2015). Equine hospitals primarily examine equids at the hospital premises where there may be multiple RCVS or European recognised specialists with full nursing and support teams and more detailed diagnostic and therapeutic options. Clinic-based practice is an interim, providing additional facilities and services to support predominantly first opinion, ambulatory veterinary surgeons (Mayes, 2015). In ambulatory equine practice, consultations occur 'in the field' at owners premises or equestrian establishment such as a livery yard. This type of equine work is often undertaken by general practitioners who perform an equivalent role to GPs in human medicine (Quentin-Baxter *et al.*, 2005; Mayes, 2015) by assessing patients on a first opinion basis. In contrast to human medicine however, further diagnostic testing and treatments including surgeries may be undertaken in the remote setting rather than referral to a central hospital.

Equine care and welfare begins with the horse owner. There are an estimated 944,000 horses in the UK with approximately 450,000 horse owners (BETA, 2015). Horse owners act as proxies in equine care, taking responsibility to ensure the needs of their animals are met (Leckie, 2001; Birke *et al.*, 2010).

One of the responsibilities of the horse owner in this role is to ensure that veterinary attention is sought on behalf of the animal, when it is showing clinical signs of disease or injury. The sequence of events between recognition of a problem and treatment requires many observations and decisions to be made by owner, health professional and veterinary practitioners.

The RCVS states “in order to be fit-to-practice, veterinary practitioners hold the responsibility to ground their decisions on sound, objective and up-to-date evidence, when available” (Coe *et al.*, 2008; RCVS, 2013). Ambulatory equine practitioners are often making decisions in an isolated environment with limited equipment and resources (Wild *et al.*, 2017), providing a challenge to implementing evidence-based veterinary medicine at the point of care. Evidence-based decisions should not be exclusive to the veterinary practitioner; the horse owner has an important role in equine decision making both independently and in collaboration with veterinary surgeons. It could be argued that evidence-based medicine should underpin decision making regarding all aspects of equine care, from the recognition of disease by the horse owner through to treatment by the veterinary surgeon. For this reason, evidence-based materials must be targeted at horse owners, equine stakeholders and veterinary surgeons simultaneously.

An obligation of veterinary surgeons contained within the Codes of Conduct is the provision of twenty-four hour care for first aid and pain relief for animals (RCVS, 2017c). Veterinary surgeons do not necessarily have to provide ‘out of hours’ cover themselves; however, they must ‘take steps’ to ensure an appropriate level of cover is provided. It is commonplace in small animal practice to outsource emergency or ‘out of hours’ cover to specialist emergency practices that may operate out of pre-existing hospital premises (Firth *et al.*, 2014). Small animal practice is suited to outsourcing of emergency care as patients are often transportable and small animal hospitals contain the equipment and resources needed to diagnose and treat a variety of emergency conditions. Equine first opinion practices are often responsible for providing their own twenty-four hour care provision with hospitals throughout the United Kingdom for referral of cases requiring intensive

medical or surgical care (Friedman, 2012; Mayes, 2015). Equine first opinion practitioners often work remotely, alone, and operate from a vehicle with a mobile telephone as a means of contact (Lesser and Cowles, 2009; Friedman, 2012). 'Out of hours' provision of care in the ambulatory setting is a challenge due to variable resources and facilities available at the point of care (Friedman, 2012). In human medicine, around 20% of emergency clinic admissions are for non-urgent problems that would not be classified as an emergency (Thomson *et al.*, 1995a). A similar situation exists in veterinary practice: 25% of 'out of hours' admissions to an equine referral hospital in South Africa and 55% of telephone calls to a small animal emergency care provider were for non-emergency conditions (Viljoen *et al.*, 2009; Williams *et al.*, 2017). In the equine study, the equine referral centre admissions were admitted out-of-hours but did not require immediate attention and thus were not attended until the next working day. This was a common occurrence for referral cases that had appointments during the week but were admitted at the weekend for convenience (Viljoen *et al.*, 2009). It is not clear how many cases that presented as emergencies rather than out-of-hours admissions were deemed non-essential, however it should also be noted that the study was conducted at a referral centre and therefore the results may not be transferrable to first opinion practice in the UK. To discourage non-essential calls, and also to cover the extra resources and personnel required to provide a twenty-four hour service, it is common amongst veterinary practices to charge a premium for 'out of hours' care (Dunn, 2005).

Disease prevalence in the equine population has been investigated in a handful of studies. The National Equine Health survey (NEHS) is an online survey that has been conducted every year since 2010 using owner reporting of the health and disease of their animals at a specific time point. The survey is run by the Blue Cross with the aim of obtaining a cross section of the heath and disease of the equine population. In the latest published NEHS (2017), problems were reported in approximately 40% of the 15,433 horses included in the survey (Slater, 2017). The most common health problems were lameness (not related to the foot) (11.7%), laminitis (6.5%), "mud fever" (6.1%), "sweet itch" (6.1%) and Pituitary Pars Intermedia Dysfunction (PPID)

(6.0%) (Slater, 2017). The reporting of disease on the day of answering the survey reduces recall bias of memorable conditions, however it may cause a selection bias as horse owners whose animals have health conditions may be more likely to complete the survey. It is possible there is an underreporting of disease due to the inconsistencies between owner reporting and veterinary assessment of disease (Ireland *et al.*, 2012a). Other investigations of clinical disease in different populations of horses have supported the findings of the NEHS survey, with musculoskeletal disease most commonly reported (Penell *et al.*, 2005; Loomans *et al.*, 2007; Ireland *et al.*, 2012b; Ireland *et al.*, 2013; Nielsen *et al.*, 2014). The studies that ask for owner reporting of disease at a particular time point commonly report chronic conditions as the most common (Ireland *et al.*, 2012a; Ireland *et al.*, 2013; Slater, 2017), possibly due to the fact that owners were asked to report the health problems present in horses on the day of answering the survey. It is unlikely that owners experiencing emergency conditions will answer the survey on that particular day, thus this information may be lost from the studies and therefore emergency conditions may be under represented. The results of these studies are unlikely to be transferrable to the out-of-hours population as it can be hypothesized that horses that present out-of- hours in primary care practice are more likely to be affected by acute conditions rather than chronic diseases.

Veterinary opinion of common diseases has been investigated in one study (Traub-Dargatz *et al.*, 1991). Equine practitioners in the USA listed the conditions that they most frequently encountered, with differing results to the previous studies mentioned. Colic was reported as the most common condition attended, followed by respiratory disease, whilst other diseases varied in their frequency dependent on geographical location and other demographic factors (Traub-Dargatz *et al.*, 1991). The study by Traub-Dargatz *et al.* (1991) was based on veterinary opinion and therefore was likely to incorporate a degree of recall bias based on the severity and memorability of cases seen by individual veterinarians. Additionally, the data were collected via closed questions: veterinary surgeons selected from thirty six predefined categories which introduced a researcher influence and potential bias to the results. Furthermore, the study aim was to identify medical conditions which

meant that some common and surgical conditions such as lameness and wounds may have been excluded. The study design by Traub-Dargatz *et al.* (1991) may provide an explanation for the discrepancy between the results of that study and some of the other common condition studies (Penell *et al.*, 2005; Ireland *et al.*, 2012a; Ireland *et al.*, 2013; Slater, 2017). These studies provide us with an indication of health problems encountered by equine practitioners, however they do not identify the most commonly seen conditions outside of normal working hours in first opinion practice.

The financial importance of conditions encountered in veterinary practice can be obtained from insurance company data. The most common equine claims in 2015 in the United Kingdom made to one insurance company (Petplan equine) were published online (PetPlan, 2016). The total cost of Degenerative Joint Disease (DJD) was £730,000 which was the largest amount for a single condition. This was followed by colic, laminitis, Pituitary Pars Intermedia Dysfunction (PPID) and desmitis, with the five conditions totalling claims of nearly £2.5 million. Similarly, in studies investigating insurance data in Sweden, musculoskeletal conditions, specifically joint disease was also the most common reason for mortality claims (Egenvall *et al.*, 2006). A potential problem with using studies based on insurance data is that insurance claims do not necessarily correlate with common conditions, particularly as the number of horses covered by insurance is unknown, although it has been reported to be approximately 30% in a Swedish study (Egenvall *et al.*, 2008). There is a potentially significant proportion of the horse population that are excluded from insurance studies due to the percentage of horses without insurance. Also, horse owners may not submit claims for all problems encountered, and may focus on submitting the more expensive conditions and problems. There were likely to have been exemptions or constraints of some of the insurance policies that were included in the studies (Penell *et al.*, 2005; Egenvall *et al.*, 2006; Egenvall *et al.*, 2008), adding an influencing variable that may have introduced some bias to the results. These features are likely to affect the reliability of the results that means they are not directly applicable to the general horse population.

A study of 125,584 cases presenting at 50 dedicated small animal emergency centres in the UK identified the most common emergency presentations in canines as vomiting, trauma, collapse and wounds (Firth *et al.*, 2014). The findings for feline emergency problems from the same study were trauma, lethargy, wound and collapse. The study by Firth *et al.* (2014) was possible as the data were collected from a collective of practices under one organisation. As has already been discussed, equine veterinary practice has a different structure to small animal practice and the emergency care is not delivered in the same manner. Additionally, small animal practice incorporates multiple species that are commonly affected by different conditions to equine patients (Nielsen *et al.*, 2014) meaning it is inappropriate to extrapolate small animal emergency data into equine practice.

1.1 Brief structure of thesis

The main studies contained within this thesis are divided into three main sections, following a review of the literature. The literature review section (Chapter Two) consists of a critical review of the literature about evidence-based medicine, evidence-based veterinary medicine and the methods of implementing evidence-based practice. The chapter culminates with a discussion about the suitability and applicability of the different methods for veterinary practice.

The first section of the thesis (Chapters Three and Four) was designed to identify an equine emergency condition with a major welfare impact, to be used as a focus for research in subsequent studies within this thesis. This was investigated from both the perspective of veterinary practices (Chapter Three) and horse owner (Chapter Four). Chapter Three describes a retrospective study of cases seen ‘out of hours’ in two practices over a three year period. This work includes information about the primary assessment of ‘out of hours’ cases; signalment and clinical history, presenting signs, the diagnostic and treatment approaches and outcomes of the cases will be reported. Chapter

Four is a survey of experienced livery yard owners about which conditions are common and important in the horse.

The second section (Chapters Five and Six) investigated veterinary practitioners' and horse owners' approaches to horses with abdominal pain, to identify where knowledge or resources are lacking. In Chapter Five, veterinary practitioners' approaches to equids presenting for primary assessment of abdominal pain 'out of hours' were investigated through a more detailed study of the retrospective case data focused on a single clinical condition (abdominal pain). This work presents information about the primary assessment of 'out of hours' cases of abdominal pain and identifies which aspects of the primary presentation are significantly associated with critical outcomes ('red flags' for critical cases). Chapter 6 explored horse owners' knowledge, experiences and approach to colic in depth using a mixed methods survey. Knowledge and resource gaps were identified, and used to inform the development of evidence-based educational materials for horse owners.

Each chapter concludes with a discussion of the work within it, including study limitations and recommendations for future work. The final discussion in Chapter Seven incorporates findings from all the studies undertaken with discussion of the overall study design and limitations. The wider impact and implications of the findings within this thesis is also discussed, followed by a description of 'REACT', educational colic resources that were collaboratively developed and disseminated for both horse owners and veterinary surgeons. Finally, there are recommendations for future work or studies that have been identified and the overarching conclusions of the thesis, which sum up the main impact and outcomes of this piece of work.

1.2 Thesis aims and objectives

The central aim of the thesis was to determine how advances in evidence-based veterinary medicine had the potential to achieve the greatest impact on equine health and welfare. The objectives were to:

- Review methods of implementing evidence-based medicine in clinical practice and determine their suitability for veterinary medicine.
- Explore ‘out of hours’ practice in order to identify common emergency conditions that are associated with a negative impact on equine health and welfare.
- Investigate horse owner perception, understanding, experience and approach to the most common emergency conditions.
- Describe the primary assessment, treatment and outcomes of equids with abdominal pain (colic) that presented ‘out of hours’ in first opinion equine practice.
- Identify gaps and limitations in the knowledge and resources available to equine owners and highlight the information required to implement and facilitate evidence-based decision making in horses with abdominal pain.

Chapter 2 Review of the current literature on evidence-based medicine and evidence-based veterinary medicine

2.1 Evidence-based medicine

The purpose of this section is to define and describe evidence-based medicine (EBM). The origins, definition and process of EBM will be discussed along with some of the perceived advantages and difficulties in practising of EBM. Finally, organisations that assist with EBM dissemination and some examples of practical application of EBM will be presented.

2.1.1 What is Evidence-based medicine?

Evidence-based medicine (EBM) is a medical paradigm that developed in the 1990s from the evolution of clinical epidemiology and critical appraisal (Sackett *et al.*, 1996; Sackett, 1997b; Sackett, 1997c). One of the original pioneers of EBM in the 1990s was David Sackett, whom was responsible for much of the early progress of the EBM movement. Sackett *et al.* (1996) defined EBM as “the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients”. Ultimately, the underpinning message of EBM is to make clinical decisions in medical practice based on the highest level scientific evidence, providing a consistent and high quality level of care to medical patients (Rosenberg and Donald, 1995; Timmermans and Mauck, 2005) Different levels of scientific evidence are explained in the following section. Conducting evidence-based medicine is necessary to ensure that clinicians remain up to date with current knowledge and therefore provide the best care and outcomes for patients (Sackett and Rosenberg, 1995; Holmes and Ramey, 2007).

2.1.1.1 *Levels and quality of evidence*

An appreciation and understanding of different levels of evidence is necessary to base decisions on the highest level, quality scientific evidence in both human and veterinary medicine. Historically, a pyramid of evidence had been used to demonstrate the 'strength' of different types of evidence in a hierarchical manner. Systematic reviews were considered as the highest level or strongest evidence available, whilst *in vitro* studies and expert opinion were weaker, lower level evidence (Cockcroft and Holmes, 2003; Vandeweerd *et al.*, 2012d). It has been suggested that the pyramid of evidence could be no longer fit for purpose and more flexible explanations such as the staircase of evidence have been suggested to incorporate quality and level of studies in combination (Arlt and Heuwieser, 2016; Shaneyfelt, 2016; CEBM., 2017b). It was necessary to demonstrate the potential overlap between categories; for example, a well-designed lower level study may provide higher quality evidence than a poorly designed randomised controlled trial (RCT) (Cockcroft and Holmes, 2003). The staircase of evidence (Figure 1) highlights the overlap between the categories. Although studies at the top of the staircase are more likely to be true than those lower down, it is not necessarily the case due to the differences in study quality (Arlt and Heuwieser, 2016). Assessment of study quality should be conducted through a thorough critical appraisal process (Sackett, 1997b). The staircase schematic demonstrates how no study in isolation will provide the absolute truth, but rather the highest quality studies at the top provide the strongest evidence with the least uncertainty and therefore the results are most likely to be true (Arlt and Heuwieser, 2016).

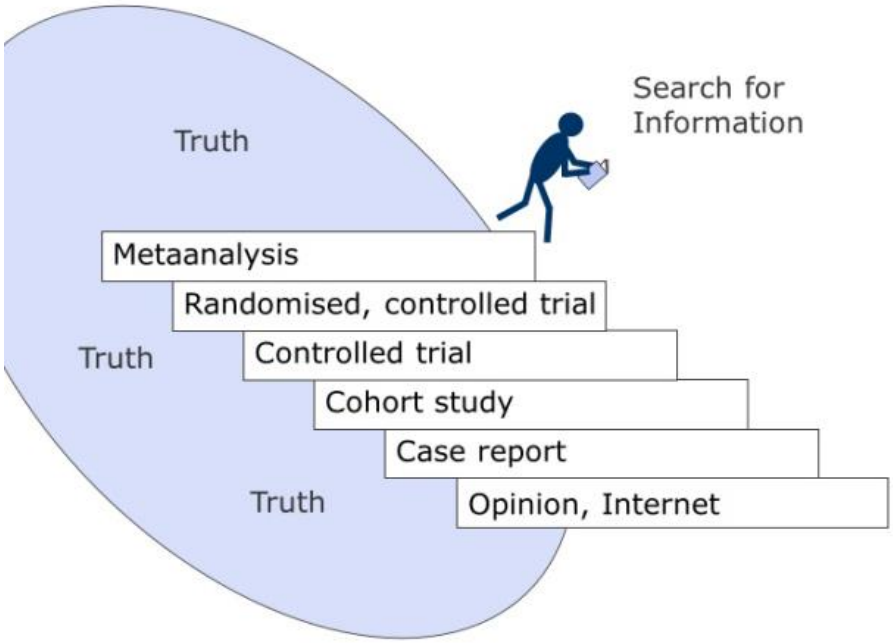


Figure 1: The staircase of evidence taken from (Arlt and Heuwieser, 2016).

In addition to the study type and quality, it is necessary to consider the clinical question, as different clinical questions require different study types (Cockcroft and Holmes, 2003; Vandeweerd *et al.*, 2012d). A randomised controlled trial would be suitable for investigating a treatment for a disease but to investigate prognosis for animals with a specific disease, a prospective cohort study could be more suitable (Vandeweerd *et al.*, 2012e). Given that different research questions require different study types, it is evident that there will not be systematic reviews or RCTs available in the literature for all topics (Sarasin, 1999). In conducting EBM (or evidence-based veterinary medicine), it is therefore necessary to use the best quality studies which incorporate the highest level of scientific evidence available on a given topic (Sackett *et al.*, 1996; Sackett, 1997b; Imrie and Ramey, 2000; Vincent, 2004).

2.1.1.2 *The steps of practising evidence-based medicine*

Evidence-based medicine has five steps. These have been described in the literature in many forms, but all have the same underlying concepts. The five steps adapted from Sackett (1997b) are shown below. The treatment of Parkinson's disease using the principles of EBM is provided as an example (Sampaio *et al.*, 2002).

1. **Ask the question:** Identify an information need and create an answerable question.
    a. Example: A clinician has a patient with Parkinson's disease and is unsure of the best course of treatment. They create the question: "What is the best treatment in patients with Parkinson's disease?"
2. **Search:** Conduct a strategic search of the literature to identify relevant studies.
    a. Example: The strategic search of the literature covers different databases (Cochrane library, Medline, Embase) using predetermined search criteria (includes the terms Parkinson's and treatment) to ensure all of the relevant studies are captured.
3. **Appraise:** Conduct a critical appraisal of the literature to assess the quality and validity of the studies.
    a. Example: The studies identified in step 2 are analysed and critically appraised to find the strongest (best quality, highest level) evidence that provides an answer to the clinical question "What effective treatments for Parkinson's disease exist?"
4. **Apply:** Apply the appraised evidence in conjunction with clinical expertise in practice.
    a. Example: Utilise the effective treatment(s) identified in the literature in Parkinson's disease patients.
5. **Evaluate:** Monitor outcomes of patients and assess the success of the EBM implementation.
    a. Example: Identify outcomes measures to record and analyse such as clinical symptoms associated with Parkinson's disease.

Identify any trends, for example, a reduction in clinical signs associated with treatments to indicate a successful intervention and evidence-based strategy.

2.1.2 Why evidence-based medicine is important

The General Medical Council (GMC) is the regulatory body for the medical profession in the United Kingdom. The main role of the GMC is to protect patient safety by improving medical education and standards within the profession (GMC, 2017a). In order to fulfil their role, the GMC produced a members' Code of Conduct, which doctors practising in the UK must adhere to. Included in the Code of Conduct are the seven principles, which originated from the Nolan Committee in 1995 (Committee on Standards in Public Life, 1995). The third principle highlights a requirement to use best evidence in practice: "holders of public office must act and take decisions impartially, fairly and on merit, using the best evidence and without discrimination or bias" (GMC, 2017b). This highlights the necessity to utilise the principles of EBM in order to safeguard patient care.

The overarching aim of EBM is to improve patient care (Sackett *et al.*, 1996; Holmes and Ramey, 2007) by reducing the unnecessary, potentially harmful clinical variation encountered in practice (Timmermans and Mauck, 2005). If there is inappropriate variation, some patients may receive substandard care, and therefore in using EBM, the intention is to provide the highest possible standard of care for all patients (Timmermans and Oh, 2010). Decisions regarding patients should not be made solely on evidence, instead the evidence should be considered and applied in light of the individual patient's circumstances (Sackett *et al.*, 1996). The importance of the clinician must also be considered. Two separate questionnaires of practising clinicians found there was a belief that practising EBM could assist in making clinical decisions for patients (McAlister *et al.*, 1999; Scott *et al.*, 2000). Evidence-based medicine requires clinicians to base decisions on the most current and best quality scientific evidence (Rosenberg and Donald, 1995; Timmermans and

Mauck, 2005). In order to accomplish this, clinicians must be able to perform an effective critical appraisal of the available evidence, a key skill that clinicians need to learn to prevent it being a barrier to effective implementation of EBM (Sackett and Parkes, 1998; McAlister *et al.*, 1999; Scott *et al.*, 2000). Evidence available may not be transferrable to a specific patient, and thus must be integrated with personal expertise and judgement to decide on the applicability to the individual (Sackett, 1997c; Timmermans and Oh, 2010). For example, in the case of co-morbidities, clinical decision analysis allows the clinician to extrapolate results from a trial or study based on 'average' patients and uses them to best effect for specific circumstances (Sarasin, 1999; Vincent, 2004). In summary, evidence-based medicine is vital to ensure consistent, high quality, up to date, best practice is received by all patients, whilst ensuring patient safety.

2.1.3 The issues in practising and utilising evidence-based medicine

Availability of high level evidence, oversimplification of patient care and clinician factors are the main key issues and discussion points in the implementation of EBM. One of the most widely reported barriers to conducting EBM is the level of evidence required for the process. The aim of using 'highest level' evidence in the form of randomised controlled trials (RCTs), systematic reviews and meta analyses immediately causes difficulties as they are not always available, or applicable, and lead to a perceived disregard for other alternative forms of evidence (Lalwani and Olive, 1999; Sarasin, 1999). For example, in the areas of spinal surgery and intensive care medicine, there are vast differences between patients and morbidities. In these disciplines, RCTs are often unavailable meaning that alternative forms of evidence must be sought (Vincent, 2004; Oppenlander *et al.*, 2014). EBM is not rigid in nature, and although RCTs are seen as the highest level evidence, it is widely accepted in EBM RCTs are not the best study type for every clinical question. When RCTs are not available, any available evidence should be critically appraised to determine quality, resulting in the use of the best

available evidence to underpin clinical decision making (Sackett, 1997b; Imrie and Ramey, 2000; Vincent, 2004).

Although results of clinician surveys found that EBM could prove useful in practice (McAlister *et al.*, 1999; Scott *et al.*, 2000), it was also identified that additional time pressures and skills were required in the process. A lack of effective literature searching skills and critical appraisal skills were identified as major barriers to effective implementation of EBM in practice (Rosenberg and Donald, 1995; Straus and McAlister, 2000). An additional concern is that as EBM is implemented more into practice, care could become oversimplified and patients may not be treated as individuals with unique circumstances (Hampton, 2002; Williams and Garner, 2002). Timmermans and Mauck (2005) suggested that as patient care becomes more standardised, clinicians may become less skilled and less capable of addressing variation as clinical judgement and expertise is negated. This criticism is counterbalanced by the argument that clinical judgement and expertise are deemed equally as important as evidence, and in fact a multifaceted approach should be adopted in order to provide the best and most appropriate care to individual patients (Sackett *et al.*, 1996; Timmermans and Mauck, 2005). There is still speculation as to whether and how much EBM actually improves patient outcomes, another component that makes implementation of EBM more challenging (Straus and McAlister, 2000; Sinclair, 2004). In conclusion, there are many barriers and potential issues encountered when implementing evidence-based medicine in clinical practice. Despite this, there are many studies that highlight the value of EBM, used alongside clinical judgement and expertise, with the main focus on patient care (Lalwani and Olive, 1999; Scott *et al.*, 2000; Cohen *et al.*, 2004; Vincent, 2004).

2.1.4 Organisations that focus on helping clinicians to use evidence-based medicine in practice

Effective implementation of EBM requires use of the highest quality evidence when making clinical decisions. There are currently organisations that collect, assimilate, summarise and critically appraise available evidence within the medical profession, making it readily accessible to healthcare professionals, assisting in promoting EBM in medical practice. These include, but are not limited to: The Cochrane collaboration, library and subgroups, the Centre for Reviews and Dissemination, and the Joanna Briggs Institute.

One of the largest organisations with a major role in EBM for the medical profession is the Cochrane collaboration. It was established in the early 1990's and comprises six databases which incorporate high quality research including evidence summaries (White, 2002). The content of the Cochrane library is available to all healthcare providers in addition to patients and researchers. A Cochrane review group: "The effective practice and organisation of care group" has the primary aim of updating and improving the accessibility of Cochrane reviews, thus improving dissemination of health care information within the medical profession (The Cochrane Collaboration, 2017). Cochrane systematic reviews have already been used to assist evidence-based practice in the treatment of Parkinson's disease (Sampaio *et al.*, 2002) and treatment of cervical cancer (Kitchener, 2002). In both of these studies, the results of searches conducted by Cochrane review groups were used to identify areas lacking in evidence, but also to highlight the existing high level evidence available for incorporation into evidence-based practice (Kitchener, 2002; Sampaio *et al.*, 2002). In addition to the Cochrane collaboration groups, the Centre for Reviews and Dissemination (CRD) based at the University of York, focusses on the compilation and dissemination of evidence (University of York, 2017). In a similar way to the Cochrane collaboration, the focus of the CRD research collective is evidence synthesis, conducting systematic reviews and providing databases for retrieval of evidence in order to promote its use, thus facilitating evidence-based practice (University of York, 2017). The Joanna Briggs institute (JBI) is another research collective which originally

had its roots in the nursing sector of the medical profession (University of Adelaide, 2017). The institute is highly collaborative and supports the use of evidence through the synthesis, transfer and utilisation in practice. The aim of the institute is to provide high quality evidence in an utilisable manner to provide the best possible outcomes for patients (University of Adelaide, 2017). In addition to the aforementioned, there are likely to be many other groups with a similar focus and aim, synthesising and providing high quality evidence and resources for practising clinicians.

2.2 Evidence-based veterinary medicine

The Royal College of Veterinary Surgeons (RCVS) as the regulatory body for all veterinarians within the UK, requires practitioners to use current, best available evidence to underpin their decision making (RCVS, 2013). The RCVS position statement on Evidence-based Veterinary Medicine (EVM) states that “in order to be fit-to-practice, veterinary practitioners hold the responsibility to ground their decisions on sound, objective and up-to-date evidence, when available” (RCVS, 2013). In spite of this, evidence-based veterinary medicine is still in its infancy in comparison to human medicine. There may be many reasons for this, some of which are well documented in the literature. The main reasons are limited finances in veterinary medicine in comparison to human medicine, a lack of high quality studies available, multiplicity of resources, and limited time and resources at the point of care.

2.2.1 The importance of EVM

It is important for veterinarians to become proficient in EVM to allow efficient use of scientific evidence to underpin decisions as time pressures and demands increase (Doig, 2003; Holmes and Cockcroft, 2004; Vandeweerd *et al.*, 2012d). In addition, practising EVM reduces the time lag experienced integrating research into clinical practice (Doig, 2003). In order to have the greatest benefit, EVM should focus on clinically relevant topics which have the potential to impact the largest group of patients (Everitt, 2008). Similarly to human medicine, effective EVM requires critically appraised, scientific evidence integrated with the skills and experience of the individual practitioner for application to each individual patient (Everitt, 2008; Vandeweerd *et al.*, 2012b). EVM requires education in the methodology; practitioners must acquire the skills needed to both critically appraise and objectively assess the strength of evidence and validity of studies (Doig, 2003; Holmes and Ramey, 2007; Vandeweerd *et al.*, 2012d).

2.2.2 Difficulties in transferring the practices of evidence-based human medicine to the veterinary profession

One of the main disparities between veterinary and human medicine is the limited finances that are available for veterinary research, especially patient centred (case based or practice based) veterinary research (Everitt, 2008; Lanyon, 2014). This may be a reason for the lack of studies available in veterinary medicine as a whole, and in particular why there is a deficit in the number of high quality available studies (Holmes and Ramey, 2007; Vandeweerd *et al.*, 2012b; Vandeweerd *et al.*, 2012d). In contrast to human medicine, there are relatively small numbers of randomised controlled trials in veterinary medicine, and therefore it is necessary to consider case control and cohort studies as useable evidence, especially as RCTs may not be applicable to answering every clinical question (Holmes, 2007a; Holmes and Ramey, 2007; Everitt, 2008; Vandeweerd *et al.*, 2012d). Another issue faced in veterinary medicine (that is not so prominent in human medicine) is the multiplicity of databases; accessibility is difficult as many resources are not open access and require paid subscriptions to obtain papers (Toews, 2011; Vandeweerd *et al.*, 2012b).

Due to the differences in medical and veterinary practice, it is not possible to directly transfer EBM methods from human to veterinary medicine, but instead they must be adapted to provide a more utilisable way of integrating research at veterinary primary care (Holmes and Cockcroft, 2004; Everitt, 2008; Vandeweerd *et al.*, 2012d). An additional difficulty for veterinary practitioners is the practicality in conducting EVM in first opinion settings, where time and resources are limited at the point of care (Vandeweerd *et al.*, 2012d; Wild *et al.*, 2017). This is a particular consideration in veterinary medicine as some clinicians, especially those working in farm animal and equine work, are often in remote locations without access to computers and other resources that would ordinarily be available to practitioners in human medicine (Wild *et al.*, 2017). For evidence to be utilised, it must be both available and useful to the primary care clinician (Everitt, 2008; Vandeweerd *et al.*, 2012d). Improving the accessibility of information resources at the point of care has been suggested

as a potential method of providing practitioners with current evidence for integration into practice (Toews, 2011; Vandeweerd *et al.*, 2012b). It has been demonstrated that if evidence is more readily available in a useable format, such as guidelines, protocols or evidence summaries, it is more likely to be adopted and integrated into everyday practice. The use of evidence summaries is particularly favoured as it is a way of utilising high quality scientific studies in a time efficient manner, thus making it more applicable to practicing veterinarians (Everitt, 2008; Vandeweerd *et al.*, 2012b).

In summary, it is not possible to adopt a 'copy and paste' approach from EBM in human medicine to EVM in veterinary medicine. The lack of high quality studies and universal, accessible databases mean acquiring the literature is far more challenging for the veterinary practitioner in comparison to the human medic. Additionally, remote working with poor access to resources and limited time available compound the issue further. The provision of training opportunities is necessary for veterinary surgeons to gain the skills required so that they can learn how to appraise the evidence themselves. To incorporate the use of best available evidence into veterinary practice and decision making, evidence must be provided in an accessible, preferably critically appraised, summarised format.

2.2.3 EVM: Disseminating the evidence

There are very few resources which provide high quality, critically appraised evidence available for veterinary practitioners. Systematic reviews are rarely available due to a small literature base and lack of high quality studies on a particular topic (Holmes and Ramey, 2007). The regulatory body of the veterinary profession, the Royal College of Veterinary Surgeons (RCVS) has an independent charity associated with it: RCVS Knowledge. RCVS Knowledge was created in 2013, from what was previously called the RCVS Charitable Trust (RCVS, 2017a). The aim of RCVS Knowledge is to support and assist in the use of EVM in clinical practice (RCVS, 2017a). To ensure the dissemination of high quality evidence, the RCVS Knowledge website has

links to sources of critically appraised evidence from other institutions (the Centre for Evidence-based Veterinary Medicine (CEVM) and the Banfield journal), as well as its own knowledge summaries and an EVM journal: Veterinary Evidence (RCVS, 2017a). Banfield Veterinary Hospital in the USA publish a CAT in their own journal each issue (every three months) that can be freely accessed and used by veterinarians. The provision of an archive also allows browsing and searching of previously published CATs for specific clinical questions (Banfield Pet Hospital, 2017).

The Centre for Evidence-based Veterinary Medicine (CEVM) at The University of Nottingham provide BestBETs for Vets, a source of critically appraised evidence in summary form that is available to veterinarians in practice (CEVM, 2017b). Previously compiled Best Evidence Topics (BETs) for different species (currently bovine, ovine, canine and feline) are published in the Veterinary Record journal (Dean *et al.*, 2015) and are catalogued on a website in the public domain (Dean *et al.*, 2015; CEVM, 2017b), allowing practitioners the ability to browse and search for evidence-based answers to specific clinical questions. In addition to BestBETs, the CEVM provides the 'VetSRev' resource, a searchable database of systematic reviews from the veterinary literature. VetSRev highlights where high quality studies are available and assists in the dissemination of these, reducing the time required to perform literature searching for clinicians in practice (CEVM, 2017a).

There is a movement towards increasing the use of evidence in veterinary practice. New resources are becoming available in the veterinary field, which has been assisted by the development of RCVS knowledge. The focus on collaboration and pooling of resources and expertise is necessary in order to provide clinically relevant evidence that is practically applicable in the point of care setting. If more utilisable resources are developed, the use of evidence in practice may become more commonplace.

2.3 Methodologies commonly used to incorporate evidence-based practice in human medicine

There are many different methodologies used to incorporate evidence-based medicine into clinical practice, particularly in human medicine. The main aim of these methods is to underpin decision making with scientific evidence or standardise clinical practice in certain procedures or disciplines. Investigating methods used in the implementation of EBM in practice is particularly confusing to navigate and understand, particularly as evidence-based veterinary medicine (EVM) is in the primitive stages when compared with human medicine. Incorporation and adoption of EVM is impeded by a lack of rigid definitions and terminology in the field, with the existence of multiple definitions for a single term, and the interchangeable use of different terminologies. The initial challenge of understanding EBM is exacerbated by these factors. An understanding of the processes involved in the different methods is required to assess their appropriateness for use in the veterinary profession. A description and explanation of each method is provided, including successes and barriers encountered in human medicine and where relevant, veterinary medicine. The individual methods are critiqued and reviewed, prior to an evaluation of the applicability for use in veterinary practice. At the end of the chapter, there is a discussion about the suitability and appropriateness of the different methods for veterinary practice.

2.3.1 Quality improvement methods

Quality improvement methods are cyclical processes that evaluate a system or process in healthcare, identifying further areas for improvement. Originating in the manufacturing industry, various quality improvement methods have been successfully adopted and used in human medicine (Nicolay *et al.*, 2012). The cyclical process begins with identifying an area for development, an improvement strategy based on pre-existing data is adopted and evaluation of the impact of intervention is undertaken, completing the cycle (Plsek, 1999; Gupta *et al.*, 2008). A commonly used cycle in quality improvement methods

is the Plan – Do – Study – Act (PDSA) (or Plan – Do – Check – Act (PDCA)) approach (Figure 2). The PDSA approach has been widely described and used in quality improvement studies in existing literature (Gupta *et al.*, 2008; Bookman *et al.*, 2010; Lynch-Jordan *et al.*, 2010; Nicolay *et al.*, 2012; Vaux *et al.*, 2012; Ambroggio *et al.*, 2013; Choi *et al.*, 2013).

A broad description of the steps in the PDSA cycle:

1. Plan: Evaluate current practices and identify an area for improvement. Plan the intervention(s) including staffing, patient inclusion, resources required, management processes, outcomes to be measured and other considerations that are necessary for individual circumstances.
2. Do: Implement the intervention(s) that were previously planned in the relevant department/ discipline. Record the results of the intervention (an example could be the length of hospital stay after surgery).
3. Study: Analyse the results and evaluate the effectiveness of the intervention(s). Compare with previous data if these are available.
4. Act: Take action dependent on the results. Improvements may dictate similar interventions in other departments or processes. If there are further improvements that can be made, these should be identified, continuing the cycle.

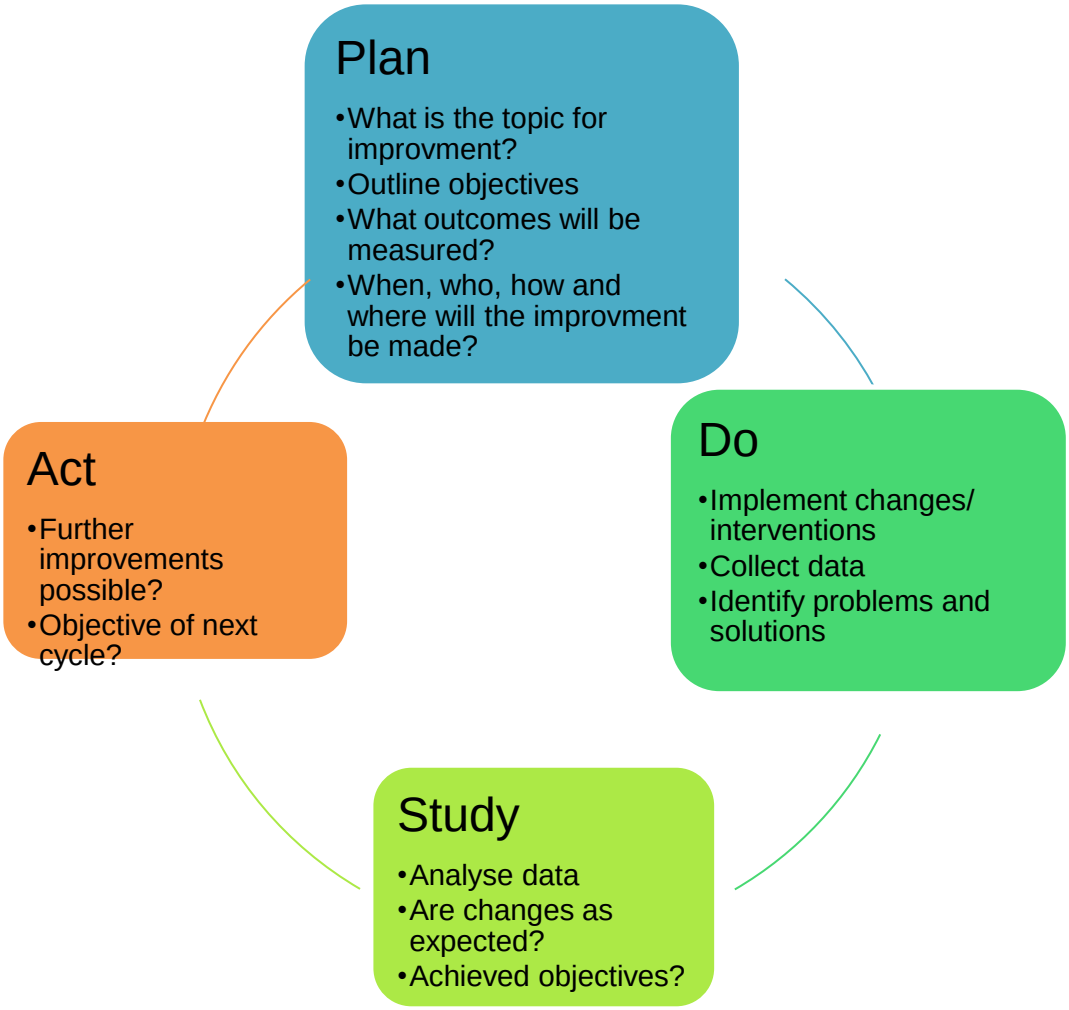


Figure 2: PDSA cycle for quality improvement. Adapted from Gupta *et al.* (2008).

There are four key criteria that are necessary in an area of medicine to facilitate change, including an appreciation of the complexities of clinical practice, flexibility, collaborative learning and openness to EBM (Plsek, 1999). The ultimate aim of quality improvement methods is the provision of the highest possible standard of care. In a systematic review of quality improvement methods derived from the manufacturing industry it was found that interventions were often based on suboptimal evidence (Nicolay *et al.*, 2012). Therefore, it can be inferred that to achieve the goal of providing the

highest possible standard of care, the best available evidence should be compiled prior to adopting quality improvement methods.

Effective implementation is determined by the ease of adoption of the quality improvement methods with minimally disruptive interventions more easily adopted. An example of this was demonstrated by Lynch-Jordan *et al.* (2010) where a novel measurement system was introduced to assess disabilities associated with chronic pain. The measurement system was easily adopted into clinical practice, thus making it more effective; an increased number of health professionals used the tool resulting in an improved continuity of care for patients. Success of quality improvement methods also requires education and continued professional development (CPD) of healthcare professionals (Lavoie Smith *et al.*, 2009; Vaux *et al.*, 2012). Training in the process results in a better understanding and therefore assists in uptake in clinical practice Riley *et al.* (2009). In addition to training, collaborative engagement and the recruitment of champions also proved to increase the successful adoption of interventions (Burns *et al.*, 1992; Raven *et al.*, 2011). CPD and training require time and resources at both a practice and individual clinician level. This is unique to the veterinary environment due to the nature of the NHS as an entity in human medicine and potentially poses an additional barrier to adoption in the veterinary field. Ultimately, any factors that can affect implementation of quality improvement methods must be considered and addressed, prior to commencing the process of quality improvement.

The use of quality improvement methods can improve adherence to pre-existing national guidelines (Ambroggio *et al.*, 2013), whilst reducing variation in clinical practice and harmonising treatments and outcomes both in referral and primary care practice (Bookman *et al.*, 2010; Harris *et al.*, 2013). In the past, the integration of these methods with clinical audit has been described to assess the effects of interventions (Cox *et al.*, 1999). Using this combination of methods should streamline processes and improve the adoption of EBM, however it is not commonplace in the literature, making its feasibility questionable. The cyclical process involved in Quality improvement is specific to individual processes or areas of medicine. Therefore, quality assessment and development of a tailored evaluation and implementation plan must be

undertaken, resulting in a time consuming process. Quality improvement methods would not be directly transferrable from human to veterinary medicine as they are not cross disciplinary within the medical profession. Assessment of clinical practice, development and adoption of quality improvement methods would not possible for each individual process or technique used in primary care veterinary practice due to the time, personnel and financial constraints in the veterinary profession.

2.3.2 Clinical Audit

The definition of audit used in the National Health Service (NHS) is “a quality improvement process that seeks to improve patient care and outcomes through systematic review of care and the implementation of change (HQIP, 2015). Audit itself is merely the assessment of something (Oxford English Dictionary, 2017). Clinical audit is viewed as an essential part of medical practice that has been used in some areas of medicine for many years (Mercey, 1992). In the late 1990’s, government policy was published to incorporate clinical audit into the process of clinical governance (Department of Health, 1998), making it mandatory to use the auditing cycle in the NHS. Additionally, individual hospital trusts were made accountable for ensuring these measures were implemented and upheld. The aim was to standardise and improve care across the NHS as a whole and continue to strive for progression (Department of Health, 1998). The rationale for making clinical audit a compulsory process was to safeguard patient care through the monitoring and improvement cycle, improving the standards of clinical care provided to patients (Figure 3).

Clinical audit identifies key areas for improvement and assesses the impact of changes implemented in these areas (Verma, 2012). A vital component of the cycle is the secondary analysis (re-auditing) of data to determine the success of interventions and highlight further areas for improvement (Verma, 2004). The auditing process is most rewarding if it is based upon high quality data, the recording of which has become more commonplace in human medicine in

recent years due to the introduction of clinical coding (Verma, 2012). The results of clinical audit are often compared to best practice standards or guidelines, to help reduce variation in clinical practice (Verma, 2004; Dazley *et al.*, 2013). The process of comparing audit results with best practice standards is known as benchmarking and is used to check if processes and operations are meeting or exceeding requirements or whether there is a possibility for improvement (Department of Health, 2010). In addition, benchmarking against pre-existing evidence-based guidelines assists to integrate evidence-based practice into human medicine. Due to the cyclical nature of clinical audit, once improvement strategies have been implemented, data can be re-audited and monitored with continual comparison against best practice guidelines to make further improvements.

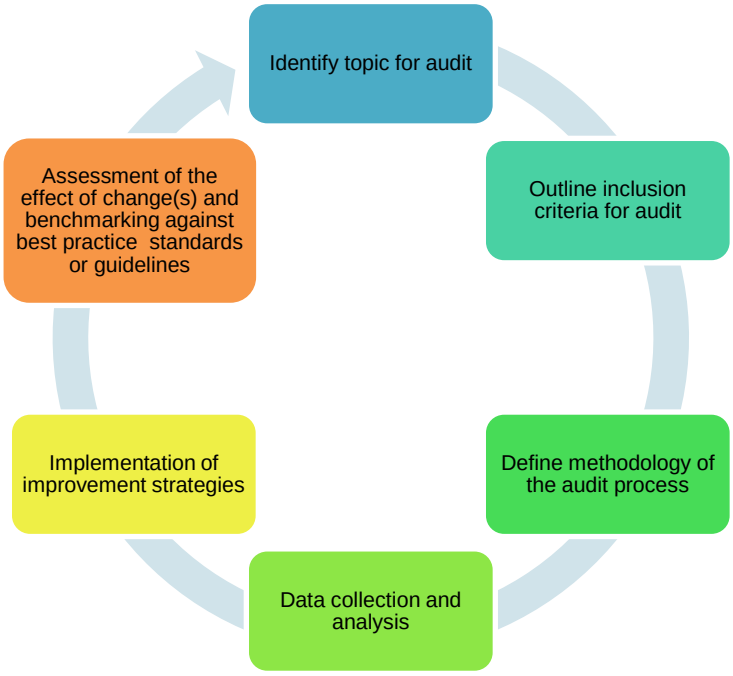


Figure 3: The process of clinical audit in the medical profession. Adapted from Verma (2004).

2.3.2.1 *Clinical audit in the veterinary profession*

Clinical audit in the veterinary profession is more advanced than other methods used to improve clinical standards. Rather than focussing on the medical literature, it is more appropriate to consider veterinary studies as the traditional medical framework for clinical audit is not transferrable to the veterinary profession (Waine and Brennan, 2015). Some key studies describing the process of clinical audit in veterinary medicine are highlighted in Table 1.

Table 1: Key papers in the veterinary literature, describing the process of clinical audit.

Author	Papers
Mosedale	Introducing clinical audit to veterinary practice (1998)
Rayment	Clinical audit – a means of evaluating 'quality' (2002)
Mair	Evidence-based medicine and clinical audit: what progress in equine practice? (2006) Clinical governance, clinical audit, and the potential value of a database of equine colic surgery (2009)
Godsall	Using clinical audits as tools for positive change in practice (2008)
Viner	Clinical audit in veterinary practice - The story so far (2005) Using audit to improve clinical effectiveness (2009)
Dunn	Clinical audit: A tool in the defence of clinical standards (2012)
Waine	Clinical audit in veterinary practice: theory v reality (2015)

The first efforts to introduce the concepts of clinical audit to the veterinary profession were made in the 1990s, when anaesthetic mortality in small animal practice was identified for audit in one practice (Mosedale, 1998). Since then multiple different clinical audit cycles have been described and used in the literature, creating confusion as to which is the most appropriate clinical audit cycle for practitioners to adopt. One of the main discrepancies in

the pre-existing literature is the process of benchmarking, specifically what standards to benchmark against. Dunn (2012) suggests the use of pre-existing gold standards whilst Viner (2009) suggests creating guidelines. Ultimately, the major problem facing first opinion veterinary practice is a lack of relevant evidence-based guidelines that could be used as standards for benchmarking (Mair and White, 2008; Mair, 2009; Wylie, 2015). This problem was addressed by Burford *et al.* (2014) whom suggested conducting an initial audit, then using the results as your standard for future benchmarking. If the initial audit found no room for improvement in practices or procedures, subsequent audits would monitor for maintenance of standards. However, if there were potential developments that could be made, subsequent audits would look for improvements. A simplified 5 step cycle is described by Waine and Brennan (2015) which can be adapted and used in first opinion veterinary practice (Figure 4). Once a topic for audit is identified, preparations for the process are made. The data are collected, analysed and discussed, informing changes that need to be made. These changes are implemented prior to a re-audit which completes the cycle (Waine and Brennan, 2015).



Figure 4: The 5 step cycle of clinical audit for use in first opinion veterinary practice. Taken from Waine and Brennan (2015).

Clinical audit in veterinary practice has the same aim as in human medicine: improving patient care and clinical effectiveness and improving clinical standards for veterinary patients (Viner, 2009; Dunn, 2012). A move towards the use of clinical audit was supported by the veterinary profession when surveyed in a study by Viner (2005). Critically, it is not evident whether the survey was sent to all sectors of the veterinary profession or whether it focused on a single species or discipline. Additionally, the survey was completed by 900 veterinary surgeons, which only represents a small percentage of the total population at the time. According to the Royal College of Veterinary Surgeons (RCVS) in the 2006 annual report, there were over 21,000 veterinary surgeons in the UK at the time (Robinson and Hooker, 2006). This means that there is possibly a degree of bias to the study e.g. those that advocate clinical audit being more likely to participate, and therefore the support from the profession as a whole remains unknown. More in depth research is necessary to identify the opinions and concerns that are representative of the profession as a whole, and across different species and disciplines.

There are many possible benefits of conducting clinical audit in veterinary practice. Undertaking effective clinical audit can increase standards of patient care (Mair and White, 2008) and improve patient safety (Oxtoby, 2014). Clinical audit also has the potential to improve the use of evidence-based medicine in decision making at the point of care (Dunn, 2012; Waine and Brennan, 2015). The process can also provide evidence to demonstrate the efficiency and benefits of clinical procedures (Mair and White, 2008; Viner, 2009). It has also been suggested that clinical audit may provide a defence against professional complaints and litigation (Dunn, 2012), although the creation of ‘league tables’ and increased pressure on already stressed veterinary surgeons have been voiced as potential concerns (Viner, 2009).

In recent years, The Royal College of Veterinary Surgeons (RCVS) has developed a voluntary practice standards scheme which requires the undertaking of clinical audit to achieve accreditation as part of clinical governance (RCVS, 2017b). Although, unlike the NHS, it is not a mandatory requirement, it is a step towards clinical audit becoming more commonplace.

As more veterinary practices enter the scheme, the process of clinical audit within the veterinary profession will become more routine and accepted. For clinical audit to be successfully adopted into the veterinary profession, education is required on how to conduct a successful clinical audit with the appointment of champions to drive the process (Viner and Jenner, 2005). Clinical audit is a valuable tool with many potential benefits to improve clinical standards in veterinary practice. The lack of evidence-based guidelines in the veterinary profession means clinical audit must adopt a different approach compared to human medicine. There is scope to incorporate other methods of adopting evidence-based practice alongside clinical audit, however as a first step the key is keeping the process simple (Waine and Brennan, 2015) and assessing current practices to provide a crucial starting point (Burford *et al.*, 2014).

2.3.3 Best practice guidelines

The terms best practice guidelines and evidence-based guidelines are often used interchangeably in the literature. Where these terms are used in the following subchapter they are describing guidelines that are based upon critically appraised evidence, with identification and appropriate infilling of any paucities in the published literature. The most appropriate definition of best practice guidelines is explained by Thomson *et al.* (1995b): guidelines "provide appropriate care based on scientific evidence and broad consensus, leaving room for justifiable variations in practice". This definition takes into account the use of evidence-based medicine and reduction in unnecessary variation in practice, whilst still accounting for clinical freedom and use of experience. The aim of using best practice guidelines as with other methods of implementing EBM is to improve patient care through the use of the highest quality evidence on a given topic (Lewthwaite and Girouard, 2006; Eccles *et al.*, 2012).

2.3.3.1 *The development of best practice guidelines*

The development process of best practice guidelines begins with the identification of a topic or subject where intervention will improve patient care. Relevant stakeholders in the area, such as doctors and patients, should be identified and included in the development process (Eccles *et al.*, 2012). To ensure the best quality evidence is utilised in guideline development, the available evidence in the discipline should be collated and critically appraised to assess quality, possibly through a systematic review or meta-analyses (Cameron *et al.*, 1999; Wilne *et al.*, 2007; Wilne *et al.*, 2012). In subjects where evidence is lacking, expert panels have been constructed to achieve consensus on specific statements (McQueen and Dennis, 2007; Rosenthal, 2012). Once evidence-based statements have been formulated and collated, they can be incorporated into a clinical practice guideline (Shekelle *et al.*, 1999). Guideline development is not the endpoint of the process; guidelines must be revisited, assessed, redeveloped and updated as research advances (Freel *et al.*, 2008; Carvalho, 2012).

2.3.3.1.1 Case study: The Head Smart campaign

The Head Smart campaign focused on diagnosis of childhood brain tumours. The justification for the campaign was that prolonged symptom intervals (time from symptom onset to diagnosis) led to increased tumour associated disability and mortality (Wilne *et al.*, 2010b). The reasoning for a long symptom interval was that brain tumour presentation was diverse and also mimicked many other conditions that were less severe in nature (Wilne *et al.*, 2007). Symptoms were also variable between different age groups. Guidelines were available via the National Institute for Clinical Excellence (NICE) at the time of the campaign; however, these were not based on the best available evidence and were only applicable to primary care, with the endpoint being referral (Wilne *et al.*, 2010b). The objective of Head Smart was to develop evidence-based guidelines for primary and secondary care, covering symptoms, assessment and imaging for brain tumours in children in different

age categories (Wilne *et al.*, 2010b). A systematic literature review and meta-analysis was undertaken alongside a cohort study in order to obtain the best available evidence (Wilne *et al.*, 2007; Wilne *et al.*, 2012). The evidence was then subjected to a multi-disciplinary workshop and Delphi consensus process in order to develop the guidelines (Wilne *et al.*, 2010b). A Delphi consensus process aims to achieve consensus on statements generated by a panel or workshop. Each statement is sent to the participants who are asked to rate their level of agreement on a Likert scale ranging from strongly agree to strongly disagree. In the literature, there are differing opinions on the level of agreement required for a statement to be accepted (Loughlin and Moore, 1979; Hasson *et al.*, 2000; Green *et al.*, 2004; Keeney *et al.*, 2011). Hasson *et al.* (2000) and Keeney *et al.* (2011) recommend a consensus of 75%, the same level that was used in the Head Smart campaign. The number of rounds involved in the process can vary from one study to the next, in relation to the scale of the study and the resources available.

Once developed, the guidelines were then disseminated nationwide via multiple methods including a website, information materials for all stakeholders (parents, GPs and referral clinicians) and a publicity campaign. The impact was measured by collecting symptom interval data; the result was a reduction in symptom intervals and earlier diagnosis in children suffering with brain tumours (Headsmart, 2017). This detailed example of the process of using best practice guidelines highlights all aspects of the cycle that was described previously, and demonstrates how the use of best practice guidelines can have a measurable impact.

2.3.3.2 *Best practice guidelines in human medicine*

Guidelines have been endorsed by the NHS since the late 1990s via national policy (NHS, 2017). In addition, Two respected bodies in medicine, The National Institute for Health and Care excellence (NICE) and the World Health Organisation (WHO) have advocated the use of guidelines. On both the NICE (http://www.nice.org.uk/guidance) and WHO websites

(http://www.who.int/publications/guidelines/en/) there are hundreds of published best practice guidelines in addition to information for patients and the public. These guidelines can be used as a resource for healthcare practitioners or health authorities who wish to implement best practice guidelines to improve patient outcomes. When patient outcomes are significantly improved through the use of guidelines, it is evident why they are seen as beneficial. Guideline development however is much removed from guideline uptake and adoption; the development and distribution of best practice guidelines is no guarantee that they will be adopted, particularly by primary care clinicians (Bloom *et al.*, 2004; Spiegel *et al.*, 2009). A transparent and inclusive development process and a targeted dissemination campaign increases adoption of guidelines in practice (McQueen and Dennis, 2007; Shekelle *et al.*, 2012). Additionally, tailoring guidelines to specific clinical groups and appointing an individual to oversee guideline implementation assists in uptake (Currin *et al.*, 2007; Schiro *et al.*, 2011). The concern with adopting and utilising guidelines is that they result in a reduction in the clinical freedom of practitioners, and a disregard for clinical experience and expertise. Further trepidation amongst clinicians is that they may be open to litigation if they do not adhere to guidelines, which leads to a “cookbook” approach to medicine (Timmermans and Angell, 2001). Furthermore, in certain departments, the stringent following of guidelines has had a negative impact on doctors’ decision making skills and ability to utilise clinical judgement in certain situations. This particularly manifests when treating patients with co-morbidities as often guidelines are developed for a single condition in an otherwise healthy patient, meaning poor adaptability of the guidelines themselves. It is in these patients in particular where the use of clinical judgement, expertise and experience is paramount for the provision of the highest standard of care. The complexity of using guidelines, accompanied by lack of time in the medical profession are two additional barriers to guideline adoption (Francke *et al.*, 2008). These issues in particular are further exacerbated in veterinary medicine. Another criticism of using guidelines is the timescale for development; once guidelines have been developed, it is likely that the underpinning evidence is outdated, particularly in human medicine where new evidence is generated and published regularly (Elwyn *et al.*, 2016).

2.3.3.3 *Best practice guidelines in veterinary medicine*

Guidelines are less readily available and therefore are used more rarely in the veterinary profession than in human medicine. There are a few examples where guidelines have been developed using robust methodology and critical review of the available evidence to produce outputs based on the best available evidence (Sparkes *et al.*, 2010; Wapenaar *et al.*, 2011; Fletcher *et al.*, 2012; Sparkes *et al.*, 2015). The RECOVER guidelines were developed for use in cardiopulmonary resuscitation in dogs and cats (Fletcher *et al.*, 2012). These guidelines followed an evidence-based approach; a systematic review of the literature, categorisation according to quality of the study design and level of evidence, generation of consensus statements and conversion into guidelines. The RECOVER guidelines are comprehensive, designed to assist in the resuscitation of patients. The methodology for guideline development was clear and they were based upon the best available evidence which had been critically appraised (Boller and Fletcher, 2012). Although these guidelines have been successfully adopted in one small animal hospital (ACVECC, 2017), it is unknown whether these have been successfully implemented in other veterinary practices.

A guideline that is known to have been used more widely than RECOVER is the sustainable control of parasites in sheep (SCOPS) guideline which was first published in 2004 (SCOPS, 2017). The development process was similar to RECOVER; evidence was reviewed and consensus reached following a workshop of different stakeholders. Learmount *et al.* (2015) investigated the success of the SCOPS guidelines by comparing farms using the guidelines with those that were using a more traditional method of anthelmintic administration finding that fewer treatments were administered on SCOPS farms. The SCOPS evidence is reviewed on a regular basis and the guidelines are amended and updated accordingly (SCOPS, 2017).

It is a common problem to encounter weak or lacking evidence in veterinary practice, however there are still options available to develop guidelines based on the best available evidence. A study investigating treatment of uterine prolapse in cattle by Wapenaar *et al.* (2011) described the use of a Delphi

consensus method to consolidate expert opinion to form guidelines. The ‘treatment of uterine prolapse’ guidelines were assimilated in a way that could be readily adapted and used in primary care practice. A problem with practitioners utilising guidelines in veterinary medicine is the variable quality of published studies. Some studies detail ‘guideline’ development with a questionable, non-evidence-based methodology that is not recognised or robust (Sweeney *et al.*, 2005; Carney *et al.*, 2014). The study by Carney *et al.* (2014) generates statements based on the accumulative clinical experience and opinion of the authors of the study; this represents low level evidence, which has not been through a consensus process and thus is likely subject to a degree of bias. Streptococcus equi (strangles) infection guidelines were generated in a similar manner (Sweeney *et al.*, 2005). Although it was reported as a consensus statement, it was an expert consensus rather than a recognised evidence-based consensus method such as a Delphi process. The exact methods of the study were not clear and whilst it was suggestive that evidence was used where it was available, what the evidence was, and whether it was critically appraised was not mentioned. In addition, where evidence was lacking or conflicting, the authors generated the statements using their own expert opinion and experience without a consensus process as validation (Sweeney *et al.*, 2005). These studies highlight the inconsistent approach and therefore variable quality of available guidelines which is likely a barrier to the widespread adoption of guidelines in veterinary practice.

To conclude, best practice guidelines have been readily used in human medicine with positive outcomes, although some challenges of over-standardisation of procedures have become more apparent in recent years. The barriers to guideline implementation are perhaps amplified in veterinary medicine; time and resources are particularly limited at the point of care, it may be difficult to find an individual to oversee the process, and the complexity of adapting guidelines to individual patients is unrealistic with the demands of the profession. Best practice guidelines often relate to a specific area or process in medicine and therefore undertaking development of guidelines, across multiple diseases and species is an unrealistic aim. Furthermore, the development, reassessment and updating of guidelines

requires specific skills such as critical appraisal and is a time consuming and resource heavy process. This is compounded by the lack of high quality studies in the veterinary literature, meaning statements would have to be generated via workshops and a Delphi consensus process, further increasing the time and resources required for guideline development and dissemination. Finally, concerns over the lack of clinical freedom and use of experience may be another factor preventing the widespread use of best practice guidelines in the veterinary profession.

2.3.4 Clinical protocols

Protocols are similar to guidelines in that they provide a series of steps to follow when diagnosing or treating a certain condition. In the Oxford English Dictionary, the definition of a protocol in human medicine is: “A procedure for carrying out a scientific experiment or a course of medical treatment”. It can prove difficult to distinguish the difference between guidelines and protocols or whether the terms are used interchangeably. The nature of protocols in science are akin to a series of instructions that should be stringently followed, however this is not reflected in the published medical literature. Instead the literature demonstrates that in a similar way to guidelines, protocols should be a flexible guide for patient care based upon best quality peer reviewed evidence, accounting for national recommendations (Wesley Ely *et al.*, 2001). The aim of protocols is to provide clear, logical steps in the diagnosis and management of conditions, allowing scope for clinical judgement and expertise, whilst supporting practitioners through the decision making and treatment process (Fuss and Pasquale, 1998). An additional aim of incorporating protocols in practice is to address inconsistencies between practitioners and improve the efficiency and quality of care received by patients, although protocols aren’t necessarily used even if they are available (Mills *et al.*, 2005; Afessa *et al.*, 2007; Delaney *et al.*, 2010; Hislop and Tierney, 2011). It is evident when considering these aims and definitions of

protocols why the distinction between guidelines and protocols is blurred and the terms are often used interchangeably of each other.

Assessing the success of protocols can be conducted through clinical audit to check the consistency of adherence to a protocol whilst improving reliability and providing assurance that outcomes are improved (Back *et al.*, 2003). If multiple protocols exist on a given topic or procedure, evidence must be compared and consolidated, and areas that are lacking evidence should be highlighted; auditing can assist in identifying these areas (Back *et al.*, 2003; Owen *et al.*, 2004; Altman *et al.*, 2011). Castiella *et al.* (2011) conducted a study to compare two protocols for determining liver iron concentration. Traditionally used liver biopsies were compared against a method using MRI. The MRI method tended to overestimate iron overload of the liver, questioning the requirement for an additional protocol, when liver biopsies were an accurate measure. Although MRI was less invasive, the higher cost and increased pressure on resources without added clinical benefit questions the necessity of this protocol in clinical practice. Protocols must be feasible, practical and applicable to clinical practice without overcomplicating procedures or introducing confusion. If there is conflicting or missing evidence between different protocols, this must be addressed and relevant steps must be taken to achieve a consensus (Owen *et al.*, 2004; Altman *et al.*, 2011). If statements reach a required level of agreement, they can be incorporated into a clinical protocol (Arnold *et al.*, 2008; Altman *et al.*, 2011). This is of particular importance when considering topics that lack abundant, high quality evidence (Arnold *et al.*, 2008; Arnold *et al.*, 2009). A consistent theme between all methods of adopting EBM is the requirement to update and consolidate information as research and evidence progresses and advances, and clinical protocols are no different (Arnold *et al.*, 2008; Arnold *et al.*, 2009). Continued collection and analysis of data is vital to ensure the effectiveness of the protocol is maintained. This was highlighted in a study by Gilpin *et al.* (2010) where initially, a decolonisation programme protocol for MRSA showed positive results, however when MRSA levels were re-evaluated after 12 months, 45% of the patients who were initially decolonised tested positive for MRSA again. If the study population had not been followed and retested, the

true efficacy of the protocol would not have been known, demonstrating the importance of short and long term follow up, and re-evaluation of outcomes.

Lack of staff support, active resistance and issues with the procedures already in place are barriers to adoption of protocols in human medicine, barriers which are reduced with identification, acknowledgement and a clear implementation strategy (Kelly *et al.*, 2006; Geng *et al.*, 2011; Arendts *et al.*, 2014).

2.3.4.1 *Clinical protocols in veterinary practice*

Clinical protocols are apparently widespread in the veterinary literature, however there are no published studies detailing evidence-based protocols. Protocols are advocated by regulatory bodies in the veterinary profession, notably the British Equine Veterinary Association (BEVA) and the Horserace Betting Levy Board (HBLB). BEVA developed a template named as the 'PROTECT ME' protocol (BEVA, 2017a) to help reduce antibiotic resistance (Figure 5). Certain antibiotics are classified as 'protected' or 'avoided' by the World Health Organisation. These antibiotics are listed on the BEVA website alongside the PROTECT ME templates. Protected antibiotics may be used as an alternative treatment in certain circumstances outlined by the individual practice whereas avoided antibiotics should never be used. BEVA encourages the use of best available evidence when developing practice policy with links to relevant journal articles on its website (BEVA, 2017b). It is unclear whether these articles have been critically appraised for quality or not, or whether the attached papers are updated as new evidence is published. If the process is executed correctly at a practice level and the protocol is adopted and followed by all members of the practice, this provides a good example of an evidence-based protocol. It is of course possible to create the protocol that is based solely on opinion and experience of an individual or a group of senior partners of the practice, potentially disregarding the evidence and creating a protocol which exacerbated antimicrobial resistance. There is also no governance, and therefore it is a voluntary, opt in scheme with the earnest on the practice to

create and implement the use of the protocol; a template can only guide so much. As with all evidence-based processes, there is a requirement to revisit the evidence and update the protocol as time progresses, a factor which is also the responsibility of the individual practices. Ultimately, BEVA are attempting to encourage practices to implement a tailored evidence-based protocol to reduce antimicrobial resistance which can only be viewed as a positive stance despite some of the pitfalls of the approach. Antimicrobial resistance is a global health problem in both the medical and veterinary sectors, meaning there must be a collaborative effort to prevent antimicrobial resistant infections by ensuring appropriate antibiotic use (WHO, 2017). It is inevitable that there will be a degree of variation between the quality of the protocols developed by individual practices, however it is a step towards utilising a more evidence-based approach in practice.

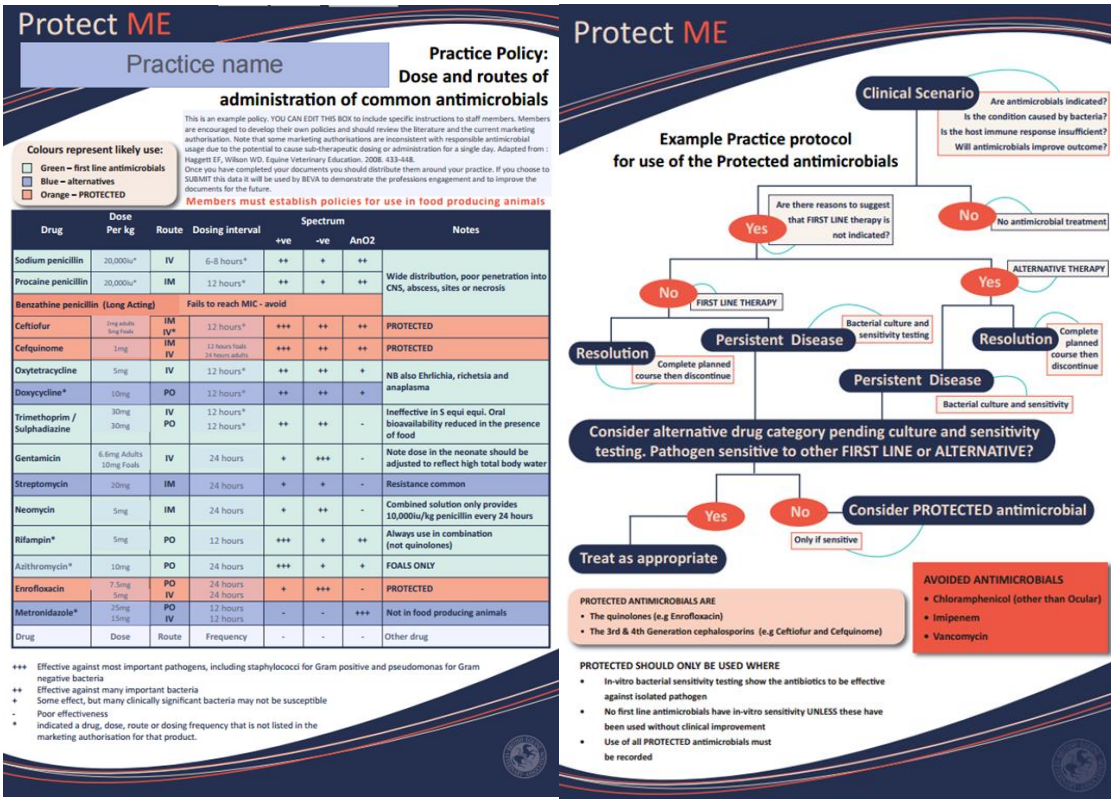


Figure 5: BEVA 'PROTECT ME' practice policy template for responsible antibiotic use (taken from the BEVA website, 2018).

In addition to the ‘PROTECT ME’ protocol, the HBLB codes of practice contain additional protocols for use in equine practice. The HBLB is the statutory body for the horseracing industry, and the codes of practice have been developed

for equine breeders and veterinarians (HBLB, 2017). The codes of practice are voluntary recommendations and include biosecurity protocols for artificial insemination, encompassing semen collection and handling and mare preparation and insemination (HBLB, 2017). These protocols are provided as numbered steps to follow in order to minimise the risk of transmission of venereal or notifiable diseases. These protocols perhaps fit the traditional scientific definition of a protocol as they are stepwise instructions that more rigid and clear to follow. The codes are reviewed on a yearly basis and amended if necessary based on scientific or practical reasons, suggesting that the codes are based upon current scientific evidence at all times. It is not clear however, what the quality of the evidence is, whether it is critically appraised or how the evidence is incorporated.

The applicability of clinical protocols in veterinary practice is similar to best practice guidelines. Clinical protocols have been successfully used in the medical field and there is a drive towards their use in a limited number of topics, particularly in equine veterinary medicine. Again, in a similar way to best practice guidelines, barriers faced in human medicine are likely to be exaggerated in veterinary practice. For protocols to be used widely throughout the veterinary profession and across species, they must first be developed which would be time consuming and largely impractical. The understanding and clarification of the definition of a protocol is important and necessary, as is the aim of what the individual protocol is trying to achieve. A stringent set of rules may be desirable for some processes such as the disinfection of an operating theatre or the maintenance of equipment where continuity between operators is beneficial to achieve the same outcome. In clinical decision making, stepwise instructions rather than a flexible guide based upon high level scientific evidence may be less desirable for the practitioner, and therefore there may be resistance against the use of protocols due to a perceived lack of clinical freedom (Viner, 2010). Profession wide use of evidence-based clinical protocols is unlikely to occur in the near future due to the lack of those already available and the input required for the development process. The challenges of incorporating evidence-based protocols are much the same as have been previously described for best

practice guidelines: a concern over lack of clinical freedom, time and resource intensive development process and lack of abundant high quality evidence in many areas all contribute to the difficulties in adopting EVM in general. It is therefore necessary to identify a more suitable method or combination of methods for conducting EVM in practice.

2.3.5 Evidence summaries: Critically Appraised Topics (CATs), Best BETs and Systematic reviews

An evidence summary in this instance is defined as any method of incorporating evidence into clinical practice or clinical decision making where the evidence has been strategically searched, critically appraised and assessed for quality, resulting in a conclusion. There are different methods that can be incorporated under the umbrella of evidence summaries, including but not limited to critically appraised topics (CATs), best evidence topics (BETs) and systematic reviews.

2.3.5.1 *Critically appraised topics (CATs)*

A critically appraised topic (CAT) is a method of using evidence-based medicine (EBM) in practice: a one page summary is created from appraising the highest level evidence to a specific clinical question (Sauve, 1995). CATs were first developed by David Sackett and utilize the five principles of EBM: Ask, Search, Appraise, Apply and Evaluate (Sackett, 1997a). The CAT begins with a structured question which forms the basis for a literature search. The results of the search are subjected to a rigorous critical appraisal in order to determine the quality of the evidence and the applicability to clinical practice, with a final evaluation and conclusion to answer the original question (Wyer, 1997). CATs are invaluable to clinicians in areas of medicine where high level evidence is available for appraisal. The introduction of computer tools such as “CAT crawlers” (Dong and Mondry, 2004; Dong *et al.*, 2004) and “CAT makers” (CEBM., 2017a) means that finding or conducting a new CAT is a

relatively rapid and straightforward way to use the best available evidence in clinical decision making. The requirement for high level evidence means CATs are less applicable in situations where evidence is lacking or low quality (Mackway-Jones *et al.*, 1998).

It is common that CATs fail to reach a definitive conclusion due to insufficient evidence (Guinane, 2013). In some topics, where a definitive outcome is reached, there is great benefit of having a CAT to inform clinical practice. This was demonstrated in a study by Razavi *et al.* (2012) where 5 different imaging modalities for diagnosing urinary tract cancers were compared. The study was able to reach detailed conclusions, and therefore recommendations could be made for different circumstances such as upper urinary tract malignancies or bladder cancers. The study was also able to form recommendations regarding contraindications of using iodinated contrast or radiation in specific patients. CATs in veterinary practice aren't as common as in human medicine, although there are advances towards more widespread use. Banfield veterinary hospital in the USA publishes a CAT every three months in their journal, and provide a catalogue of previously published CATs on their website that are readily available to practitioners (Banfield Pet Hospital, 2017). RCVS Knowledge have followed suit in the United Kingdom, publishing CATs every three months under the term knowledge summaries in their journal "Veterinary Evidence". RCVS Knowledge is the charitable branch of the Royal College of Veterinary Surgeons, and was founded to promote evidence-based decision making through improving the accessibility of resources to practicing clinicians (RCVS, 2017a). It is positive that there are more evidence summaries and methods of incorporating EBM in practice readily available, however it is questionable what merit there is in introducing further terminologies and potentially to what is already a perplexing paradigm for many in the veterinary profession.

2.3.5.2 *Best Evidence Topics (BETs)*

A BET is a modified version of a CAT with the same underlying principles. BETs however use the best available evidence which may not necessarily be the highest level evidence, in comparison with CATs where the highest level evidence is sought (Mackway-Jones *et al.*, 1998). Best BETs were developed in the medical profession at the Manchester Royal Infirmary emergency department over 15 years ago (BestBETs, 2017). A 'BET' is a Best Evidence Topic and consists of a structured three part question for which the highest level evidence available is searched in a systematic manner (Mackway-Jones, 2000). Part one of the question requires definition of the patient (or patient group), part two highlights the intervention and comparator, and part three is the measurable outcome. The question is also called a PICO question (Patient, Intervention, Comparison, Outcome) (Richardson *et al.*, 1995; Sackett, 1997a). Once the PICO question is constructed, the evidence is critically appraised to provide a 'clinical bottom line' which provides an answer to the clinical question (Khan *et al.*, 2011). The clinical bottom line is readily available to practicing clinicians, allowing decisions to be made based on the best available evidence, particularly in areas where top level evidence in the form of systematic reviews is lacking (Mackway-Jones, 2000).

BETs were successfully adopted in human emergency departments as they provided clinicians with the ability to combine rapid decision making and evidence-based medicine (BestBETs, 2017). In insulin dependent diabetic adults, glucose was found to be superior to glucagon when treating an accidental hypoglycaemia (Boyd and Foex, 2000). The study also commented on the lack of high quality evidence available in the area; however, a clinical bottom line could still be reached due to overwhelming evidence for the effects of glucose administration, despite the quality of the available studies. A Bet where a clinical bottom line couldn't be reached in emergency medicine was for the use of antibiotics in isolated base of skull fractures in adults (Butler and Carley, 2000). The study concluded that there were 2 meta-analyses in the area but the studies they analysed were poor quality and therefore a randomised controlled trial was necessary to best answer the question. BETs

are becoming a more utilisable method of applying evidence-based medicine to practice, particularly in areas where high quality evidence is lacking and a clinical bottom line is needed quickly. Using a BET allows clinicians to make decisions based on the available evidence. More importantly, they are applicable and useable in time pressured situations such as emergency departments. To make BETs more accessible, it would be advisable to have a searchable 'filing system' to see if a BET has already been conducted on a specific topic.

2.3.5.2.1 Best BETs in veterinary practice

BestBETs are not widely used in veterinary medicine at present. The Centre of Evidence-based Veterinary medicine (CEVM) at The University of Nottingham pioneered the use of Best BETs in veterinary medicine (CEVM, 2017b). The CEVM uses the same methods as described on the human BestBETs website (BestBETs, 2017; CEVM, 2017b), using CAB in addition to MEDLINE for literature searching (Grindlay *et al.*, 2012). The CEVM constructed a website (www.bestbetsforvets.org.uk) which has completed BETS accessible to all veterinary clinicians. The PICO question and clinical bottom line are both provided (Figure 6) with the option to view the search process if necessary. Vets are able to search BETs by species or topic and where a BET is not available, the clinician can suggest one for the CEVM to complete (Dean *et al.*, 2015). There is also information on how to use BETs when supporting clinical decisions. There are currently BETs available for cats, dogs, cattle and sheep. In addition to the Best BETs website, the BETs have also been published in the veterinary record with the aim of accessing more practising clinicians (Dean *et al.*, 2015).

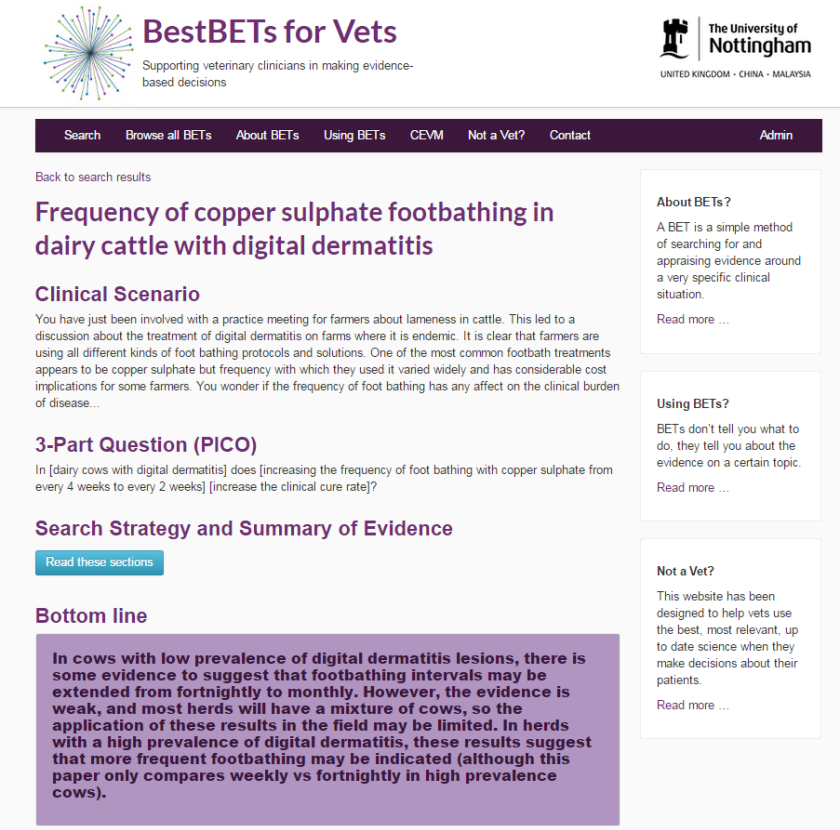


Figure 6: Screenshot of an example of a BET available to clinicians on the Best BETs for Vets website.

2.3.5.3 *Systematic Reviews*

The aim of a systematic review is to consolidate existing published evidence and identify any paucities in the evidence-base (Holmes, 2012). The literature is consolidated succinctly following a thorough critical appraisal process (Cook *et al.*, 1997; Sarasin, 1999). A research question or aim is formulated and the inclusion and exclusion criteria for the study are formulated (Egger *et al.*, 2001). A systematic search of the literature is conducted using appropriate terms; databases, article reference lists, personal communication and designated review registers are included in the process (The Cochrane Collaboration, 2017). Identified studies are cross-checked against the inclusion/exclusion criteria, and those that meet the criteria continue in the systematic review. They are then critically appraised; the validity, quality of the methods and relevance are evaluated against a predetermined

appraisal/scoring tool (CASP, 2013). The highest scoring studies are analysed and interpreted, creating a conclusion of the best available evidence to be utilised in clinical practice (Miettinen, 1998; Sarasin, 1999; Torgerson, 2003; The Cochrane Collaboration, 2017). To help authors in reporting systematic reviews the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) statement was generated in 2009 (Moher *et al.*, 2009). In human medicine, there are specific organisations to conduct and disseminate systematic reviews in health care research, most notably the Cochrane collaboration with a database of thousands of systematic reviews accessible to underpin clinicians decision-making (Egger *et al.*, 2001; The Cochrane Collaboration, 2017). Development of a similar resource for veterinarians was undertaken by the Centre for Evidence-based Veterinary Medicine (CEVM) with the creation of the VetSRev database of veterinary systematic reviews; with 544 currently available (CEVM, 2017a). There are many types of review that can be conducted, however systematic reviews are considered as the most robust and applicable review for answering clinical questions (Grant and Booth, 2009). They are often incorporated into the development of best practice guidelines (Silagy *et al.*, 2001), although they are arguably more useful as a standalone entity; providing a succinct summary of critically appraised evidence to practitioners.

2.3.5.4 *Conclusion of using evidence summaries in veterinary practice*

Evidence summaries may be a more utilisable form of practising evidence-based veterinary medicine, particularly as the critical appraisal of the evidence is already completed and therefore the practising clinician has a summary of the evidence which is ready to use. Additionally, clinicians don't necessarily have to acquire extra skills in literature searching and critical appraisal, but can still base their decision making on the best available evidence. Veterinarians seeking evidence is a positive step in implementing evidence-based medicine in practice. Time pressures and the realities of veterinary practice mean that providing clinicians with evidence that is 'ready to use'

makes the process more likely to be adopted. Evidence summaries are only available for specific clinical questions; however there are constantly more being published in accessible formats assisting in expanding the evidence-base. Furthermore, the ability to propose clinical questions means that clinicians may be able to get a summary of the evidence that is directly relevant to their clinical queries and individual practices, albeit with some delay. Additionally, the opportunity to acquire the relevant skills to conduct some of the different types of evidence summaries means that practitioners could be able to conduct their own, further promoting evidence-based practice. Evidence summaries are methods of practising evidence-based medicine that could be used widespread at the point of care. They provide clinicians with a critical appraisal of the available evidence enabling them to conduct a rapid, inexpensive assessment of the applicability for incorporation into clinical decision making.

Decision making in any sphere of veterinary medicine is an inherently complex process. Clinical decision making of veterinary surgeons is the continuation of the process once an owner has decided to seek veterinary attention. It involves health professionals making decisions about the care of individual patients, which is part of the skill of practising in such professions (Higgs, 2008). Clinical decision making in human medicine includes assessment of the patient, which diagnostic tests to undertake and what different treatment options are suitable and available (McGee, 2015). The steps in clinical decision making described in human medicine are also transferrable to veterinary medicine as the process of working from presentation, through diagnosis to treatment of a condition is the same regardless of whether the patient is human or animal. Once the veterinary surgeon has decided upon the diagnostic and treatment options available to the patient, the decision making on behalf of the animal moves towards a relationship centred care approach involving both the owner and veterinary surgeon (Frankel, 2006; Adams and Frankel, 2007). Animal owners expect to be provided with a full explanation including the advantages and disadvantages of a range of treatment options that are available to their animal to enable them to make an informed decision (Coe *et al.*, 2008). To enable evidence-based decision

making, a holistic approach is needed that considers the role of both owners and veterinary surgeons as major stakeholders in the decision making process.

2.3.6 Implementing evidence-based veterinary medicine in equine first opinion practice

The paradigms of evidence-based medicine (EBM) and evidence-based veterinary medicine (EVM) have been discussed at length within this literature review demonstrating the complexity and confusion that is currently associated with evidence-based practice across medical disciplines. Different methods of implementing EBM have been discussed, highlighting both the advantages and difficulties. Veterinary practice is removed from human medicine in multiple ways including differences in regulation, the diversity encountered by types of veterinary practices and the vast difference in the quantity and quality of available evidence. These are just a few of the factors that mean many methods of incorporating EBM into human clinical practice are not directly transferrable to veterinary medicine in the author's opinion. It is proposed that evidence is most likely to be utilised if it is accessible, and provided in a summarised, easy to use format.

In order for veterinary surgeons to adopt evidence-based veterinary practice, the evidence provided must be flexible to fit with the demands of the profession (Wild *et al.*, 2017). Furthermore, rather than dismissing lower level evidence as meaningless, more emphasis must be placed on using the best available evidence, especially given that high level evidence is limited in veterinary medicine (Arlt and Heuwieser, 2016; Shaneyfelt, 2016). If all studies that are viewed as low level evidence are discarded the evidence-base is further narrowed, thus compounding an already apparent problem (Dean *et al.*, 2015; CEVM, 2017b; RCVS, 2017a). Instead, it is necessary to identify flaws in studies and interpret the findings in light of this in order to support clinical decision making (Doig, 2003; Holmes, 2007b; Everitt, 2008; Vandeweerd *et al.*, 2012b). The importance of experience and clinical

expertise should not be underestimated, especially given that these factors are pivotal in determining the applicability of the evidence to individual patients. Evidence-based veterinary medicine should not intend be a rule book of how to treat different conditions, rather that scientific evidence underpins and supports the decisions made by clinicians (Everitt, 2011; Jackson and Hauser, 2017).

The lack of evidence available in veterinary medicine needs addressing by both conducting more research in areas where studies are lacking, and also consolidating what evidence already exists (Curtis, 2016; I.V. Wild *et al.*, 2017). Ideally, future studies should be designed with the most robust and appropriate methodology for the study type (Vandeweerd *et al.*, 2012b), to help in broadening and enriching the evidence-base (RCVS, 2017a). To consolidate evidence when high level studies are not available the existing literature on a topic should be assessed and utilised to develop evidence summaries with input from all stakeholders (Kerbyson, 2015; CEVM, 2017b; RCVS, 2017a). Where appropriate, animal owners and other invested parties should be included in the process of evidence synthesis, rather than solely using specialist opinion (Wilne *et al.*, 2010b). This approach would ensure the development of useable evidence that addresses the needs and requirements of all those who may be involved in decisions that affect the welfare of the horse.

Much can be learnt from human medicine regarding the dissemination of evidence-based materials as all stakeholders are targeted as a matter of routine when evidence-based resources are disseminated (Hodgson *et al.*, 2007; Fogle *et al.*, 2008; Fogle *et al.*, 2010; Lecouturier *et al.*, 2010; Dombrowski *et al.*, 2012). In veterinary medicine, if evidence-based material was accessible and appropriately pitched, it may have a greater impact on animal welfare. This would allow evidence-based, patient-centred decision making from recognition of disease through to treatment (Everitt, 2008; Everitt, 2011). If the owner is aware of the recent evidence surrounding recognition of disease and prompt assessment, they can ensure timely veterinary intervention is sought. Following this, it is the responsibility of the veterinary surgeon to make evidence-based decisions by combining their experience

and expertise with the individual case requirements and underpinning scientific literature to deduce the best, most appropriate diagnostic and treatment options (Everitt, 2008; Everitt, 2011; Vandeweerd *et al.*, 2012b). Communicating these decisions with the owner is of paramount importance to ensure that ultimately the horse owner can make informed decisions based upon scientific evidence (Christiansen *et al.*, 2016).

There is potential for veterinary practitioners to make evidence-based decisions at the point of care. At present, evidence-based practice is limited in veterinary medicine, and is certainly not commonplace as is the case in human medicine. A thorough review of the different methods of incorporating evidence-based medicine into practice was undertaken, and whilst some methods have not been studied in veterinary practice, a few examples exist where adoption of evidence-based veterinary practice has been attempted with varying success. It is proposed that the main barriers that have the greatest impact on implementation of evidence-based practice are the limited time and resources available at the point of care. It is therefore important to bear these in mind when trying to incorporate evidence-based methods into veterinary practice. The standard approach to adopting EVM is to make practice 'fit' with the human methods that are in widespread use. Human EBM is not without its problems, and therefore rather than following the same pathway, there is an opportunity to learn from the mistakes and difficulties that have already been faced in human medicine. Instead, veterinary practitioners should aim to tailor EVM to the requirements of the profession, providing the most suitable, useable combination of methods to promote the widespread use of evidence in veterinary practice.

Clinical audit can be a valuable tool in veterinary practice, and can be used as a standalone method of assessing and improving practice, or combined with other evidence-based implementation methodologies. Combining clinical audit with other methods enables clinicians to improve their practices using evidence-based decision making. The author believes that clinical audit should be widely adopted and used throughout different types of practice across the profession to ascertain the quality of practices and services provided and strive to improve upon these. The barriers to clinical audit that

are faced in the profession are likely due to the over complication of the process; keeping audit simple is the key to it becoming more widespread (Waine and Brennan, 2015). Identifying a single topic for audit and completing the process, identifying areas for improvement or determining that the services provided in this area are of a high standard would be a beneficial first step. Furthermore, practices could then benchmark against their previous results and determine and quantify improvements, or maintain their standards, as suggested by Burford *et al.* (2014). Clinical audit is not enough to promote evidence-based practice, but instead should be used as an adjunct to other methods.

Evidence-based veterinary medicine is a potentially complex process for clinicians that requires time and skills for successful implementation. This does not mean that EVM should be discounted in the veterinary profession, however it does perhaps dictate which methods of implementing EBM would be most suited to veterinary medicine. The realities of veterinary practice mean that clinicians are more likely to implement evidence-based decision making if the evidence has been searched and critically appraised previously. For this reason, evidence summaries may be the existing method of promoting evidence-based practice that are most applicable to the veterinary profession at the present time. CATs and BestBETs are already available and are regularly published for use, providing an invaluable resource for practitioners who require an answer to a specific clinical question (e.g. what treatment is best for a specific condition). These types of evidence summaries answer specific clinical questions from a narrow subject area. To promote more widespread implementation of EVM, there is a necessity for a method of implementing evidence-based practice over a wider subject area. Therefore, larger topics should be summarised into statements to form a unique type of evidence summary that can be adopted and used by veterinary professionals.

When systematic reviews are available, these can assist in forming the evidence-base, however it is also necessary to incorporate lower quality studies, rather than dismissing them. This is particularly important given the paucity of the evidence-base in many areas in veterinary medicine. Studies should be critically appraised, allowing identification of areas lacking in

evidence. Addressing areas lacking evidence is perhaps the challenge as further research or processes (such as systematic reviews) may be required. If further research is not possible, moving down the pyramid of evidence may be an option, such as outputs from an expert panel to temporarily fill the voids, whilst more robust studies are undertaken. The role of the horse owner in shared evidence-based decision making is incredibly important, and therefore where appropriate, pet owners should be incorporated into the development of evidence-based materials.

Section 1 – Identification of a focus

The first section of the thesis (Chapters Three and Four) focuses on research that aimed to identify a common emergency condition with a major welfare impact in equids, which would become a focus for research in subsequent studies.

Chapter 3 Investigation of conditions seen during 'out of hours' primary assessment

3.1 Background

There is a lack of peer- reviewed data about out-of-hours conditions that are seen in first opinion equine practice. As previously mentioned, Viljoen *et al.* (2009) investigated the admissions to a university referral hospital in South Africa outside of normal working hours. The most frequent causes for admission were attributed to the gastrointestinal system (64%) and the musculoskeletal system (19%), with over 50% of all admissions due to complicated medical or surgical cases of colic. The study was conducted in South Africa, and therefore the results may not be transferrable to the UK as disease incidence and prevalence may vary dependent on geographical location, climate and other demographic factors. Also, it is possible that because the admissions were to a referral hospital, some of the cases could have been refractory to treatment in the field. Another study analysed the survival rates of emergency admissions to a university referral hospital in the United States of America (Southwood *et al.*, 2009). Due to the study population, there are similar concerns as with the Viljoen *et al.* (2009) study when applying the results to first opinion practice in the UK. In addition, the results of the study by Southwood *et al.* (2009) do not provide robust data for common conditions seen out-of-hours since the more critical conditions may have a greater mortality rate, although they may be less common. Given these factors, there is currently no utilisable data for 'out of hours' emergencies seen in first opinion equine practice in the UK. Obtaining information on common

emergency conditions at primary assessment, including diagnostics and treatments administered could help inform practice policies and veterinary surgeons on where best to centre finances, training and resources, whilst also identifying foci for owner education.

3.1.1 Study aim and objectives

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 proportion of different conditions presented for primary assessment outside of normal working hours at two equine veterinary practices in the United Kingdom.
- To describe the diagnostic tests used most commonly during primary assessment of equids visited outside of normal working hours in two equine veterinary practices in the United Kingdom.
- To document the treatments that are frequently administered during assessments outside of normal working hours in two equine veterinary practices in the United Kingdom.
- To evaluate the outcomes of patients seen for primary assessment outside of normal working hours in two equine veterinary practices in the United Kingdom.

3.2 Materials and Methods

This project was reviewed and approved by the Ethics Committee, School of Veterinary Medicine and Science, University of Nottingham.

3.2.1 Study design and data collection: extraction of cases from practice records

The target population was identified as first opinion equine clinicians or practices who undertook their own provision for ambulatory twenty-four hour care, thus covering conditions seen outside of 'normal' working hours. A convenience sample of two practices with a first opinion equine department were recruited to participate in the study. The first practice was an RCVS accredited equine veterinary hospital based in Kent, UK. 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 specialist and emergency services. Within the practice there were six recognised specialists and three advanced practitioners. The second practice was a first opinion equine veterinary practice with clinic facilities based in the east midlands, UK. There were eight first opinion ambulatory vets conducting 'out of hours' visits during the period of data collection, with an additional 2 veterinary surgeons working within the clinic. The practice had full diagnostic and surgical facilities and a 24hr emergency service. Within the practice there was a European Specialist, an EVCS and American diploma holder and five post graduate RCVS certificate holders.

Both practices provided a list of 'out of hours' calls, compiled using the practice management systems (Eclipse at Practice A and Spectrum at Practice B). Relevant cases were identified via the charging systems used by the PMS to select all cases that received both an 'out of hours' visit and examination fee, thus forming a retrospective case series. 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. All information that would enable traceability of the client (client name, animal name and visit date) was kept alongside the numeric code in a password encrypted Microsoft Excel (2013) spreadsheet for each practice. The first fifteen cases from each practice were selected for use in the pilot study. The information from each individual case was recorded on separate data capture forms and any difficulties using the form were recorded and assessed. After a pilot study, an 'other' section was added to signs of colic or abdominal pain, as the previous list was discovered to be too limited. In addition, the degree of recovery question was removed as assessment of this was unreliable and often required assumptions to be made based on case records.

The collection of data was conducted over a one year period. Cases were retrieved by the researcher (A. Bowden) from the PMS system using the list of cases that were charged an 'out of hours' examination and visit fee that was initially provided by the two practices. The password encrypted spreadsheet was used to identify the individual cases prior to completion of corresponding data capture forms. Cases were excluded from the study 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 information about the presentation, diagnosis and treatment from the initial visit was recorded. Subsequent visits were considered to determine the outcome of the presenting condition. For example, if the horse was euthanased at a subsequent visit because of the same condition it presented for, the outcome was recorded as euthanased. If the condition required multiple treatments for resolve, subsequent treatments were not recorded, however the outcome was logged as 'required multiple treatments'. In instances where one animal received two 'out of hours' visits for different, unrelated complaints, two 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. Additionally, if an animal presented with more than one condition at a single visit, it was within the scope of the data capture method to incorporate multiple morbidities within one form. The forms were populated

offline in Adobe Reader (Adobe Systems Inc., San Jose, CA) and saved as Portable Document Format (PDF) files.

3.2.2 Development of the data capture form

A bespoke data capture form was developed (Appendix A) based around the expected key elements of a consultation. The main sections were identified as: signalment and history, presentation and clinical signs, diagnostic approach, treatment administered, outcome. The 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 first section “signalment and history” was developed to enable recording of the coded identification number, age and breed as free text, and sex, insurance and preventative healthcare status of the horse as closed drop down menus. The breeds/ types of horse recorded across the two practices were grouped and categorised accordingly (Table 2) after data analysis.

Table 2: Categorisation of breeds/types of equine as described in the case records of animals at two practices in a retrospective case series of 1,729 equids seen 'out of hours'.

Category	**Breed or Type**
1: Equines excluding horses	Donkey, Mule
2: Small ponies	Shetland, Welsh Section A, Miniature horse, Miniature Shetland, Shetland x, Falabella
3: Large ponies	Pony, Welsh Section B,C, Welsh, Welsh x, Fjord, Fell, Connemara, Connemara x, Riding pony, Highland, Highland x, New Forest, New Forest x, Dartmoor, Fjord, Dales, Dales x, Haflinger, Native
4: Arab type	Arab, Arab x, Anglo Arab
5: Cob type	Cob, Cob x, Welsh Section D, Welsh Cob
6: Light horse	*TB, TB x (except ***ID x TB), Morgan, Appaloosa, Hackney, Hackney x, Trotter, Trotter x, Standardbred, Quarter Horse, Riding Hack
7: Sports horse type	+WB, WB x, ++ISH, Hunter, Andalusian, Lipizzaner, Spanish, ***ID x TB, KWPN, Oldenburg, Oldenburg x, French, Fresian, Fresian x, **ID, ID x, Irish, Irish x, Westphalian, Selle Française, Holstein, Hanoverian, Hanoverian x, Gelderlander, Cleveland Bay, Cleveland Bay x, Russian, Trakehner
8: Heavy horses	Shire, Shire x, Clydesdale, Clydesdale x, Percheron, Percheron x, Suffolk Punch

*TB= Thoroughbred, **ID = Irish Draught, ***ID x TB= Irish Draught horse crossed with Thoroughbred, +WB= Warmblood, ++ISH= Irish Sport Horse, 'x' = crossed with another breed/ type

Previous clinical history (any conditions diagnosed in the year preceding the 'out of hours' call), concurrent conditions (ongoing health complaints such as degenerative joint disease), and the presenting complaint were recorded in a closed drop down menu section. VeNom coding is a validated, internationally recognised system that includes a standard set of clinical veterinary terms for multiple species. Equine VeNom codes (VeNom Coding Group, 2013) were considered for use when categorising conditions, however the database of equine VeNom codes was unobtainable after several requests and therefore this was not possible. Diseases were categorised by body system primarily prior to subcategorization into disease/ condition subtypes. A list of categories (Appendix B) 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. An 'other' category was included to record conditions which did not fit predetermined categories. These were entered as free text, and then categorised during the analysis stages of the research. 'Recent relevant history' was defined as any factors noted in the clinical records by the veterinary surgeon which may have had clinical relevance to the primary reason for the 'out of hours' call and was recorded as an open response option. This included but was not limited to: reoccurrence of a condition, a possible cause for the condition, other clinical signs mentioned by the owner, or a concurrent related condition. Finally, any current medications the horse was receiving were also recorded in this section.

Presentation and clinical signs section included closed and open text recording formats. Closed responses included whether the information had been recorded in the clinical notes or not, whilst the open text allowed detail of specific clinical notes. A list of clinical signs options were created by A. Bowden and included: change in demeanour, increased heart rate, murmur or arrhythmia, increased respiratory rate, pyrexia, abnormal mucous membranes, abnormal capillary refill time, abnormal coat, signs of colic or abdominal pain, signs of lameness or abnormal movement, neurological signs, presence of a wound, and presence of swelling. A definition of normal parameters for heart rate, respiratory rate and temperature was set based on

personal correspondence with the veterinary surgeons at the individual practices (heart rate 28-40 beats per minute, respiratory rate 8-16 breaths per minute, temperature 37.5 – 38.3 ^{o}C). The normal values used for this study differ from those that were used to determine the normal range in Chapter 6, where textbook values were used. The reason was that it would allow accurate interpretation where veterinary surgeons had not recorded a value but has described a case as having a 'normal heart rate' for example. Each question also had an open text box for further information. In questions where more than one response was possible (e.g. clinical signs of abdominal pain), multiple option responses were provided, along with a free text box. A free text 'other' box was included at the end of each section.

The diagnostic tests section was designed as tick boxes to identify where tests had been used, and a free text box to provide detail of the results. The diagnostic test list (created by A. Bowden) included: haematology and biochemistry, abdominal auscultation, urinalysis, faecal assessment, rectal examination, nasogastric intubation, ultrasonography, radiography and abdominocentesis. An additional free text 'other' box was included to provide detail of any other diagnostic tests that were conducted but were not listed on the data capture form.

Administered treatments were the focus of the next section of data capture. Therapeutic treatments were categorised according to type e.g. antibiotics, with a tick box to identify the treatments administered. A free text box was available for each category to provide the detail of the treatment e.g. antibiotics – penicillin. Treatment categories (created by A. Bowden) included: analgesics, steroids, sedation, spasmolytics, oral fluids, intra-venous fluids, antibiotics, limb surgery, abdominal surgery, hospitalisation for intensive nursing, intra-articular medication, condition specific drugs (e.g. pergolide administration for PPID), anthelmintics, hot or cold therapy, exercise and box rest (restricted movement). Again, an additional free text 'other' box was included to provide detail of any other treatment administered.

The final section of the data capture form focussed on the outcome of the case that was visited 'out of hours'. Where the outcome of the case was

determined at the ‘out of hours’ visit, this was recorded, however where there were subsequent consultations for the condition attended ‘out of hours’, the case record was scrutinised to determine the final outcome of the case. A drop down box was included to determine whether cases resolved (with no, single or multiple treatments), were euthanased, or died without euthanasia. The recovery of cases was also recorded to determine whether there had been a full, partial or no recovery from the condition. ‘Full recovery’ was defined as an animal returning to its previous state, whilst a ‘partial recovery’ denoted a requirement for ongoing treatment or a limitation of the condition preventing return to its previous state (e.g. no longer rideable). ‘No recovery’ meant the condition remained as severe despite treatment. The drop down boxes could be left blank if the data for case outcomes were not recorded. Free text boxes were provided as an adjunct to the questions in this section to enable recording of more detail and further information. A closed drop down box was provided to record cases where a definitive diagnosis was reached. The same system-based categories were used that were developed for the presenting complaints in the ‘signalment and history’ section (Appendix B). The definitive diagnosis question was completed only where the clinician recorded a diagnosis in the animal’s clinical record. The duration of veterinary care was also recorded in free text format. This was defined as the duration between the ‘out of hours’ visit and resolution of the condition through treatment, euthanasia or death of the animal. Complications of the condition were identified via a closed drop down box, with an open response box to provide further detail. A ‘complication’ was defined as an event or secondary condition which occurred as a direct consequence of the primary complaint, requiring additional treatment. The conclusion of the data capture form was an open text box for any comments relating to the case that were not suitably recorded on the remainder of the form.

3.2.3 Data sorting and 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, and therefore an Excel spreadsheet containing all of the cases over three years was generated for each practice. The original spreadsheet for each practice was kept for reference, containing all of the raw data (both numerical and free text). 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 21, IBM Corporation, 2012) for further analysis. Continuous variables were subject to descriptive statistics including mean, mode, median and range, whilst percentage frequencies were calculated for all categorical data.

3.3 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. Case data were collected by the researcher during a one year period. Each case took between five and ten minutes to transfer into the data recording sheet, dependent on the complexity and detail of the individual cases, resulting in approximately 325 man hours for the creation of the dataset. The mean number of cases attended out of normal working hours was 577 cases per year for practice A and 291 cases per year for practice B (

Table 3).

Table 3: The number of cases attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen 'out of hours'.

	Practice A				Practice B			
	Overall	2011	2012	2013	Overall	2011	2012	2013
Number of cases attended	1729	561	586	582	873	262	305	306

The distribution of the age and sex of horses seen during this time was similar for both practices: the mean age was 13.7 for practice A (s.d. +/- 8.5) and 13.8 for practice B (s.d. +/- 8.7), whilst the ranges were 0 – 40 years old and 0 – 44 years old for practices A and B respectively. Sex 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 commonly attended by both practices (52% practice A, 55% practice B) followed by mares or fillies (44% practice A, 41% practice B), and stallions or colts (4% practice A, 3% practice B). There were

80 breeds/ types of horse recorded across the two practices, which were grouped into the categories described in Table 2 during data analysis.

The insurance status of animals was not accurately recorded as it was not possible to distinguish those that were not insured and those that did not have an insurance status noted on their clinical record. The majority (67%) of patients were vaccinated (n=1,150/1,729 at practice A, n=589/873 at practice B). Routine dental care was less frequently provided by the veterinary practice (34%, n=581/1729 at practice A; 43%, n=379/873 at practice B). Less than 1% of animals at each practice were recorded as unvaccinated or having no dental care; the remainder of the animals had no data recorded for vaccination or routine dental care status.

Of the 1,729 cases seen for practice A, 1,707 of the horses presented with one condition at the visit, forty-six presented with two separate conditions, whilst four presented with three conditions at the same visit. Twenty two horses had no recorded presenting complaint, which resulted in 1,757 separate conditions recorded as being seen for primary assessment at practice A. Of the 873 cases seen by practice B, 823 of the horses presented with one condition at the visit, 40 presented with two complaints, whilst 50 had no recorded presenting complaint. There were therefore 863 conditions recorded as seen for primary assessment for practice B. The conditions reported at the initial visits were categorised by the body system affected (Figure 7). Conditions relating to the gastrointestinal system were most commonly categorized (43%, n=748/1,757 of conditions at practice A; 38%, n=331/863 of conditions at practice B), followed by the musculoskeletal system (36%, n=625/1,757 of conditions at practice A; 37%, n=323/863 of conditions at practice B) in horses receiving primary assessment ‘out of hours’ at both practices. Gastrointestinal conditions included any ailment of the gastrointestinal tract: dental abnormalities, tongue problems, oesophageal obstruction, colic, liver disease, diarrhoea, weight loss, GI ulceration, inflammatory bowel disease and neoplasia were included under the gastrointestinal system.

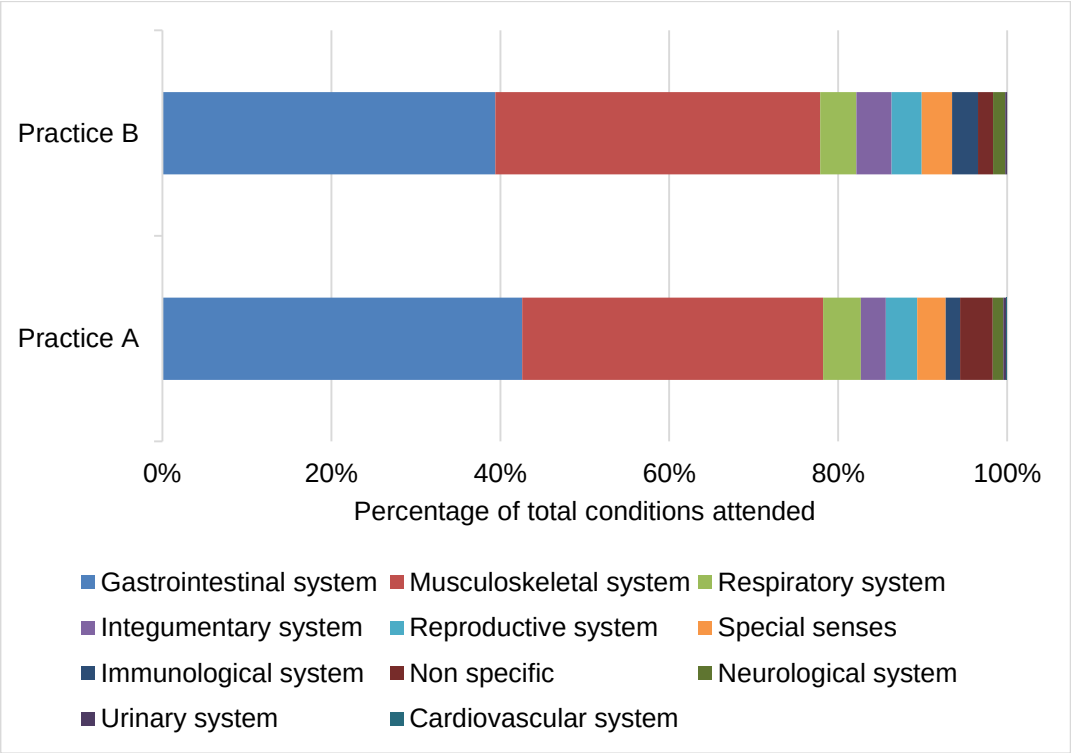


Figure 7: The conditions affecting equids (categorised by body system affected) that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen ‘out of hours’.

The most common presenting complaints for both practices over the three year period were colic (35.2% both practices, n=619/1,757 Practice A; n=304/863 Practice B), wounds (19.5%, n=342/1,757 practice A; 19.6%, n=169/863 practice B) and lameness (10.1%, n=178/1,757 practice A; 12.7%, n=110/863 practice B). Other common presenting conditions at both practices were respiratory distress (3.4%, n=60/1,757 practice A; 2.0%, n=17/863 practice B) and undefined eye problems (3.0% both practices, n=52/1,757 Practice A; n=26/863 Practice B). Oesophageal obstruction accounted for 3.4% (n=60/1,757) of the total ‘out of hours’ caseload of practice A, whereas laminitis was responsible for 4.1% (n=35/863) of presentations ‘out of hours’ at practice B. The remaining 25.4% and 24.2% of the caseloads of Practice A and B were comprised of 48 and 49 different conditions respectively (Figure

8). The results were consistent when the data were considered annually, with no skew identified for any individual year for each practice.

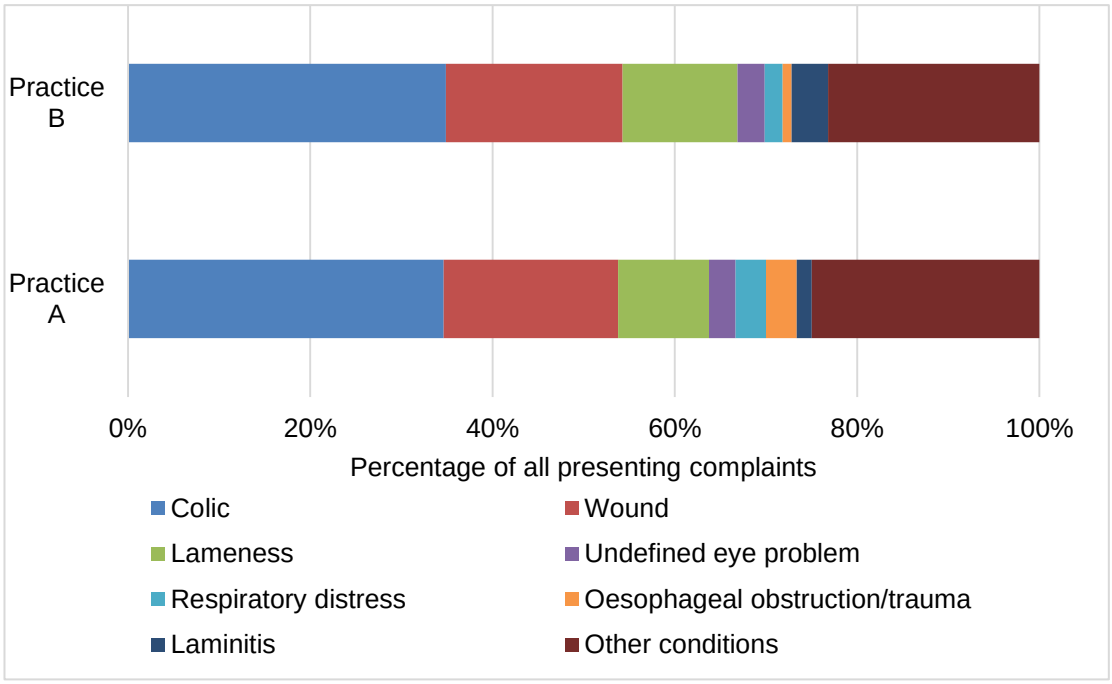


Figure 8: The presenting complaints of equids that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen 'out of hours'.

The most common diagnostic tests (Figure 9) undertaken outside of normal working hours were rectal examination (35%, n=611/1729 practice A; 19%, n=163/873 practice B) and nasogastric intubation (11%, n=194/1729 practice A; 7%, n=63/873 practice B) or 'other' tests (4%, n=77/1729 practice A; 11%, n=96/873 practice B). This was a consistent finding when each year was analysed individually. Blood sampling was performed in 8% of cases at practice A (n=140/1729) and 7% at practice B (n=63/873).

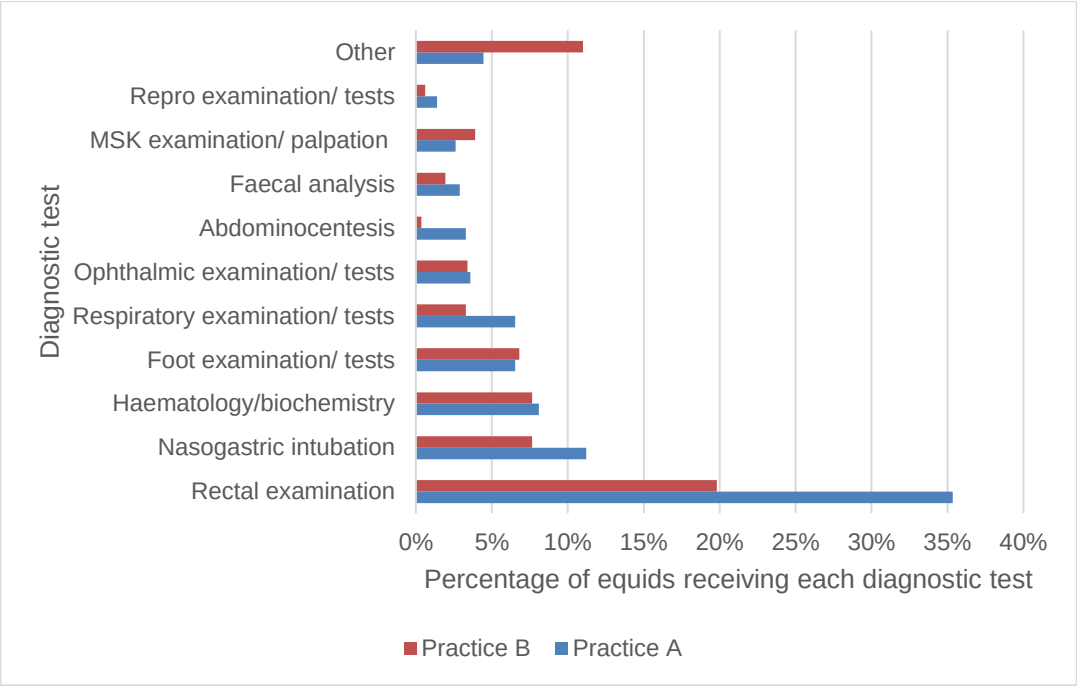


Figure 9: The diagnostic tests conducted on equids attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen 'out of hours'.

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 antibiotics. Analgesics were used in 73% (n=1,254/1,729) of cases at practice A and 78% (n=683/873) at practice B. There were eight different analgesics used across both practices (Figure 10). Flunixin was the most commonly administered (27%, n=466/1,729 practice A; 38%, n=329/873 practice B), whilst Phenylbutazone was used frequently by both practices (19%, n=332/1,729 practice A; 31%, n=269/873 practice B). Ketoprofen was administered regularly at practice A (24%, n=421/1,729) in contrast to practice B (0.2%, n=2/873).

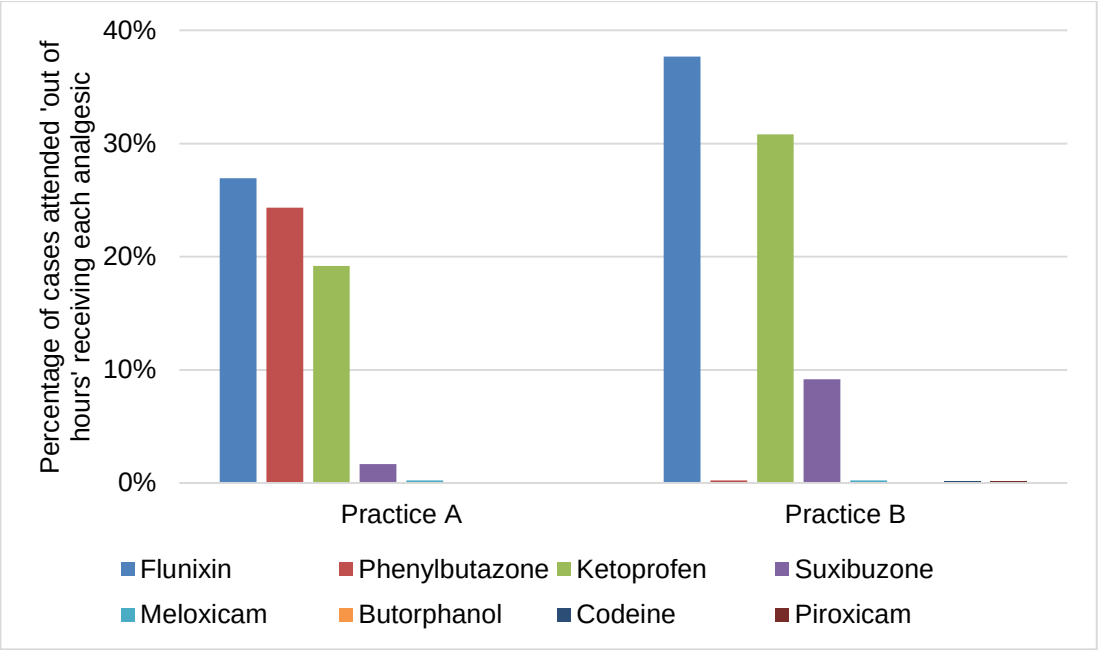


Figure 10: The analgesics administered to equids that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen ‘out of hours’. Codeine, piroxicam and butorphanol were administered to n=1 horses, therefore the data are not visible.

Antibiotics 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 antibiotics or antibiotic combinations given at both practices (24 at practice A and 27 at practice B). Potentiated sulphonamides (TMPS) in isolation were the most common antibiotic used over the three year period (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).

The outcomes of cases attended by both practices were consistent over the three year period (Table 4). The majority of the cases attended resolved with a single treatment (58%, n=995/1705 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=421/1705 Practice A; 28%, n=235/845 Practice B). Approximately 13% of cases were euthanased (n=225/1705

Practice A; n=114/845 Practice B) when the caseload was considered over the whole study period (range 11.3%-16.2% when each year was analysed individually).

Table 4: The outcomes of cases attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen ‘out of hours’.

	Practice A				Practice B			
	Overall	2011	2012	2013	Overall	2011	2012	2013
Number of cases with known outcomes	1,705	556	583	566	845	256	298	291
Percentage of cases that resolved with single treatment*	58% (n=995)	60% (n=338)	57% (n=333)	56% (n=324)	57% (n=480)	55% (n=143)	54% (n=166)	56% (n=171)
Percentage of cases that resolved with multiple treatments*	25% (n=421)	24% (n=132)	26% (n=154)	23% (n=135)	28% (n=235)	31% (n=81)	29% (n=87)	22% (n=67)
Percentage of cases that were euthanased*	13% (n=225)	11% (n=63)	13% (n=75)	15% (n=87)	13% (n=114)	11% (n=29)	12% (n=38)	15% (n=47)
Percentage of cases that resolved without treatment*	3% (n=51)	3% (n=19)	3% (n=17)	3% (n=15)	1% (n=8)	1% (n=2)	1% (n=3)	1% (n=3)
Percentage of cases that died*	1% (n=13)	1% (n=4)	1% (n=4)	1% (n=5)	1% (n=8)	0% (n=1)	1% (n=4)	1% (n=3)

* Expressed as a percentage of the total number of cases with known outcomes.

The horses that did not survive due to death or euthanasia (Figure 11) were most commonly affected by colic (45%, n=112/238 at practice A and 59%, n=61/122 at practice B). Other common reasons for non-survival at practice A were recumbency without clinical signs of other conditions (such as colic) (10%, n=25/238) and the fracture of a limb (6%, n=14/238), whilst at practice B it was horses affected by limb wounds with no obvious initial synovial involvement (10%, n=12/122) or wounds with obvious synovial involvement (5%, n=6/122).

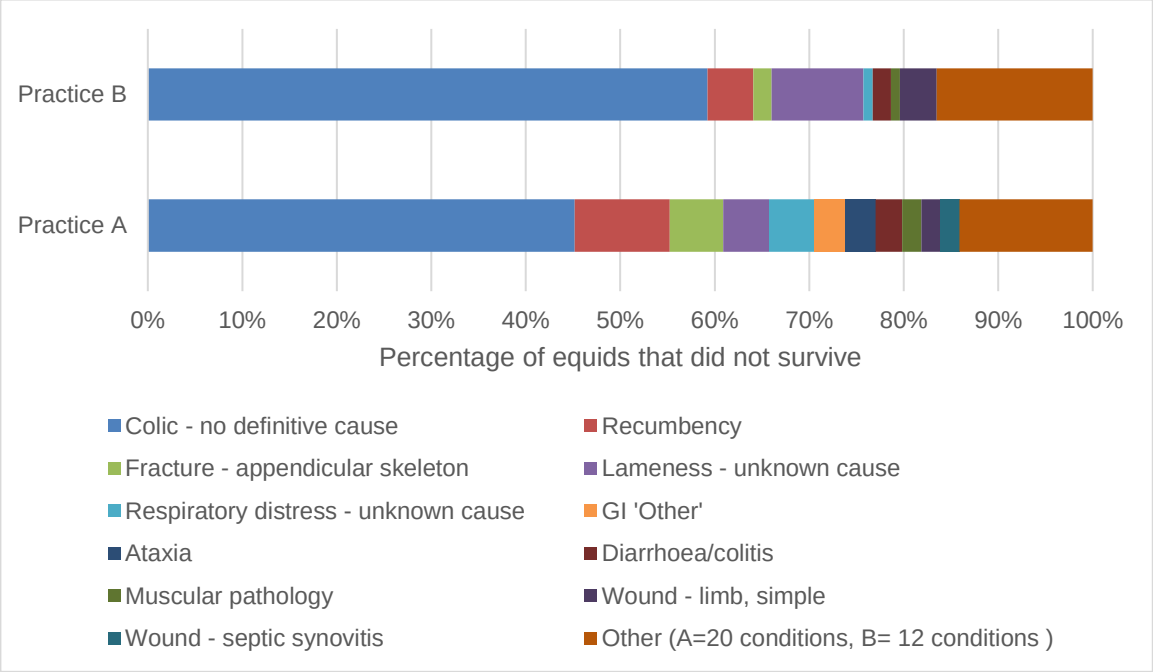


Figure 11: The conditions affecting equids that did not survive (n=238/1,729 at practice A, n=122/873 at practice B) that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 2,602 equids seen ‘out of hours’.

3.4 Discussion

This is the first study to investigate cases seen at primary presentation outside of normal working hours in equine veterinary practice. There were 2,602 out-of-hours consultations over a period of three years from 1st January 2011 to 31st December 2013 at two equine practices in the United Kingdom. There were 64 separate conditions assessed outside of the practices' normal working hours, however the most common reasons for veterinary attendance at both practices were abdominal pain (colic), wounds or lameness. The diagnostic tests and treatments administered were likely attributable to the case profiles of the practices, however this would require more thorough investigation of the data and analysis of the separate conditions to determine which diagnostic tests and treatments were used in the different presenting conditions. Differences between the practices for analgesic and antibiotic use may be due to different practice policies. A significant number of equids seen 'out of hours' did not survive (14% of study population euthanased or died; n=360/2602). This outcome was most commonly associated with colic, which accounted for approximately half of all non survivors within the study, in total 7.4% of the study population that were euthanased or died related to colic.

The study aimed to provide an overview of conditions seen outside of normal working hours, and the outcomes of these cases. Data was collected on conditions seen outside of normal working hours only, rather than emergency conditions. Emergency conditions can happen on any day, at any time, and therefore any 'emergencies' that occurred during working hours were not included in the study. Equally, any condition seen outside of normal working hours was included in the study whether it was deemed to be an emergency or not. Identification of cases using the charging codes on the practice management systems meant that it was only possible to identify cases charged an 'out of hours' fee. It would have been impossible to find all emergency conditions for each practice using this method as there was no separate charge for emergency conditions. Instead, it would have required subjective interpretation of every case seen by the practice to decide whether it was an emergency or not. This opinion was likely to vary between

individuals, thus potentially inducing bias to the results. It is important to note that it is beyond the scope of the study to describe the prevalence of different conditions within primary care equine veterinary practice as a whole, especially as this study was limited to analysing data from two practices. 'Out of hours' practice was the focus for the study as there are no studies available in this area currently. In addition, 'out of hours' practice is generally more likely to be comprised of emergency type conditions due to the increased costs attributed to 'out of hours' practice (Dunn, 2005; Egenvall *et al.*, 2008). Visits 'out of hours' are often more stressful due to isolated conditions and increased pressures attributable to critical cases and the need for rapid decision making (Mayes, 2015). The nature of 'out of hours' practice provides the greatest opportunity to identify and implement potential interventions to improve outcomes.

The study used a retrospective case series methodology which has both advantages and disadvantages. An inherent weakness of retrospective studies is they are more likely to have variations and missing data as the collection was not planned and controlled (Hassan, 2005). A prospective study may have allowed for a more complete dataset; however, this was not feasible within the time and financial constraints of the project, and would also have required development of a data collection system which was compatible with the practice management system. Compliance is also a potential issue with prospective studies, particularly where multiple vets are involved, in 'out of hours' emergency conditions were there are often time and practical constraints. Prospective studies may have bias introduced with over reporting of more interesting or memorable cases and omission of the opposite (Hassan, 2005; Brusco and Watts, 2015). A potential disadvantage of collecting data with input from multiple veterinary surgeons is there may be inconsistencies between the reporting of the different veterinarians. Some practitioners may record a lot of detail in their case records, whereas others may just record the significant findings rather than the details of the full assessment (including 'normal' findings). The recording of data within electronic medical records are not always accurate or consistent (Robinson *et al.*, 2015) and it was evident when examining the case records that there was

variation in clinical record keeping between practitioners. There was even 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 contained what was considered to be the 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 (Glassman *et al.*, 2000; Peabody *et al.*, 2000).

Collecting data from two practices allowed for comparisons to be drawn between the results. This improved the validity of the study, especially as the commonly conditions seen showed a remarkably similar percentage of the practices 'out of hours' caseload. 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. 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. Analysing individual case records was incredibly time consuming (approximately 325 man hours) and labour intensive as one operator was needed to undertake all of the data collection to ensure consistency and continuity in the process, to improve the reliability of the results. Furthermore the author/data collector was a trained veterinary surgeon and was therefore able to apply some interpretation where required and appropriate to the clinical notes. Using an alternative method such as data mining may have allowed for collection of a much larger dataset across multiple practices with a shorter data collection phase, due to the automated process. There would however have been less detail of individual cases within the dataset as a whole, in addition to a concern over 'missed' data. This is because data mining requires the collation of extensive dictionaries to ensure the process is adequate (Duz *et al.*, 2017). If the dictionaries of terms are not comprehensive enough, cases would be missed. In addition, data mining does not allow for interpretation of the case records where it is needed in order to extract relevant information, and the software may not be compatible with all

of the PMS (Welsh *et al.*, 2016; Duz *et al.*, 2017; Welsh *et al.*, 2017). Collecting data 'by hand' meant that if data were available within the case records it was collected, resulting in the most comprehensive dataset possible. This method of data collection was appropriate for this initial study to ensure capture of all of the potentially relevant data. If larger studies were to be conducted in future to further investigate cases seen 'out of hours' over a larger timescale and across multiple practices, data mining or other alternative methods may be more appropriate, and the data from this study can be used to inform these searches.

This study describes the frequency of conditions seen outside of normal working hours at primary assessment in equine practice. Colic was the most common condition attended which is consistent with the findings of another study where primary care veterinary surgeons in the United States of America nominated the conditions they saw the most frequently in practice (Traub-Dargatz *et al.*, 1991). The study by Traub-Dargatz *et al.* (1991) is not the most robust methodology and is not evidence-based as veterinarians nominated the conditions seen, rather than recording the specific caseload of the veterinary surgeons. This leaves the results open to bias, especially recall bias, as colic cases can be stressful, traumatic and thus more memorable. Other studies exploring common conditions seen in first opinion equine practice report musculoskeletal issues, such as lameness, as the most common disorders (Loomans *et al.*, 2007; Ireland *et al.*, 2012b; Ireland *et al.*, 2013; Nielsen *et al.*, 2014; Slater, 2017). Lameness was the third most common reason for veterinary attendance outside of normal working hours at the two practices in this study. A likely explanation for the discrepancy between the current study and those that described musculoskeletal disorders as most common is the differences between the study aims, specifically the fact that this study investigates conditions seen outside of normal working hours in particular, rather than in practice as a whole. This explanation can also be extended to wounds, another condition that was seen commonly in this study but are not reported as commonly in previous studies that have looked at the overall caseload (Slater, 2017). Furthermore, studies that determine the prevalence at a specific time point may not capture the conditions such as lameness and

wounds that are likely to be shorter in duration than more chronic conditions such as lameness. This is possibly due to the fact that colic and wounds can be cured with treatment, whereas for chronic musculoskeletal conditions such as degenerative joint disease, treatment is aimed at managing the condition rather than seeking a cure (Southwood *et al.*, 2009; Ireland *et al.*, 2011a; Ireland *et al.*, 2012b). It can be inferred from these results that lameness is more common when looking at overall caseload rather than 'out of hours' work alone, and the opposite for wounds: they are more frequently seen 'out of hours' but comprise a smaller percentage of the overall caseload of a practice.

This study highlights the importance of colic (abdominal pain) in particular, which alone accounts for over a third of the conditions seen 'out of hours'. Colic is not a specific disease but rather a term used to describe the clinical signs exhibited by equids with abdominal pain (Moore and White; Moore, 2005; Mehdi and Mohammad, 2006; Moore, 2006). Therefore, in this study, the equids that had colic were demonstrating signs of abdominal pain, but it is unlikely they had the same underlying pathology due to the multiple underlying causes of colic (Moore and White; White, 1984; White, 1990; White and Edwards, 1999a). Colic was previously reported as a major cause of death in the horse (Tinker *et al.*, 1997a; Ireland *et al.*, 2011b), which is consistent with this study as horses suffering from colic were a large proportion of the mortalities in the study population. Equids affected by colic within the study population will be further explored in Chapter 5.

Diagnostic tests that were most frequently used 'out of hours' were rectal examination and nasogastric intubation. These tests are frequently used in the primary assessment of horses with colic (Curtis *et al.*, 2015a; Curtis *et al.*, 2015b) and therefore it is anticipated that these would be regularly performed given that colic was the most common condition attended outside of normal working hours. Sedation was commonly administered 'out of hours', however it was beyond the scope of the data collection to determine what the purpose of administration was as it was often charged for but the reason for use was 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 (Mair and

Edwards, 1998; Mair and Mellor, 2005). Analgesics were the most common treatment administered which is consistent with other studies (Mair and Mellor, 2005; Curtis *et al.*, 2015a). Furthermore, flunixin was often the analgesic of choice, possible due to its improved anti-inflammatory and analgesic properties when compared with phenylbutazone (Mair and Mellor, 2005; Keegan *et al.*, 2008; Sanchez and Robertson, 2014; Cook and Blikslager, 2015). Ketoprofen was an analgesic that was frequently administered at practice A, whereas it was rarely used at practice B. Ketoprofen provides appropriate analgesia for use in horses, particularly for treatment of abdominal pain (Longo *et al.*, 1992), and it is reported to have fewer adverse effects than other analgesics in the horse (MacAllister *et al.*, 1993). The rationale for the use of different treatments and classes of drugs would need to be investigated further as it is beyond the scope of this study.

The outcomes of cases attended by both practices in the study were similar. Approximately 13% (n=225/1,705 practice A, n=114/845 practice B) of animals attended outside of normal working hours were euthanased, with a 14% (n=238/1,705 practice A, 122/845 practice B) overall mortality rate (horses that were euthanased or died). These results are similar to another study that investigated mortality in geriatric horses (Ireland *et al.*, 2011b). The study by Ireland *et al.* (2011b) reported that mortality rate in geriatric horses was 11% overall, although this was variable dependent on age, with older horses (>25 years) having a higher mortality rate than comparatively younger horses (15 – 24 years). The majority (94%) of these horses were euthanased (n=111/118), with only seven animals dying (either found dead or collapsed following exercise). Interestingly, in the study by Ireland *et al.* (2011b), 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. Different conditions are likely to have different mortality rates. This study has highlighted that a significant number of horses seen ‘out of hours’ are euthanased. This is a particularly important welfare consideration that warrants further investigation. The reasons for euthanasia need clarifying, whether they are planned events or the result of a sudden morbidity or deterioration of a pre-existing condition. Factors that

affect emergency decision making in ‘out of hours’ euthanasia is also lacking in research from both owner and veterinary perspectives. Finally, identification of the conditions implicated in ‘out of hours’ euthanasia and further exploration of the welfare implications that affects these cases is needed.

3.4.1 Recommendations for future work

1) A large proportion of the equine patients that were attended outside of normal working hours had colic, accounting for a third of the overall ‘out of hours’ caseload. The subset of horses with abdominal pain will be further investigated within this thesis to add to the evidence on colic, particularly as studies investigating primary care practice are limited as most are centred on referral hospital populations.
    a. The common presenting signs, diagnostic tests and treatments administered will be investigated, and the overall case outcomes will be explored.
    b. Subsequently, the data will undergo statistical testing where appropriate to determine whether there are any presenting signs that can be used as ‘red flags’ to aid the early identification of cases that are likely to be critical in nature (requiring intensive medical or surgical treatment for resolve) (Sobri *et al.*, 2003; Downie *et al.*, 2013). The prognosis of critical cases improves if they are identified early and therefore receive prompt treatment (Proudman *et al.*, 2001; Archer, 2004; Southwood *et al.*, 2009). If significant correlations are found between specific presenting clinical signs and critical cases, it may assist in improving the welfare and outcomes of these cases.
2) A standardised method of data recording and sharing system for ‘out of hours’ cases would enable future evaluation of much larger datasets with more complete information compared with what is achievable using a retrospective study design. This would require collaboration of a large number of veterinary practices to have maximum benefit, with the creation of a database of ‘out of hours’ cases. This would provide

an opportunity for more robust recording of data (Hotchkiss *et al.*, 2007; Nulty, 2008; Boden *et al.*, 2013; Murray *et al.*, 2015), allowing conclusions to be drawn around 'out of hours' equine primary care practice.

3) The results of this study have implications for training requirements and support for veterinary surgeons, particularly new and recent graduates. The common conditions that have been highlighted in this study provide a focus for training and personal development, as new and recent graduates are able to focus their training and research on the more common techniques and skills they will require in the field. For example, colic cases were most common so they could concentrate their time on honing their nasogastric intubation and rectal techniques. Furthermore, the outcomes of cases may be of interest when considering support mechanisms for new graduates in practice. If a high proportion of cases (approximately 1 in 5) seen 'out of hours' are euthanased, are new/recent graduates prepared and equipped to cope with this procedure in such situations?
4) There are also considerations that may affect clients, particularly if they are making unplanned, snap decisions once a condition becomes critical with little support. Decision making of horse owners and veterinary surgeons individually and in combination requires further qualitative studies to determine the factors that affect decision making in these situations.
5) Finally, cases with poor outcomes are a largely unknown population as there are no studies available in this area at present. These horses are arguably a crucial population as animals that do not survive may have significant compromises in their welfare prior to death. It is necessary to investigate the reasons for euthanasia, the conditions responsible for non-survival and the factors that contribute to a decision to pursue euthanasia rather than treatment in different conditions.

3.5 Conclusion

This is the first study to investigate cases seen at primary presentation outside of normal working hours in primary care equine practice in the United Kingdom. ‘Out of hours’ equine primary care practice is a subject that is lacking in evidence, particularly regarding decision making at the point of care. Further study in this area is warranted to evidence and reiterate the important conditions, and the unique factors that affect decision making in this setting. 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, and providing appropriate educational materials and support for veterinary surgeons involved in ‘out of hours’ calls. The latter is particularly relevant given that provision of twenty-four hour care is a requirement of the governing body of the profession and adequate support is integral to ensuring the welfare of equine veterinary surgeons. In an ambulatory setting, cases may cause the veterinary surgeon to be isolated in potentially dangerous situations where the diagnostic tests and treatments administered leave the practitioner exposed to an increased risk of injury (Anon, 2014; Mayes, 2015).

This study identified that colic, wounds and lameness were the most common conditions seen in ‘out of hours’ equine veterinary practice. Further research is needed to determine the generalisability of these results, however these data could be used to inform the training and education of undergraduate students and recently qualified veterinary surgeons. There was a high number of non-survivors, a population where there is currently no research evidence available and where there are potentially significant welfare implications. The conditions affecting non-survivors and factors affecting the decision for euthanasia need further investigation from both an owner and veterinary perspective to evaluate whether euthanasia is timely and appropriate.

Chapter 4 Evaluation of yard owners' opinions of common equine conditions that require veterinary attendance

4.1 Background

The horse owner plays a crucial role in the maintenance of their animals' health and welfare, however there are few studies about owners' opinions or experiences of equine health. The geriatric population has been investigated from an owners perspective, with a research group conducting studies concentrating on disease prevalence, quality of life and factors affecting the decision to euthanase elderly equids (Ireland *et al.*, 2011a; Ireland *et al.*, 2013). Whilst common conditions in horses have been investigated in multiple studies with fairly consistent results (Loomans *et al.*, 2007; Ireland *et al.*, 2012a; Ireland *et al.*, 2013; Nielsen *et al.*, 2014; Slater, 2017), data for emergency conditions in particular are lacking. There is a single study available in the literature which was based upon veterinary opinion of what emergencies are commonly encountered, however it was conducted over 25 years ago (Traub-Dargatz *et al.*, 1991). The previous study (Chapter 3) investigated 'out of hours' practice rather than emergency conditions due to the reasons and justifications mentioned, however the focus for this chapter was emergency conditions explicitly.

It is important to identify conditions that pose a concern to the horse owner population in the UK as these provide a focus where education may help to address some of these worries. Evaluating owners' opinions and experiences of certain conditions will also help to emphasise the reasoning for further exploration of a particular disease. The rationale for looking at emergency conditions is that these are likely to be scenarios where the owners are unprepared, and therefore an educational campaign may have greater impact. Emergency cases often involve critical decisions made under time pressures, and the horse owner may not have the time or the ability to access information or discuss the condition.

4.1.1 Study aim and objectives

The aim of the study was to identify which emergency problems experienced horse owners considered to be the most common and concerning in the horse.

The objectives of the study were to:

- Conduct an online survey of experienced horse owners' opinions on the common diseases/conditions in horses excluding routine dental care or vaccination.
- Evaluate horse owners' opinions on the most common emergency diseases/conditions in horses that require veterinary attendance.
- Determine which disease/condition horse owners considered the most concerning.
- Assess horse owners' experience of emergency conditions.
- Identify what factors influence horse owners' decision making in emergency situations.

4.2 Materials and Methods

4.2.1 Target population

The online survey using open and closed questions was distributed to a known list of experienced horse owners (registered with The British Horse Society as yard owners).There were 503 potential participants identified, all of whom were emailed a cover letter (Appendix C) with a link to the final version of survey (Appendix D). After two weeks, a reminder email was sent to all those who had not completed the questionnaire. At this time, a request was made to those not intending to participate to provide a reason. This was to assess the degree of non-response bias affecting the results of the survey.

4.2.2 Construction of survey

The questionnaire was initially written in Microsoft Word (2013), and then transferred into the cloud-based internet survey tool SurveyMonkey, California. The questionnaire included an introductory paragraph and compulsory informed consent section (Appendix E) according to The Data Protection Act (1998), and guidelines from BSA (2002) and BERA (2004). Participants were informed about anonymity and their right to withdraw from the study at any time.

The framework of the questionnaire was four sections consisting of:

1. Veterinary Conditions
2. Emergency Situations
3. Owners' demographic information
4. Owners' advice seeking behaviour

Once the questionnaire was developed, feedback was sought from other researchers including the two supervisors (both equine veterinary surgeons) and another PhD student. The questionnaire consisted of open and closed questions, using different formats as described in Table 5. A short introductory paragraph was included at the start of each new section, highlighting the need for participants to answer the questions as honestly as possible, without using resources to assist them. Free text boxes were provided at the end of each section for any further comments, and there was a feedback section at the end of the questionnaire. Participants had the option of providing their email address if they wanted further correspondence about the study and other future work.

Table 5: Details of questions included in the first draft in an online survey of livery yard owners about common conditions in horses, including question types and response options. These were the questions as distributed to the pilot population.

Section			**Question**	**Type of question**
A	Veterinary conditions	1	There are many reasons vets are called out to horses. What do you think are the most common reasons a horse requires veterinary care (not including routine treatments such as vaccinations and dental care)?	Open question. (three free text boxes)
		2	There are also a number of critical conditions which may require emergency treatment by the vet. What do you think are the 3 most common CRITICAL (life threatening) conditions that vets are called to horses for?	Open question. (three free text boxes)
		3	Which three veterinary conditions are the most concerning to you as a horse owner?	Open question. (three free text boxes)
		4	Do you feel confident at what point you should call a vet out to your horse(s)?	Closed question.
		5	If you answered NO to the previous questions, please give a brief explanation of why you would not feel confident in knowing when to call a vet.	Open question. (free text response)
		6	If your horse was in a CRITICAL (life threatening) condition, which factors would most influence your decision making with regards to whether you were going to treat a horse or euthanase it. Please rank these in order, with 1. being the most likely to influence your decision making	Ranking question of nine provided answers.
		7	Are there any other factors that would influence your decision making? If so, please mention them briefly below.	Open question. (free text response)
B	Emergency situations	1	Have you ever had to call a vet in an emergency?	Closed question.
		2	If you answered YES to question 10 (they have had to call a vet in an emergency), please complete the rest of this page, If you answered NO, please skip to page 4. What have been the condition(s) that have affected your horse(s) in the situations when you have called the vet in an emergency? Please tick all that apply	Closed question. (seven provided answers and a free text response)
		3	In the emergency situations mentioned above, do you feel you made the right decision in calling the vet?	Closed question.

		4	In the emergency situations mentioned above, do you feel the vet was called out soon enough?	Closed question.
		5	If you answered NO to the previous question, please briefly comment on why you do not think the vet was called out soon enough.	Open question. (free text response)
		6	How easy do you find it knowing the right time to call the vet?	Closed question.
		7	When you've had to call a vet in an emergency situation previously, how traumatic have you found the experience as a horse owner?	Closed question.
		8	If you would like to comment further on your experiences of emergency situations, please use the box below.	Open question. (free text response)
C	Owners' demographic information	1	What age category do you belong to?	Closed question.
		2	Are you male/female	Closed question.
		3	How long have you kept horses for?	Open question. (free text response)
		4	How many horses do you have at the moment?	Open question. (free text response)
		5	What type of yard do you keep your horses on?	Closed question.
		6	Who cares for your horse(s) most of the time?	Open question. (free text response)
		7	Do you have any equine qualifications? (BHS, pony club, veterinary nursing, college course, degree etc.) If YES, please state below.	Open question. (free text response)
		8	How experienced would you say you were as a horse owner?	Closed question.
D	Owners' advice seeking behaviour	1	Where would you usually seek advice from with regards to your horse's health? Please tick all that apply.	Closed question.
		2	Please comment on what order you would seek advice.	Open question. (free text response)

4.2.3 Pilot survey

The survey was approved by the Ethics Committee of the School of Veterinary Medicine and Science, University of Nottingham. The survey was piloted by 15 horse owners, to highlight any flaws in the wording of the questions or question types, and receive feedback from the pilot population. Prior to distribution, amendments were made (Table 6) and the finalised questionnaire (Appendix D) was re-checked by the Ethics Committee.

Table 6: Details of the amendments made to the common conditions questionnaire after the pilot stage, prior to distribution to British Horse Society (BHS) approved livery yard owners in an online survey of livery yard owners about common conditions in horses.

Section	Question	Details of amendment
Information and consent	N/A	• Additional detail was given to the information section (Appendix E). • Under 16's were included in the population, if parental consent were given. • The terms of consent were given as bullet points with the heading "consent". This enabled the removal of multiple tick boxes in exchange for a single tick box. • The tick box to confirm the information had been read and consent was given was set as a compulsory question. This ensured participants could not proceed without providing consent.
Veterinary conditions	4. Do you feel confident at what point you should call a vet out to your horse(s)?	• Question removed due to misinterpretation and confusion of participants.
	5. If you answered NO to the previous question, please give a brief explanation of why you would not feel confident in knowing when to call a vet.	• Question removed as it relates to question 4 of this section which has also been removed.
	6. If your horse was in a CRITICAL (life threatening) condition, which factors would most influence your decision making with regards to whether you were going to treat a horse or euthanase it.	• Additional answer added to ranking question based on free text comments of pilot participants.
Emergency situations	2. What have been the condition(s) that have affected your horse(s) in the situations when you have called the vet in an emergency?	• Many participants used the 'other' comment option resulting in an extensive list, proving the existing list was inadequate. • A comprehensive answer list was formed using an adapted human critical care SNOMED system (Appendix F).

		• In the question 'Please tick all that apply' was changed to 'This list of emergency conditions has been compiled from veterinary correspondence and is very comprehensive. Please do not be concerned if you have not experienced all of these but simply tick ALL of the conditions that are relevant to you personally.'
	3. In the emergency situations mentioned above, do you feel you made the right decision in calling the vet?	• Question removed. • All participants answered 'Yes', and some feedback commented that they viewed it as condescending and it put them off answering the questionnaire.
Yard owner demographic information	3. How long have you kept horses for?	• Question type changed to a closed question.
	4. How many horses do you have at the moment?	• Question type changed to a closed question. • Question wording changed due to change in target population: o "How many horses do you have responsibility of care for at the moment?"
	5. What type of yard do you keep your horses on?	• Wording of question altered due to change in target population: o "What is the management of the horses on your yard?
	6. Who cares for your horse(s) most of the time?	• Wording of question altered to: o "Who cares for the horses on your yard most of the time?" • Question type changed to a closed multiple option response question.
	7. Do you have any equine qualifications? (BHS, pony club, veterinary nursing, college course, degree etc.)	• Question type changed to a closed question with only one answer allowed. • Additional information included after question o "If you have more than 1 qualification, please state the highest level of qualification."
	8. How experienced would you say you were as a horse owner?	• Wording changed to: o "How would you rate your level of experience with regards to horse care?"
	Additional questions: a) What discipline are the horses in your care predominantly used for?	Closed question.
	b) At what level do the horses in your care compete at?	Closed question.

Advice seeking behaviour	2. Please comment on what order you would seek advice.	• Question type changed to a closed question due to many different interpretations of the question in the pilot. Question re-worded as: "Please comment on who you would seek advice from in the first instance."

4.2.4 Data sorting and analysis

The survey was accessible over a total of 17 days (between 1/1/14 and 24/1/14); however, it remained online for two weeks after to accommodate late responses. Data collected during the study period was transferred to Microsoft Excel (2013) for data handling and analysis. Data were checked and cleaned with incomplete data (where only the consent section was finished) removed prior to analysis. Quantitative data were subject to descriptive analysis for preliminary exploration of the data. This included calculation of the mean, median and range for continuous variables, and percentage frequencies and mode for categorical variables. Free text responses throughout the questionnaire were reviewed and categorised enabling ranking based upon the frequency of different themes. Categorisation of responses occurred in a stepwise manner: categories were formed based on the content of the free text responses with subsequent comments analysed to determine whether they could be included to a pre-existing group, or whether a new category was needed. Once all comments were categorised, the themes that had been identified could be ranked based on how many comments incorporated each theme. The survey included one ranking question about factors influencing decision making in emergency situations. The closed response options were formulated using the results of a study that investigated horse owner decision making in horses suffering from abdominal pain (Scantlebury *et al.*, 2014). A standardised weighting was calculated for each of the responses to enable quantification of the values and identify which factors most affected decision making in the study population.

4.3 Results

There were 104 participants who completed the survey.

Figure 12 demonstrates how they were recruited and the number that are lost at each stage of the process. The response rate for the questionnaire was 23%.

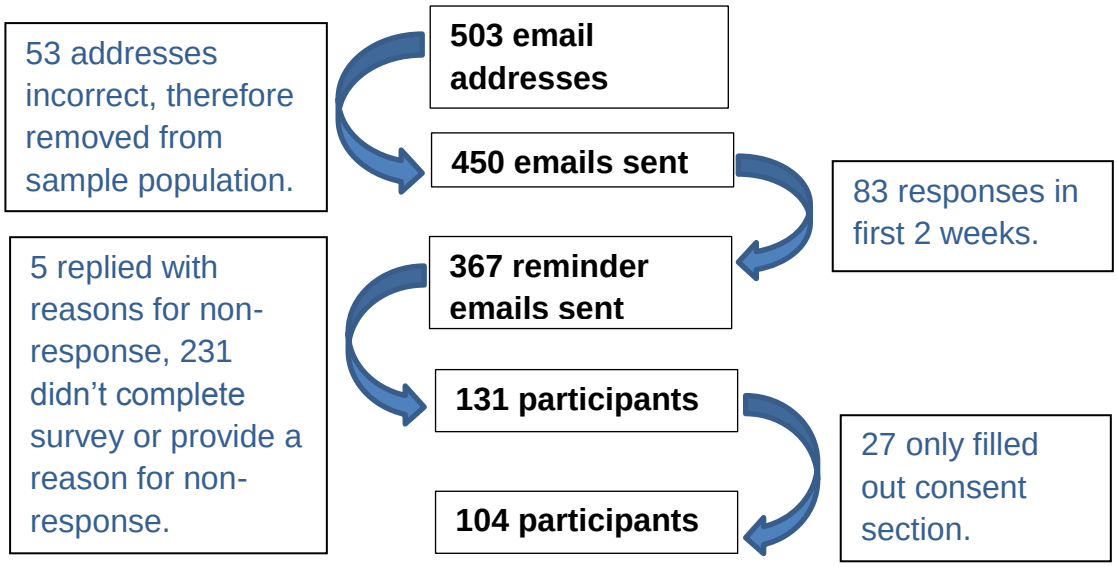


Figure 12: Recruitment of yard owners to participate in a questionnaire about common conditions in horses using a list of British Horse Society (BHS) approved livery yards.

The demographics of the study will be presented first in the results to provide an overview of the study population. In the online questionnaire this was the penultimate part completed by participants.

4.3.1 Demographic information

There were 32% of participants aged between 45 to 54 years old, whilst no participants were under 24 years old (Figure 13). Females accounted for 89% (n=91/102) of participants. The majority (97%, n=97/100) of participants had

kept horses for more than ten years, whilst 58% (n=58/100), had kept horses for more than 30 years.

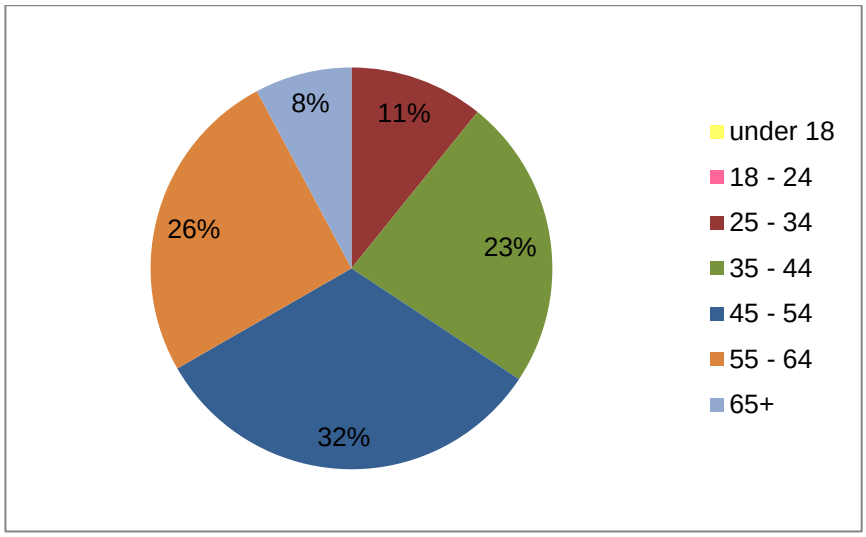


Figure 13: The distribution of ages of participants (n=102) in an online survey of livery yard owners about common conditions in horses.

The number of horses that yard owners had responsibility of care for varied considerably (Figure 14) although the majority (51.5%, n=52/100) had more than 30 horses in their care.

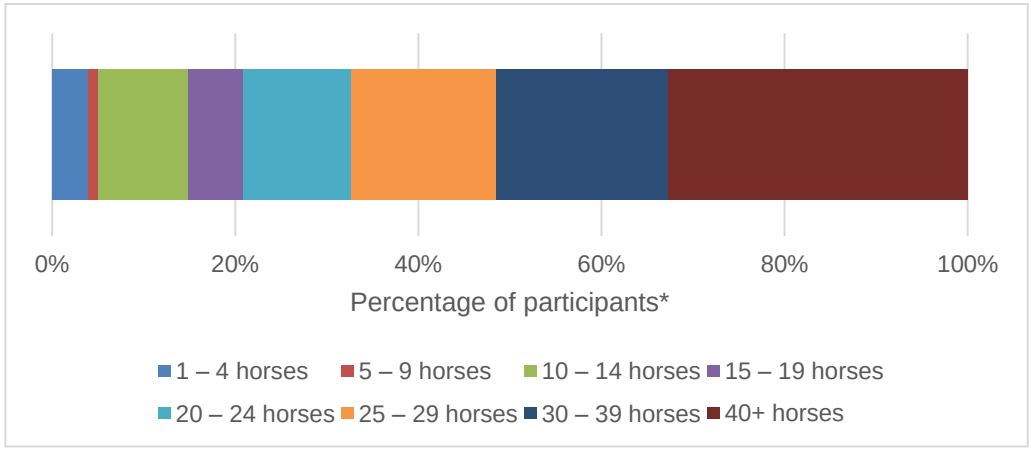


Figure 14: The number of horses under the care of livery yard owners (n=101) in an online survey about common conditions in horses. *expressed as a percentage of the number of participants that answered the question.

Most of the livery yard owners had mixed management strategies on their premises, with the most popular management types being full livery and DIY. Full livery (yard staff delivering the daily care) was provided by 46.5% (n=45/99) of yards, whilst DIY livery (owner centred daily care of the horse) was offered by 39.4% (n=39/99). The majority (reported by 73.6% of yard owners n=64/87) of horses kept on livery yard owners premises were used for general purpose activities. Qualifications held by livery yard owners varied from none (16%, n=17/104) to equine undergraduate degrees (8%, n=8/104). The majority of participants (65%, n=68/104) held formal equine qualifications from the British Horse Society (BHS). The vast majority of participants (95%, n=97/102) felt they were experienced in horse care.

The livery yard owners sought advice from their veterinary surgeon (99%, n=100/101), farrier (77%, n=78/101) and physiotherapist (41%, n=42/101) most frequently. Other sources of advice were friends and family, trainers, paraprofessionals, yard staff and the internet. When asked who they would seek advice from first, 24.5% (n=23/94) of participants would always go to a vet, whilst a further 67% (n=63/94) would seek advice from a farrier for foot related problems and a vet for any other condition.

4.3.2 Veterinary conditions

Livery yard owners were asked to provide their opinion on what the most common reasons for veterinary visits were, excluding attendance for vaccination or routine dental treatment. Figure 15 shows the ten conditions that were most frequently highlighted by yard owners. The most commonly identified conditions were colic (83%, n=87/104), lameness (75%, n=78/104), wounds (54%, n=56/104) and 'injury' (16%, n=17/104). A further 28 conditions were mentioned, but the percentage of participants that included these in their answers was less than 5%.

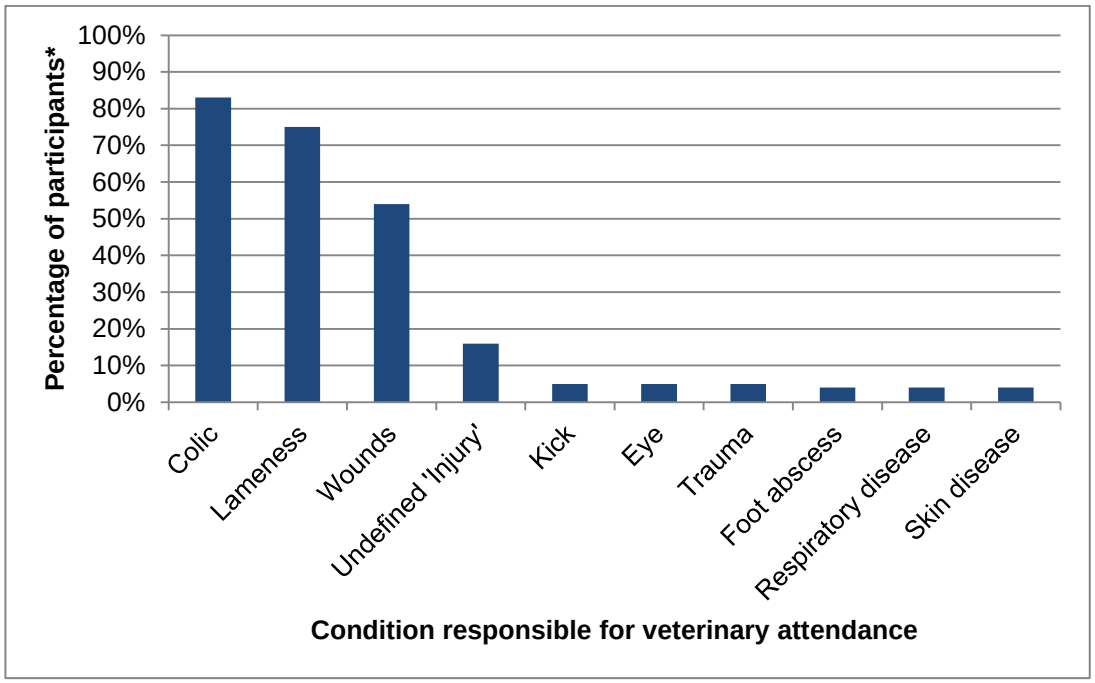


Figure 15: The most common conditions responsible for veterinary attendance (excluding vaccination and routine dental care) based on the reported opinions of livery yard owners (n=104) in an online survey about common conditions in horses. Only the top ten ranked conditions are shown. *Expressed as a percentage of the number of participants that answered the question.

Participants were also asked for their opinion on which critical conditions (requiring emergency attention) were the most common. The top 10 conditions nominated are shown in Figure 16. Colic was recorded by the greatest percentage of participants (98%, n=101/103), followed by wounds

(49%, n=50/103) and fractures (22%, n=23/103). Other frequently mentioned conditions were serious injury (15%, n=15/103), choke (12%, n=12/103), laminitis (12%, n=12/103) and grass sickness (10%, n=10/103). There were a further 21 conditions mentioned, three of which were mentioned by less than 10% of participants, and the remaining 18 conditions were mentioned by less than 5% of participants.

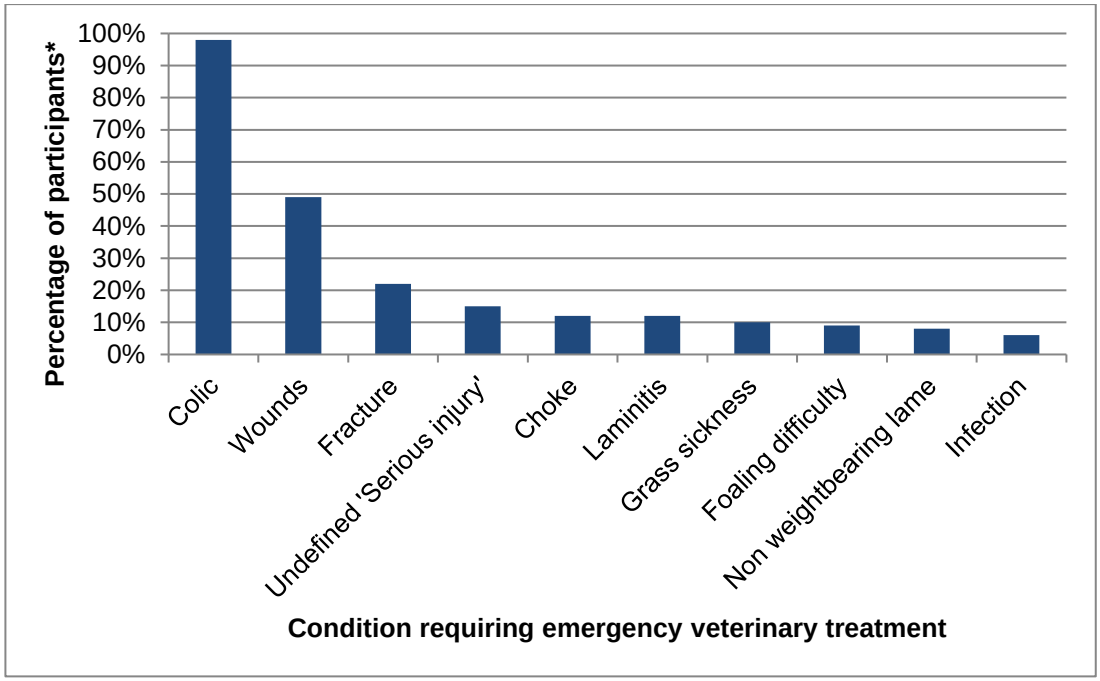


Figure 16: The most common conditions requiring emergency treatment based on the reported opinions of livery yard owners (n=103) in an online survey about common conditions in horses. Only the top ten ranked conditions are shown. *Expressed as a percentage of the number of participants that answered the question.

In addition to the conditions they felt were most common, participants were asked which conditions caused them the most concern. The 10 most concerning conditions to the study population are demonstrated in Figure 17. In free text responses, the most concerning conditions nominated by participants were colic (94%, n=92/99), lameness (36%, n=35/99), wounds (21%, n=21/99), serious injuries (17%, n=17/99), laminitis (16%, n=16/99), fractures (15%, n=15/99), strangles (15%, n=15/99) and infectious diseases (12%, n=12/99). A further four conditions were mentioned by more than 5% of participants (grass sickness, choke, respiratory disease and endocrine

disease) and an additional 19 conditions were mentioned by less than 5% of participants.

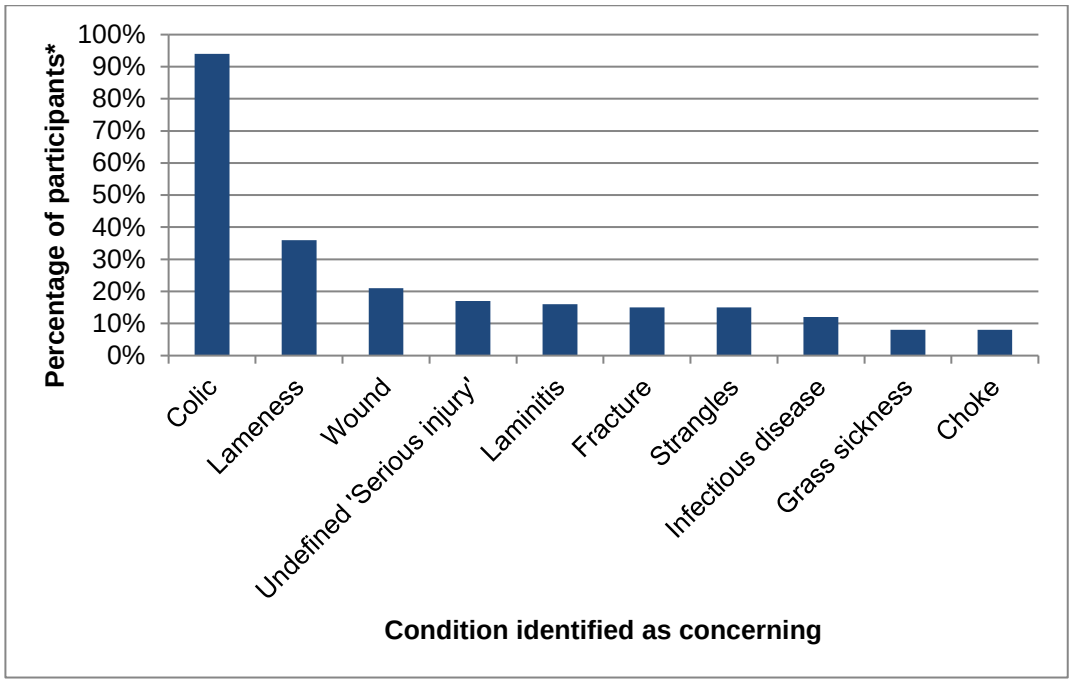


Figure 17: The conditions that were the most concerning based on the reported opinions of livery yard owners (n=99) in an online survey about common conditions in horses. Only the top ten ranked conditions are shown. *Expressed as a percentage of the number of participants that answered the question.

Yard owners were asked to rank the factors that would most influence their decision making with regards to choosing treatment or euthanasia when a horse was critically ill (Figure 18). The factors with the greatest impact on decision making were: the amount of pain and suffering the horse was experiencing and the likelihood that the condition would resolve with treatment. 43% of participants chose to use the free text box associated with this question. The main themes that emerged from analysis of the comments were: multifactorial decision making, veterinary advice, sentimentality and length of ownership of the horse and whether the horse would have to travel for treatment. In addition to these, concerns were raised about length of recovery and whether the horse's temperament would lend itself to the recovery process. Additional influencing factors mentioned were how "useful"

the horse was to the business and, previous experience including outcomes of a condition.

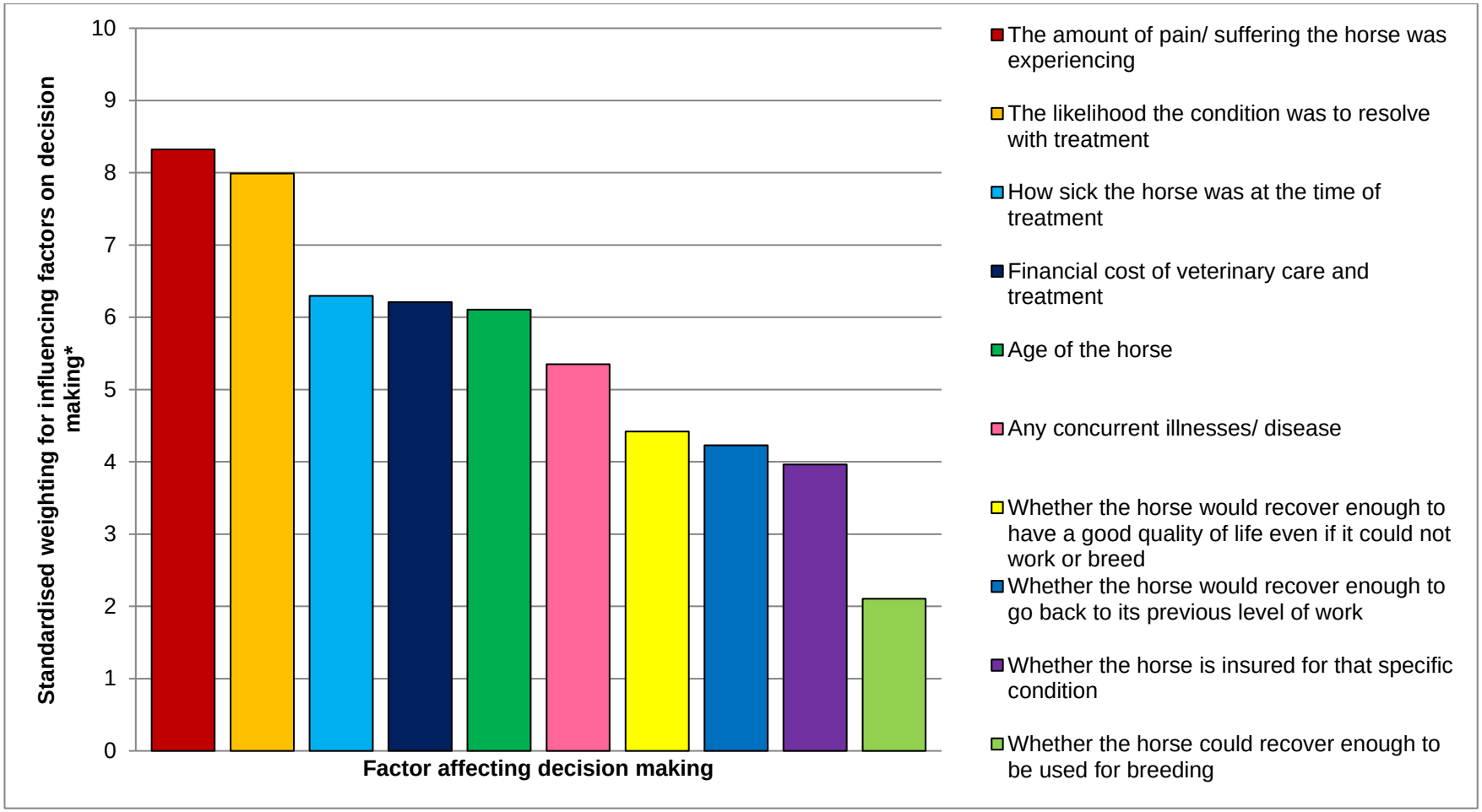


Figure 18: Standardised weightings of different factors affecting livery yard owner decision making (n=104) in critical situations as reported in an online survey of livery yard owners about common conditions in horses. *The factor affecting decision making was ranked by participants from a closed list. Factors ranked as more important were given a higher weighting, therefore a higher standardised weighting is equivalent to a greater influence on decision making.

4.3.3 Emergency calls

There were 103 participants (99%) who had previous experience of emergency conditions where a vet had visited a horse as a result of a condition that they considered to be an emergency. Those without personal experience were not required to complete the emergency experiences section. There were 38 separate conditions that had been experienced by participants (Table 7). The most frequently experienced conditions by the study population were colic (96%, n=99/103), wounds (92%, n=95/103), laminitis (66%, n=68/103), choke (59%, n=61/103) and foot abscesses (57%, n=59/103).

Table 7: Conditions that had been experienced by livery yard owners (n=103) in an online survey about common conditions in horses.

Condition experienced	**% of participants***	**No. of participants (n=x/103)**
Colic	96%	99
Wound	92%	95
Laminitis	66%	68
Choke	59%	61
Foot Abscess	57%	59
Foot penetration	49%	50
Joint/ bursal infection/ penetration	48%	49
Acute respiratory distress	48%	49
Fracture with no evident wound	47%	48
Uveitis	42%	43
Lymphangitis	41%	42
Tendon rupture/ laceration	40%	41
Rhabdomyolysis	40%	41
Fracture with open wound	39%	40
Strangles	38%	39
Cellulitis	32%	33
Ligament rupture/ laceration	31%	32
Collapsed horse	27%	28
Neuropathy	21%	22
Severe haemorrhage (not from nose)	21%	22
Ataxia	18%	19
Cardiac conditions	17%	18
Grass Sickness	17%	18
Joint luxation/ dislocation	16%	16
Seizures	16%	16
Eye penetration	16%	16
Epistaxis	15%	15
Poisoning	13%	13
Melting ulcers	13%	13
Problems whilst foaling	11%	11
Problems after foaling	11%	11
SIRS	10%	10
Neonatal conditions	9%	9
Post castration bleeding/ infection	9%	9
Other myopathies	8%	8
Urological conditions	8%	8
Gestational problems	8%	8
Notifiable diseases	3%	3

*Expressed as a percentage of the number of participants that answered the question.

The majority (96.1%, n=99/103) of participants believed the vet had always been called out to see an emergency soon enough. Those participants who had experienced a delay in veterinary treatment reported this was due to the yard owner or the veterinary surgeon. Yard owner factors included waiting to observe a horse and not realising the extent of injury or an inability to contact the individual horse owners, and not having permission to act on their behalf. Circumstances where veterinary surgeons were unavailable for immediate attendance was due to attending other emergencies at the time of the call or a large distance to travel. Most livery yard owners (95.2%, n=98/103) did not find it difficult knowing when was the correct time to call a veterinary surgeon. Whilst 37% (n=38/103) of participants felt that emergency visits were a traumatic experience for them personally, 44% (n=45/103) had no strong opinion on whether the experience(s) were traumatic for them personally or not.

There were 24 participants (23%) who made free text comments regarding the stressful nature of emergencies. Veterinary surgeon factors that increased the distress the yard owner experienced were delays in attendance, unfamiliar veterinary surgeons and a delay in performing euthanasia of the horse. 'Horse factors' that were felt to increase yard owner distress associated with emergency situations were when the horse was obviously suffering, when the horse had suffered a fracture or when euthanasia was required. The main yard owner factor contributing to increased distress in emergency situations was the financial implication of referral, and more specifically having/finding a deposit for immediate treatment. Other comments included: yard owners experiencing a delayed reaction, emergencies becoming less traumatic with experience and coping with emergencies being part of a yard owner's occupation.

4.4 Discussion

This was the first study to investigate clinical conditions perceived to be common and important for horse owners, and evaluate their experience of equine emergencies. There were 133 livery yard owners who consented to participate, whilst 104 provided answers. The results of the survey highlighted the importance of colic amongst the horse owner population. Colic was considered to be the most common reason for veterinary attendance (excluding vaccination and routine dental care), as well as being a cause of concern for 94% of participants. Furthermore, colic was the condition that had been experienced by the greatest number of survey participants, supporting participants' beliefs that it is also the most common emergency condition.

The intention of the survey was to capture opinions about common and emergency conditions from an experienced population of horse owners. The rationale for selecting the study population as BHS registered yard owners was to remove any bias that may be caused by the vast differences in ability, knowledge and experience in the general horse owner population. The number of premises listed on the British Horse Society's approved yards list at the time of distribution was 503 meaning a response rate of 20.7% was obtained. Different methods of information and data collection were considered including interviews, focus groups and questionnaires. The data collection method needed to be qualitative as it was essential that some questions were open so the participants were not biased in their answers. A questionnaire based survey was most appropriate as it was less time consuming than the other methods, should yield a higher number of responses, and remove a degree of bias by removing inconsistencies and external influence that may be encountered both in interviews or focus groups. Postal and online questionnaires were considered for the survey. Both formats have advantages and disadvantages, and whilst online versions are inexpensive with rapid responses, the response rate is often low (Balter *et al.*, 2005; Sinclair *et al.*, 2012). Postal surveys are accessible to a greater number of people including those without internet access, however they are a more lengthy method and can be expensive when considering printing costs and

pre-paid return postage (Balter *et al.*, 2005; Sinclair *et al.*, 2012). The conclusion was that an online questionnaire was most appropriate given that the data collection period was intended to be relatively short as the main purpose of the survey was to identify a disease or condition that could be further investigated amongst a more diverse population of horse owners.

The response rate of this survey was consistent with other online surveys (Hotchkiss *et al.*, 2007; Nulty, 2008; Boden *et al.*, 2013; Murray *et al.*, 2015). The results are likely not representative of the horse owner population, given that a specific sampling frame was used. The target population were likely to be computer literate given that email addresses were available for them in the public domain, and therefore the use of an online platform was considered appropriate. The main drop out from the survey was immediately after the consent and information page (22%) making it likely that potential participants were deterred by the type of questions, the length of the survey or the requirement for consent.

The findings of this study about the conditions reported to be commonly seen in veterinary practice were in contrast to reports in other studies. In this questionnaire of yard owners, colic was identified as the most common condition seen. It has been more widely reported that musculoskeletal conditions, specifically lameness, is the most common reason for veterinary attendance (Loomans *et al.*, 2007; Ireland *et al.*, 2012b; Ireland *et al.*, 2013; Nielsen *et al.*, 2014; Slater, 2017). The differences in the literature and the current study are possibly due to the different aims of the studies, and the duration of the different conditions. Colic tends to be short duration, whereas episodes of lameness can be prolonged or permanently present in some horses. In this yard owner survey, the aim was to document participants' opinions of different conditions seen, whereas in The National Equine Health Survey (Slater, 2017) and the study of Ireland *et al.* (2013), the aim was to gain a snapshot of the conditions horses were experiencing at a particular time point, which would be more likely to identify the lameness cases. In addition to the differences in aims and methodologies, it is possible that the yard owner responses were subject to a degree of recall bias as colic is likely a more memorable and traumatic condition and therefore this may be the

reason more participants included this in their answering of common conditions in this survey. Participants were asked about common reasons for veterinary attendance, and experienced horse owners may use lay treatments and management of certain conditions, therefore they may not seek immediate veterinary attendance. Lameness may be one of these conditions that they manage initially without veterinary advice and thus colic may be a more common condition for a veterinary surgeon to attend in this population.

The next section of the questionnaire related specifically to emergency conditions. Colic was the emergency condition experienced by the greatest number of yard owners, it was nominated as the most common emergency condition, and as the condition that most concerned them. The majority of participants had personal experience of horses with colic which could be for one of two reasons. Either, it supports the notion that colic is a common emergency condition, or people with experience of colic were more likely to complete the survey as they may have had stronger opinions about emergency conditions in horses. There could have been many reasons why colic was concerning to study participants such as the concern that the lesion may be surgical, the cost involved with treatment, or, that the lesion may be severe enough to warrant euthanasia. The yard owners were not asked to provide reasons for their concern, although this is an area that warrants further investigation in the future. Our findings that colic was the most common emergency condition nominated is similar to previous reports (Traub-Dargatz *et al.*, 1991; Traub-Dargatz *et al.*, 2001; Southwood *et al.*, 2009; Viljoen *et al.*, 2009). The methodology used in the current survey differs from previous studies of emergency conditions in the literature, which have focused on referral hospital populations (Southwood *et al.*, 2009; Viljoen *et al.*, 2009), or veterinary surgeons' opinions (Traub-Dargatz *et al.*, 1991). Gastrointestinal conditions were reported to represent the highest percentage of admissions to a university equine referral hospital in the United States (Dolente *et al.*, 2008) and South Africa (Viljoen *et al.*, 2009). Colic was also identified by vets as the most common medical condition in adult horses seen in the United States (Traub-Dargatz *et al.*, 1991). In the United Kingdom, there is only one study of veterinary opinion relating to common conditions in first opinion practice. This

did not relate to emergency conditions specifically, but interestingly, gastrointestinal disease was the second most common complaint nominated by veterinary surgeons after musculoskeletal disease (Nielsen *et al.*, 2014).

Yard owners' responses to the factors that influence their decision making were very interesting. There are very few studies that look at decision making in equine critical cases, and most of these relate to veterinary decision making (Archer, 2004; Freeman and Issaoui, 2013). A study by Scantlebury *et al.* (2014) focused on owner decision making, specifically in equine colic rather than in all emergency conditions. It was found that different typologies of horse owner made different decisions about veterinary treatment. This means that the results from the livery yard owners may not be applicable to the general horse owner population. Interestingly in the yard owner survey, there were numerous free text comments relating to decision making in critical situations (data not shown) which further emphasised that owner decision making is not a straightforward process and is not reliably assessed by ranking, a comment that was supported by Scantlebury *et al.* (2014).

The majority of participants had sought veterinary attention in emergency situations, and therefore it was surprising that only five conditions had been experienced by more than half of the study participants, although it is possible that these are reflective of calls that are encountered in practice. Aside from colic and wounds, the experience of other conditions varied between participants, although it is remarkable that nearly a third of participants found emergency situations traumatic in general. The majority of participants felt they knew when they required attendance of a veterinary surgeon in emergency situations which could possibly be due to experience. Although they thought they knew when veterinary assistance was required, it doesn't necessarily reflect what would happen in a 'real life' situation. The majority of participants had formal equine qualifications and therefore could have received some formal training on equine health and disease, which may aid decision making and seeking veterinary assistance for their animals. It is reassuring that the majority of participants stated that they would phone a veterinary surgeon directly for advice, suggesting they have a strong professional relationship, and would readily use this means of contact if they

were concerned. It would be interesting to explore further the knowledge and understanding of certain emergency conditions of the general horse owner population, and how this potentially impacts the horse in these situations.

4.4.1 Recommendations for future work

The study was intended to highlight a specific condition (or conditions) for further investigation around knowledge and understanding within the general horse owner population. The identification of colic as the most important and concerning condition in horses was clear from the results of the survey, and will inform the next study of the general horse owner population. Early veterinary intervention is crucial in the prognosis of certain types of colic, and therefore this next study will focus on role of the owner in recognising clinical signs and seeking veterinary assistance. This will include horse owners' knowledge, understanding, and experience of the condition, as well as how they recognise signs of colic, and react to different situations. The overall aim of these surveys will be to identify gaps in knowledge and understanding, to develop and inform an educational campaign.

4.4.2 Conclusions

Colic was identified as overwhelmingly important to the equine yard owner population. Not only did 'colic' clearly emerge from the free text responses as the most common emergency and non-routine condition, it was also identified as the most concerning disease for those involved in the study. Owners' opinions of how commonly colic occurs are likely to be subject to a degree of recall bias, as this study also highlighted that colic is often a stressful and traumatic experience for horse owners. Finally, the results demonstrate the complexity of the decision making process and how different factors have varying impacts for individual owners. These data have highlighted concerns and opinions of yard owners and will now influence a survey of the more general horse owner population with colic as a central focus.

Section 2 – Abdominal pain (colic) in equines

The next section (Chapters Five and Six) focuses on colic (the disease identified as a focus in section 1), investigating veterinary practitioners' and horse owners' approaches to horses with abdominal pain. Chapter Five explores the subset of horses with abdominal pain from the 'out of hours' retrospective case series. Chapter 6 meanwhile investigated horse owners' opinions and experiences of colic, and identified where knowledge or resources were lacking through a mixed methods survey.

Chapter 5 Investigation of equids presenting with abdominal pain (colic) at 'out of hours' primary assessment

5.1 Background

The term 'colic' is used to describe clinical signs of abdominal pain and is therefore not a single disease in its own entity, rather a group of diseases associated with a detrimental impact on equine welfare and great economic concern (Mellor *et al.*, 2001; Traub-Dargatz *et al.*, 2001; Egenvall *et al.*, 2008). The impact has been demonstrated by these studies in the US and UK. Colic was accountable for the second largest expenditure of all conditions, and largest expenditure for an 'emergency' condition by Pet plan insurance company for claims submitted in 2015 (PetPlan, 2016). Abdominal pain can be caused by many different pathological processes, although these are predominantly related to the gastrointestinal tract, colic may also be shown by horses with non-gastrointestinal pathology or disease (Hillyer and Mair, 1997; Southwood and Wilkins, 2014). Practising veterinarians considered colic the most common emergency problem in the horse (Traub-Dargatz *et al.*, 1991), and a major cause of equid deaths (Tinker *et al.*, 1997a; Egenvall *et al.*, 2006; Ireland *et al.*, 2011b). Colic was the most common reason for an emergency

call out of standard working hours as identified in Chapter 3. The outcomes of the analysis of ‘out of hours’ cases from two equine practices documented that approximately a third of all 2,602 veterinary examinations over a three year period, were for horses with colic.

Frequently, horses with colic are treated with simple medical management and analgesia, without identification and classification of the underlying cause (Proudman, 1992; Tinker *et al.*, 1997a; Hillyer *et al.*, 2001; Proudman *et al.*, 2001; Curtis *et al.*, 2015a). A proportion of equine colic cases are critical, with a more complex or severe underlying pathological process. Critical cases of colic require intensive medical or even surgical treatment to resolve the abdominal pain (Proudman *et al.*, 2005a; Proudman *et al.*, 2005b; Suthers *et al.*, 2013; Curtis *et al.*, 2015a). In a prospective survey of horses with colic seen by veterinary practitioners over a one year period, 19% of cases (n=195/1016) were critical, with 84% (n=164/195) of these being euthanased or dying as a result (Curtis *et al.*, 2015a). The study was subject to bias as case forms were submitted retrospectively by attending veterinary surgeons making it is possible that more ‘memorable’ critical cases were recorded and submitted. The proportion of cases of colic that are critical in nature needs to be validated by further research. Prognosis of critical cases of equine colic is influenced by the early, accurate diagnosis of underlying aetiologies as the duration and degree of pathology is negatively correlated with a successful patient outcome (Fischer, 1997; Proudman *et al.*, 2002b; Proudman *et al.*, 2002a). Thus, to improve patient outcomes in horses suffering from colic, veterinary attention should be sought at the earliest possible opportunity.

5.2 Impetus for the study

Colic was the most common reason for veterinary attendance outside of normal working hours (Chapter 3). 'Out of hours' work of equine practitioners has unique challenges, and cases of colic seen during this timeframe have not been investigated as a standalone population previously. Furthermore, although colic is a topic that is well researched, the majority of the studies are published outputs from referral centres, and the applicability to general practice is unknown. Studies about primary care equine practice exist, however, these are limited in number and are largely outdated (Proudman, 1992; Tinker *et al.*, 1997a; Hillyer *et al.*, 2001). More studies are required to support and complement the existing body of evidence. Curtis *et al.* (2015a) collected data from a large number of practices across the UK, however the study was not without limitations. The methodology was reliant on veterinary surgeons completing and submitting recording forms of their clinical cases. The study showed a higher proportion of critical cases than had been reported previously (Proudman, 1992; Tinker *et al.*, 1997a; Hillyer *et al.*, 2001), and it was not clear whether this was a true result, or due to reporting bias (veterinary surgeons selecting to submit the more interesting / severe cases) (Curtis *et al.*, 2015a). The 'out of hours' dataset reported in the previous study (Chapter 3), gave the unique opportunity to conduct further detailed analysis of the specific subset of colic 'out of hours' data. Analysis of colic cases from their clinical records means that selection bias will not be present in this study, and this will allow comparisons to be made between this study and the study by Curtis *et al.* (2015a). The study by Curtis *et al.* (2015a) was the first study to report clinical signs on first presentation associated with critical outcomes, however a single study does not provide sufficient evidence to underpin clinical practice. There was a need for further investigation of critical cases of colic with additional data that was not subject to case selection bias. Agreement between the results of this study and the results reported by Curtis *et al.* (2015a) would provide stronger evidence that could be used to underpin clinical recommendations, particularly if there are common 'red flags' that could be used as early indicators of critical cases of colic (Bowden *et al.*,

2017). Identifying potential critical cases of colic at initial examination would facilitate earlier intervention, thus improving the welfare and prognoses of these cases (Proudman *et al.*, 2001; Proudman *et al.*, 2002b; Proudman *et al.*, 2002a; Proudman *et al.*, 2005a; Proudman *et al.*, 2005b; Southwood *et al.*, 2009).

5.2.1 Study aim and objectives

The aim of this study was to describe the primary assessment, treatment and outcomes of equids with abdominal pain (colic) that presented 'out of hours' in first opinion equine practice.

The objectives of the study were:

- To categorise the frequency of different causes of abdominal pain in equids presented for primary assessment 'out of hours' at two equine veterinary practices in the United Kingdom.
- To evaluate the diagnostic approach and treatments administered by veterinary surgeons during primary assessment and treatment of equids with abdominal pain (colic) 'out of hours' at two equine veterinary practices in the United Kingdom.
- To document the outcomes of equids presenting to veterinary surgeons with abdominal pain for primary assessment 'out of hours' at two equine veterinary practices in the United Kingdom.
- To determine aspects of the initial clinical assessment that can be used to differentiate critical and non-critical cases of abdominal pain (colic).

5.3 Materials and methods: Case selection, Data sorting and analysis

The study was a retrospective case series that focussed on the data collected in Chapter 3. Development of the data capture form, the study design and data collection methods and the analysis of the full dataset were covered in detail in Chapter 3, and therefore will not be addressed within this section.

The population of interest for this study was the subset of horses from the original case population that had colic. Horses suffering from abdominal pain (colic) were identified from the datasets for both practices.

The inclusion criteria for horses were a recorded case history including at least one of the following:

- a presenting complaint of colic
- a definitive diagnosis of colic (regardless of the cause)
- clinical signs of abdominal pain noted on presentation/clinical examination

Once colic cases were identified for both practices, the data were attributed to practice A or practice B, prior to pooling of the data in Microsoft Excel (2013). The rationale for pooling the data was due to the similarities identified in the analysis of the dataset as a whole (Chapter 3): there were no significant differences identified between the data from the different practices. Individual cases were categorised by year and month to allow for analysis of seasonality, although dates of visits were not included to maintain anonymity of the data. Cases within the pooled colic dataset were subject to binary retrospective classification of ‘critical’ or ‘not critical’. Critical cases were defined as cases that either did not survive due to death or euthanasia, or those animals that required critical care (hospitalisation for intensive medical treatment or surgery) for resolution of the condition. Conversely, ‘non-critical’ cases had met the inclusion criteria for a case of colic, but the clinical signs of abdominal pain had resolved with simple medical treatment (Curtis *et al.*, 2015a).

The data were subject to descriptive statistical analysis: analysis of continuous variables included mean, mode, median and range, whilst percentage frequencies were calculated for all categorical data. Data were then entered into a statistical software package (SPSS Statistics Version 24, IBM Corporation, 2012) for further analysis. Simple univariable associations were examined for their association with 'critical' outcome using binary logistic regression for signalment, history and presenting clinical signs. In addition, biologically plausible interaction terms were also evaluated. Variables showing evidence of association ($p<0.2$) were further evaluated in a stepwise forward multivariable model due to the number of potentially significant variables to identify clinical presentations associated with critical outcomes. The fit of the model in the multivariable regression was checked using Hosmer and Lemeshow analysis and classification of percentage that was correctly predicted by the model.

5.4 Results

During the period from 1st January 2011 to 31st December 2013 inclusive, 941 equids with abdominal pain had primary evaluations outside of normal working hours. The mean age of equids was 14 years old (s.d. +/- 8.4, range three months to 44 years). Sex was recorded in 86% (n=806/941) of case records, and the study population consisted of 54% (n=436/806) geldings, 42% (n=340/806) mares/fillies and 4% (n=30/806) stallions/colts. There were 66 breeds/types of equid described, which were categorised into eight main breed types (Table 8).

Table 8: Categorisation of breeds/types of equine as described in the case records of animals attended for primary assessment at two practices over a three year period (2011-2013) in a retrospective case series of 941 equids with abdominal pain (colic) seen ‘out of hours’.

Section	**Breed or Type**
1	Donkey, Mule
2	Shetland, Welsh Section A, Miniature horse, Miniature Shetland, Shetland x, Falabella
3	Pony, Welsh Section B,C, Welsh, Welsh x, Fell, Connemara, Connemara x, Riding pony, Highland, Highland x, New Forest, New Forest x, Dartmoor, Dales, Haflinger
4	Arab, Arab x, Anglo Arab
5	Cob, Cob x, Welsh Section D, Welsh Cob
6	*TB, TB x (except ***ID x TB), Morgan, Appaloosa, Hackney, Hackney x, Trotter, Standardbred, Riding Hack
7	+WB, WB x, ++ISH, Andalusian, Lipizzaner, ***ID x TB, Oldenburg, French, Fresian, **ID, ID x, Irish, Irish x, Westphalian, Selle Française, Holstein, Hanoverian, Hanoverian x, Gelderlander, Cleveland Bay, Cleveland Bay x, Trakehner
8	Shire, Shire x, Clydesdale x, Percheron x

*TB= Thoroughbred, **ID = Irish Draught, ***ID x TB= Irish Draught horse crossed with Thoroughbred, +WB= Warmblood, ++ISH= Irish Sport Horse, ‘x’ = crossed with another breed/ type

According to the case records, 29.6% (n=279/941) of the study population were recorded as having insurance, whilst 0.4% (n=4/941) had no insurance

and data were not recorded in 70.0% (n=658/941). When preventative healthcare was evaluated, 69% (n =650/941) of equids were recorded as vaccinated and 37% (n=349/941) received routine dental work through the veterinary practice. Less than 1% of the study population were recorded as either having no insurance, not receiving vaccinations or not receiving routine dental care.

Of the colic case population, 13.4% (n=126/941) had a history of colic in the 12 months preceding the 'out of hours' examination. This was recorded as one previous episode of colic in 7.6% (n=71/941) of the total colic case records, two recorded episodes in 3.4% (n=32/941), and 3 or more episodes of colic in 2.4% (n=23/941) of cases.

A small proportion (6%, n=59/941) of horses were recorded as having a concurrent condition at the time of the 'out of hours' examination. The most common concurrent conditions were pituitary pars intermedia dysfunction (PPID) (2.7%, n=25/941) and lameness attributed to degenerative joint disease (2.1%, n=20/941). Medications were being received by 6.3% (n=59/941) of equines in the study; frequently non-steroidal anti-inflammatory drugs (NSAIDs) (3.0%, n=28/941) and pergolide (PPID treatment) (2.4%, n=23/941). Not all horses receiving medication at the time of the 'out of hours' examination had a recorded concurrent condition within the clinical record.

The majority (76%, n=712/941) of cases of abdominal pain attended at primary assessment had no definitive diagnosis identified in the records; 87% (n=619/712) of these responded to medical treatment. In cases where there was a definitive diagnosis (24%, n=227/941), there were 31 different problems/lesions described as causing the abdominal pain (Figure 19). The most commonly diagnosed problems were spasmodic colic (29.5%, n=67/227), pelvic flexure impaction (17.6%, n=40/227), small intestinal strangulation (11.9%, n= 27/227), and right dorsal displacement of large colon (7.0%, n=16/227). There was no obvious seasonality in colic cases across the three year period, when each year was analysed individually, with no consistent trends in the data.

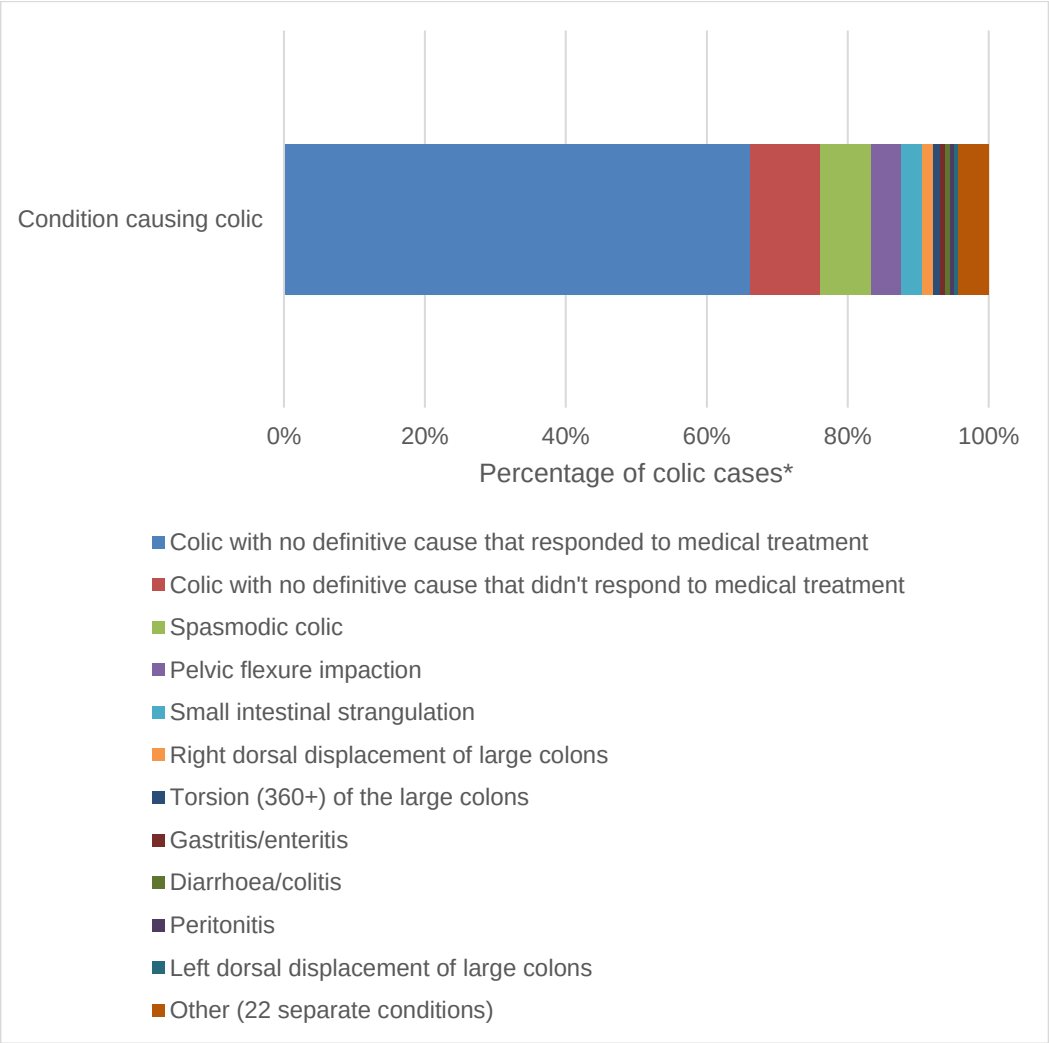


Figure 19: The conditions attributed to clinical signs of colic in equids that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013) in a retrospective case series of 941 equids with abdominal pain (colic) seen 'out of hours'.
*Expressed as a percentage of the 941 equids that were attended for abdominal pain.

5.4.1 Clinical presentation, diagnosis and treatment of equids based on clinical case records

A change of demeanour was recorded in the case records of 32% (n=299/941) of horses presenting with colic for primary assessment. This was most commonly associated with the animal displaying restless and agitated behaviour (38%, n=113/299) or dull and depressed behaviour (29%,

n=88/299) which was considered abnormal for the individual horse. A heart rate was recorded in 95.6% (n=900/941) of cases. The median heart rate recorded was 44 beats per minute (range 24 - 150), with 43% (n=387/900) having a reported tachycardia as described by the veterinary surgeon on primary evaluation (Figure 20).

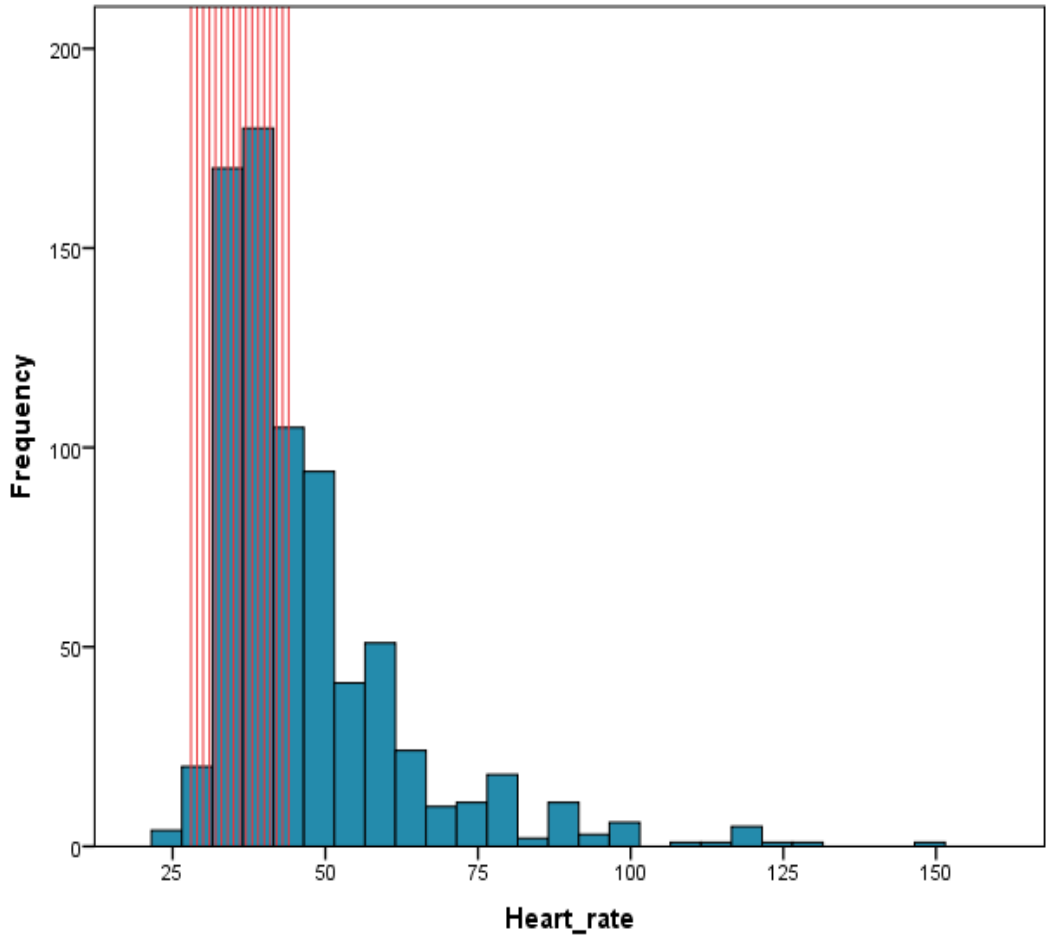


Figure 20: The frequency distribution of heart rates of 900 equids with abdominal pain that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013). The red highlighted area depicts the reference range (outlined in Chapter 3.2.1) used by the attending veterinary surgeons (28-40 beats per minute).

Respiratory rate was recorded for 63.9% (n=601/941) of cases. The median respiratory rate was 16 breaths per minute (range 6 - 80), with 56.7% (n=341/601) reported as having an elevated respiratory rate on initial clinical examination (Figure 21). Rectal temperature was recorded in the clinical notes of 55.6% of horses (n=523/941). Mean rectal temperature was 37.9°C (s.d. +/-

1.09), with 8.8% (n=46/523) recorded as pyrexic (45 had values provided). Mucous membranes were an abnormal colour in 23.9% (115/482) of cases. The most common descriptions if mucous membranes in the clinical notes were pale (61%, 70/115), congested (13.9%, 16/115), or toxic (13.0%, 15/115). Capillary refill time was described as prolonged (or >2.5 seconds) in 7.6% (n=26/341) of cases, and was recorded as normal (or <2.5 seconds) in the remaining (92.4%, n=315/341) cases.

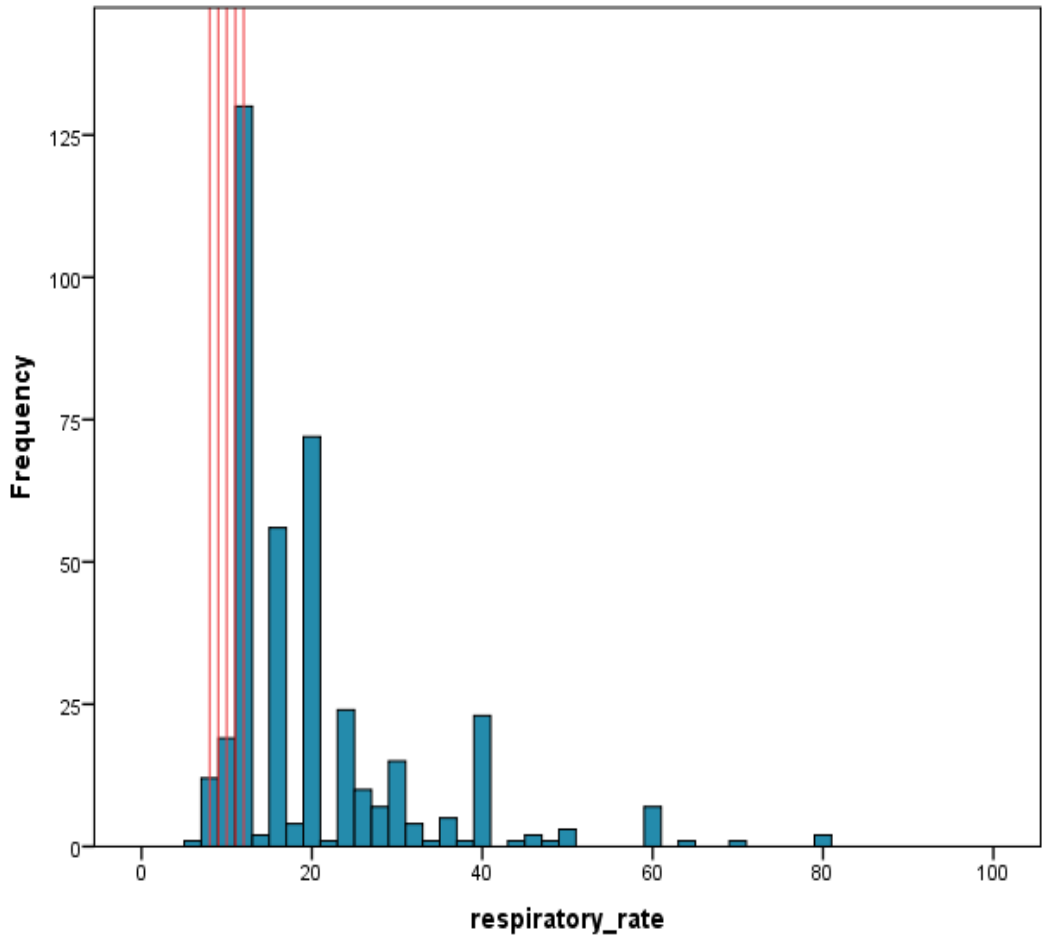


Figure 21: The frequency distribution of respiratory rates of 601 equids with abdominal pain that were attended for primary assessment outside of normal working hours at two practices over a three year period (2011-2013). The red highlighted area depicts the reference range (outlined in Chapter 3.2.1) used by the attending veterinary surgeons (8-16 breaths per minute).

The common diagnostic procedures that were performed on the primary assessment of cases were categorised and evaluated. Abdominal auscultation was recorded as performed in 93.2% (n=877/941) of cases, whilst a rectal

examination was recorded as performed in 72.8% (n=685/941) of cases. Nasogastric intubation procedure was recorded in 21.7% (n=204/941) of cases, 5.4% (n=51/941) had a blood sample taken and abdominal paracentesis was conducted in 5.1% (n=48/941) of cases.

Treatments were recorded in 94.2% (n=887/941) of cases. The most common treatment was analgesic administration which was given in 91.5% (n=861/941) of cases. Flunixin meglumine (43.3%, n=373/861), ketoprofen (28.1%, n=242/861) and phenylbutazone (26.2%, n=226/861) were the most frequently administered analgesics. Spasmolytic drugs containing hyoscine either in isolation or combination (Buscopan-20 or Buscopan Compositum) were used in 70.5% (n=663/941) of equines with colic. It was not possible in the retrospective analysis to accurately determine what percentages of each drug were administered. Oral fluids were given in 11.4% (n=107/941) of cases; most commonly this was a water and electrolyte combination (75.7%, n=81/107). The most common treatments (Figure 22) included administration of an NSAID and spasmolytic agent concurrently (64%, n=571/887) or an NSAID in isolation (18%, n=159/887). Examination of case records revealed 4.8% (n=45/941) of animals were hospitalised for intensive care / treatment. It was recorded that abdominal surgery was recommended in 6.9% (n=65/941) of cases and was attempted in 4.4% (n=41/941). Euthanasia was performed prior to any treatment administration in 3.5% (n=33/941) of cases.

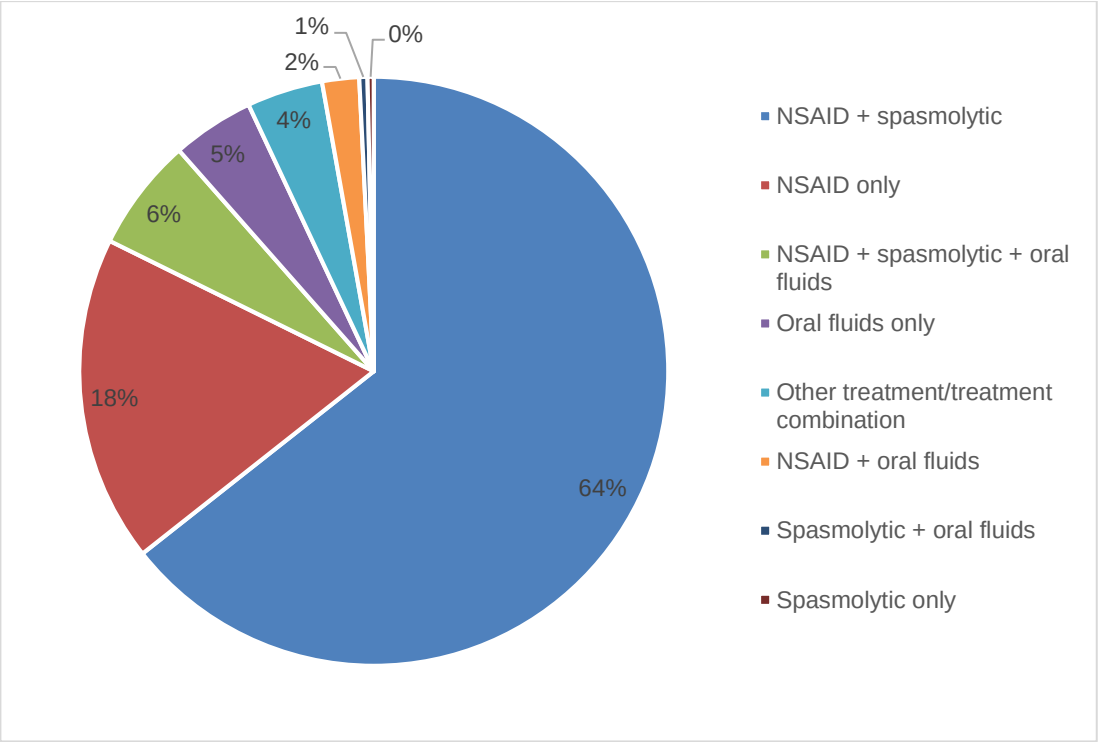


Figure 22: The treatment combinations administered in 887 equids that received medical treatment for abdominal pain (colic) at the primary assessment outside of normal working hours at two practices over a three year period (2011-2013). NSAID = non-steroidal anti-inflammatory drug.

The majority (62.0%, n=583/941) of equine patients attended 'out of hours' for abdominal pain in the study required a single treatment for resolution of the condition, whilst a further 18.5% (n=174/941) needed multiple treatments. Of the study population, 18.6% of animals did not survive the episode of colic; 17.9% (n=168/941) were euthanased and 0.7% (n=7/941) died. The remainder of equines within the study either had no obvious outcome in their case record (0.7%, n=7/941), or the colic resolved without veterinary treatment (0.2%, n=2/941).

5.4.2 Clinical features of 'critical' cases of colic

Critical cases of colic were identified from the dataset. A critical case was defined as any case which did not survive, or was believed not to have survived without significant intervention (surgery and/or intensive medical

treatment). Cases that met the inclusion criteria for a critical case were those that were either euthanased on humane grounds or died as a consequence of colic. Additionally, it incorporated animals that were hospitalised to receive intensive medical treatment or surgical intervention. All other cases of colic within the dataset were classified as not critical. There were 225 cases (23.9% of the total number of cases with colic) that were categorised as critical (Figure 23). Of the 225 critical cases, 145 (64.4%) did not survive (141 were euthanased, 4 died) without receiving intensive medical treatment or surgical intervention. Thirty nine animals (17.3%) were hospitalised for intensive medical treatment and surgical intervention was attempted in 41 animals (18.2%).

Outcomes of horses that received intensive treatment are shown in Figure 23. Of the 39 animals that were hospitalised for intensive medical treatment, 10 were euthanased after treatment failed, 1 died before it could be euthanased, and 28 recovered following treatment. The duration of hospitalisation of animals ranged from 2 - 52 days. Surgical intervention was attempted in 41 animals. Two of these horses died, one during transit to a referral hospital, and the other during induction of anaesthesia, whilst 17 were euthanased. The reason for euthanasia was not identifiable in the case records for six animals. Of the remaining 11 animals, two were euthanased prior to surgery, six during surgery after identification of the underlying pathology and three due to post-surgical complications. Twenty two animals (9.8% of the critical cases, n=22/225) that underwent surgery survived until discharge. It was not possible to determine the long term survival based upon case records.

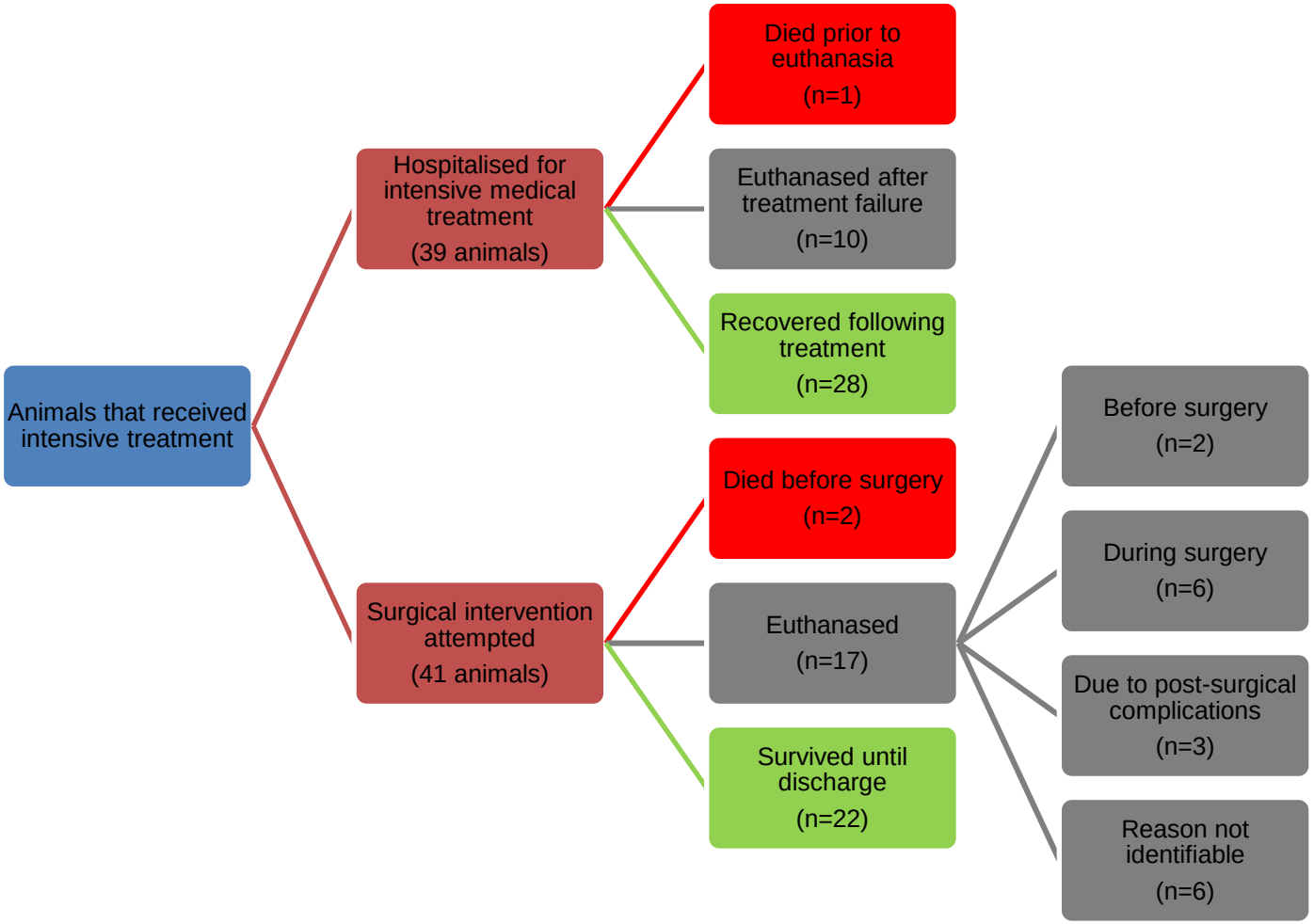


Figure 23: The outcomes of 225 critical cases of abdominal pain in equids that were attended for primary assessment outside of normal working hours and received intensive treatment at two practices over a three year period (2011-2013) in a retrospective case series of 941 equids with abdominal pain (colic) seen ‘out of hours’.

5.4.3 Univariable and multivariable models of variables associated with critical cases of colic

Univariable logistic regression (Appendix G) resulted in the identification of 19 variables showing evidence of association ($p<0.2$) to a critical outcome; there were no interaction terms significantly associated with outcome. The 19 variables identified from the univariable analysis were added in a stepwise forward multivariable model. The final multivariable model consisted of variables concerned with features of history, signalment and clinical presentation. There were three variables significantly associated with the likelihood of a case being classified as 'critical' (Table 9). Increasing heart rate ($p<0.01$) was the only continuous variable that remained in the model, whilst abnormal mucous membrane colour ($p<0.01$) and absence of borborygmi in at least one abdominal quadrant ($p<0.01$) were the categorical variables that were associated with an increased likelihood of a critical case. The final model predicted 84.3% of outcomes correctly (60.3% of critical cases and 94.3% of non-critical cases).

Table 9: Multivariable model for clinical variables (history, signalment and clinical presentation) from 941 equids that were attended for primary assessment outside of normal working hours for clinical signs of abdominal pain 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	Coefficient	Odds ratio	95% CI	p value
Increasing heart rate (beats per minute)	0.05	1.05	1.03-1.08	<0.01
Abnormal mucous membrane colour	1.69	5.40	2.86-10.20	<0.01
Absent borborygmi in 1 or more abdominal quadrants	1.12	3.06	1.40-6.67	<0.01

CI = Confidence Interval

5.5 Discussion

This is the first study to describe the primary presentation, treatment and outcomes for horses seen outside of normal working hours for abdominal pain. During the study period (1st January 2011 to 31st December 2013), 941 equids were examined at primary assessment for colic. The majority (76%) of these cases had no definitive diagnosis of the cause underlying the colic episode, although 87% of them responded to simple medical treatment. Intensive medical treatment or surgical intervention was performed in 8.5% of the study population, which is consistent with the findings of Edwards (1992) who found colic surgery was performed in six to ten percent of horses with colic, although 23.9% of the study population were defined as 'critical' (cases that required intensive medical or surgical management, were euthanased or died). The referred cases only represented a small proportion of the total cases seen. Currently, the vast majority of research is published using referral populations of animals. This study highlights the need for more research on the other types of cases seen in equine practice, especially critical cases where referral treatment options were not pursued.

This study contributes to our current knowledge about the 'critical' cases by describing the different outcomes within this group, and identifying the high number that are euthanased (n=168/941). Early recognition of these critical cases is essential (regardless of whether treatment or euthanasia is the elected option), as they represent a significant welfare concern. Multivariable modelling of this study population identified potential early indicators or 'red flags' for 'critical' cases, specifically an increased heart rate, absence of borborygmi in at least one abdominal quadrant and an abnormal mucous membrane colour. The importance of cardiovascular parameters and markers of hypovolaemia as prognostic indicators have been identified by other studies from referral hospital populations (Furr and White, 1990; Proudman *et al.*, 2001; Sutton *et al.*, 2009), but there has been only been one other study (Curtis *et al.*, 2015a) from this research group which has reported on the primary assessment of cases. The results from this study support the previous study by Curtis *et al.* (2015a) and starts to build an evidence-base to support

clinical decision making. Curtis *et al.* (2015a) found that increased heart rate, hypovolaemic markers and absence of borborygmi were significant findings in agreement with this study. Curtis *et al.* (2015a) also reported an additional significant finding of increased pain/behaviour scores, which was not significant in this retrospective study. Behavioural scoring was not possible to conduct retrospectively in this study as this information was not captured in a reliable manner due to clinicians' varying methods of reporting in clinical records. The prospective study design of Curtis *et al.* (2015a) however allowed accurate assessment and scoring of clinical signs of pain at the initial examination. The major impact of this study is that clinical parameters associated with a critical outcome were identified on the very first assessment of these horses, and therefore can be used as part of early decision-making in colic cases.

The main advantages and disadvantages of the study design used in this chapter are as described in Chapter 3, given that the same methodology and data set was used. The retrospective case series has missing data, and there is the inherent problem of only being able to collect information on what was catalogued within the case records. One example of where the study design prevented data collection that could have been useful when analysing the colic cases was behavioural/pain severity scoring. Behavioural changes were largely described and recorded by veterinary surgeons, however this was not consistent, and none of the animals were given a pain score such as the one that was used in the prospective study by Curtis *et al.* (2015a). It was not considered appropriate to retrospectively classify the behaviour of the animals attended outside of normal working hours, particularly as the data collector was not the attending veterinary surgeon present at the visits. Using a prospective collection method would have allowed for the individual veterinarians to subjectively apply a behaviour/pain score to the animals that they attended to support or contradict the findings of the Curtis *et al.* (2015a) study. It was not the initial aim of this work to focus on colic cases but instead to appreciate the 'out of hours' caseloads of two practices in their entireties, a factor that is important to bear in mind when critiquing the study design. Instead, analysis of the colic cases was a progression of the original study of

all ‘out of hours’ cases due to the emergence of colic from the results and the emphasis of the importance of abdominal pain in equines.

The majority (76%) of cases were colic treated without a definitive diagnosis of an underlying cause of the abdominal pain, consistent with findings from other studies (Proudman, 1992; Tinker *et al.*, 1997a). Difficulty reaching diagnosis may be due to a lack of an obvious anatomical abnormality, limitations in diagnostic approaches/techniques available or client preference / finance (Curtis *et al.*, 2015b). A lower rate of undiagnosed cases (56%) was reported in the prospective study by Curtis *et al.* (2015a) but this may relate to the structured recording format of the prospective study. Another possible explanation is that the prospective study by Curtis *et al.* (2015a) may have been subject to selection bias (it is not known what percentage of cases seen were reported in that study, and participants may have been more likely to submit cases with a known diagnosis or more severe cases). The underpinning finding remains that the majority of horses with colic do not have an underlying cause diagnosed.

This retrospective study provides novel information on the type of data entered in clinical records for horses seen ‘out of hours’. The heart rate of horses was the most commonly recorded clinical finding (95.6% of cases). A possible explanation could be due to the current evidence around the relationship between cardiovascular status and predicting surgical lesions, and prognosis (Furr and White, 1990; Proudman *et al.*, 2001; Nielsen, 2007; Dukti and White, 2009). Increased heart rate could be related to pain, systemic inflammatory response syndrome or hypovolaemia (Dukti and White, 2009; Southwood and Wilkins, 2014). In the primary assessment of animals where they are seen in the early stages of disease, increased heart rate is likely attributable to pain, whereas later in the disease process it may be due to pain in conjunction with clinical manifestations of systemic compromise. Recording of heart rate was followed by abdominal auscultation (93.2%) to determine the degree of borborygmi, unsurprising as it is a marker for gastrointestinal function, and many cases of colic have an underlying gastrointestinal cause (White, 1990; Cohen, 1997; Reeves, 1997; Cohen,

2003; Cook, 2009). These were followed by respiratory rate (63.9%) and rectal temperature (55.6%), which was expected given that these combined with heart rate are the three components that form the basis of any clinical examination (Coomer, 2007), whilst also reflecting the findings of the study by Curtis *et al.* (2015a). These are important components of any physical examination since respiratory rate can help diagnose respiratory conditions such as pleuropneumonia but may also be elevated in response to pain, whereas pyrexia may be indicative of an infectious pathology. Surprisingly, assessment of markers for hypovolaemia, in particularly capillary refill time were not very commonly recorded, particularly as these parameters are integral to assessing the peripheral perfusion status of the animal and were found to be 'red flags' for critical cases in the study by Curtis *et al.* (2015a). This does not necessarily mean that capillary refill time was not assessed, rather that is was not recorded, highlighting one of the possible flaws that have previously been mentioned with the study methodology. There may have been assessment of clinical parameters, but it is not always recorded, nor is it possible to determine based on the case records. This may also provide explanation for the low reporting of changes in demeanour. Given the perceived importance of demeanour when assessing abdominal pain in horses (Furr and White, 1990), a change in demeanour was not commonly reported in this study (32% of cases), although it may have been assessed in more animals. In the prospective study by Curtis *et al.* (2015a), a case record form was used to capture these data. Demeanour was assessed in all cases, highlighting the differences attributed to retrospective and prospective study designs.

The diagnostic tests that were most frequently used were rectal examination (72.8% of cases) and nasogastric intubation (21.7% of cases) which is consistent with two other studies from this research group (Curtis *et al.*, 2015a; Curtis *et al.*, 2015b). The first of these studies used a prospective study design to evaluate the diagnostic tests used in the primary assessment of colic (Curtis *et al.*, 2015a), whilst the other investigated veterinary perception and use of diagnostic tests in colic cases (Curtis *et al.*, 2015b). It can be inferred that rectal examination and nasogastric intubation are likely

the most commonly used tests in cases of colic, given that each of the studies had a different study design and therefore different limitations. The factors that influenced the decision making of whether to undertake a diagnostic test or not are unknown, and it was beyond the scope of the study to investigate these. Some possible reasons for not performing certain diagnostic tests may be that it was not considered at the first examination, was not required for diagnosis or it was not possible due to the demeanour of the horse or the lack of facilities available at the point of care (Fehr, 2007a; Southwood and Fehr, 2012; Curtis *et al.*, 2015b). Furthermore, injury to equine vets in particular has been an area of increased investigation in recent years, and perhaps equine veterinary surgeons are less inclined to put themselves at risk to perform diagnostic tests when the animal or environment are not suitable (Reijula *et al.*, 2003; Everitt, 2011; BEVA, 2014). Finally, it is important to consider that 11.4% of animals in the study population were given oral fluids as a treatment and therefore the nasogastric intubation may have been an adjunct to therapy rather than being purely diagnostic in its use (Hallowell, 2008). The most commonly administered drugs were NSAIDs, which were administered either alone (16.9% of cases), or in combination with other therapies (74.6% of cases). The types of NSAID given were consistent with other studies of colic in horses and were appropriate for management of the condition (Longo *et al.;* Archer, 2004; Keegan *et al.*, 2008; Sanchez and Robertson, 2014; Cook and Blikslager, 2015). Although the decisions behind the choice of NSAIDs used were unknown, these have been hypothesized in Chapter 3. Finally, the use of spasmolytic agents equines with colic may have been to facilitate examination (Mair and Edwards, 1998; Mair and Mellor, 2005) or as a therapy as they are licensed and indicated for use in colic with certain underlying causes (Boehringer Ingelheim Vetmedica, 2017). The efficacy of different treatments is unknown and cannot be surmised, especially given the multiplicity and diversity of underlying causes of abdominal pain in horses. Finally, the interpretation in this study was limited to the descriptions that were recorded about the approaches used and therefore there was no interpretation applied of how different approaches to diagnostics and treatment affected the outcome of individual cases.

The overall fatality rate of horses seen 'out of hours' with abdominal pain in this study was 18.6%. Euthanasia was performed in 17.9% of the equids affected by colic in the study population: 15.0% without receiving intensive medical treatment or surgical intervention, 1.1% after failure of medical treatment, and 1.8% after failure of surgery or associated complications. Fatality rates in other colic studies of general horse populations have varied, although they were reported to be lower (between 6 and 11%) in more historic studies (Tinker *et al.*, 1997a; Hillyer *et al.*, 2001; Traub-Dargatz *et al.*, 2001). The current study however had a similar fatality rate to the study of first opinion colic cases by Curtis *et al.* (2015a) where there were 16.1% of colic cases resulting in death or euthanasia (either before or after referral). It is unknown why the fatality rate in the current study and the study by (Curtis *et al.*, 2015b) were higher than those that were previously reported. It could be due to the differences between referral and primary care populations of horses with colic, whilst an additional hypothesis may be that it is due to changes in the decision making in equine colic that have occurred over time. Decision making is multifactorial and there are many aspects to consider including the horse's signalment, clinical status and its prognosis, the owner's personal and financial position and possibly the insurance status (Archer, 2004; Egenvall *et al.*, 2008; Scantlebury *et al.*, 2014). Given the current financial climate, it is possible that owners are waiting to observe their horses, and are only seeking veterinary assistance for more serious clinical presentations. Also, study design may have an important influence since studies that investigate veterinary assessment exclude any cases that do not see a veterinary surgeon (Tinker *et al.*, 1997a). Although the underlying reason for the discrepancy in fatality rate with other studies cannot be determined, it is certainly accurate in the current study due to the data collection method used. The number of critical cases of colic was higher than the fatality rate (23.9% of study population) because of successful medical and surgical treatment of underlying conditions. The success rate of horses that underwent surgery and survived to discharge was 53.7% (n=22/41), which is slightly lower, albeit similar to what has been reported in other studies (Proudman *et al.*, 2002b; Proudman *et al.*, 2002a; Archer *et al.;* Mair and Smith, 2005; Southwood *et al.*, 2010; Archer *et al.*, 2011). It is important to note that if there had been more

unsuccessful surgeries or intensive medical treatments, the fatality rate would have been higher. Colic remains a common and important condition in the horse, particularly as it is a frequent cause of mortality. The work within this study highlights the importance of primary assessment of colic where the majority of critical cases do not reach referral hospitals which is where previous research had been focussed. Furthermore, the majority of critical cases of colic do not survive, and many of these are euthanased prior to referral. The population of horses that die, although a small number, represent a significant welfare concern, particularly as the reason for death is often not clear or recorded.

5.5.1 Recommendations for future work

1. The work within this thesis combined with other research has demonstrated the importance of colic in the UK equid population from both veterinary and owner perspectives. Clinical record keeping is variable and therefore it is difficult to analyse cases of colic retrospectively in this manner, whilst there are also challenges attributed to prospective collection of colic case data. The development of a collaborative database for all colic cases seen within the UK would be invaluable to consolidate and generate evidence. A similar suggestion was made by (Mair and White, 2008; Mair, 2009)for colic surgeries, however given that there is a lack of research based upon primary care practice, and colic surgeries represent a small percentage of the horses who have colic, inclusion of all colic cases would be beneficial. Additionally, creation of a colic database would enable analysis and interpretation of the actual epidemiological status of colic in the UK equid population.
2. Decision making in equine colic is of paramount importance, particularly as decisions are often made under pressure, especially in critical cases. There are features present at the primary clinical assessment that can act as ‘red flags’ to help identify critical cases.

a. Further investigation is needed into the rapid early decision making of owners and veterinary surgeons combined, and the factors that influence the early decisions in cases of colic.
b. Most of the critical cases of colic in this study were euthanased, however reasons for euthanasia (especially in non-referred animals) were not clear. Further study of the euthanased population is warranted to determine the reasons that underpin these decisions in critical cases of colic.

3. Development of evidence-based guidance and support is needed to assist equine practitioners when differentiating critical and non-critical cases. It can be especially challenging to make evidence-based decisions at the point of care, an issue that is confounded by a large body of evidence of variable quality and applicability. Consolidation of this evidence into a condensed, useable and accessible format for both owners and veterinary surgeons that would help bridge the gap between research and first opinion equine practice.

5.6 Conclusion

This is the first study to investigate cases of abdominal pain assessed at primary presentation outside of normal working hours in primary care equine practice. Colic remains an important condition in the first opinion setting, where the majority of cases are treated without a definitive diagnosis, and many animals require referral for surgery or intensive medical treatment. Although there is much research in the field of equine colic, the vast majority is based upon referral practice data and is not directly transferrable to the general horse population, where the majority of animals with colic are treated. Further research is needed to enable a better understanding of the epidemiology of colic in the general equine population in the United Kingdom. This study highlights colic as a common and important condition in equids, where there is scope to impact and improve the welfare and outcomes of these animals through development and dissemination of evidence-based recommendations.

Chapter 6 Questionnaire-based study of equine owners' knowledge and approaches to abdominal pain (colic) in horses

6.1 Introduction

Horse owners are essential in the recognition of colic, as they are those who are likely to identify the first signs. Therefore, to improve patient outcomes, early identification of clinical signs and initiation of veterinary intervention is necessary to improve prognosis and reduce mortality rates, particularly in critical cases (Fischer, 1997; Proudman *et al.*, 2002a; Scantlebury *et al.*, 2014). Recognition of colic in equids can be challenging, especially as there are many different presentations and a plethora of clinical signs that may be exhibited by individual animals or in different circumstances (Scantlebury *et al.*, 2014). Some clinical signs exhibited by animals can be very discreet (Dabareiner and White, 1995), exacerbating the difficulty in identifying an animal with colic, a complicating factor when rapid intervention is so vital in certain cases. The role of the horse owner in ensuring rapid and appropriate care should not be underestimated. Therefore, it is important that owners are aware of all of the clinical presentations and seek appropriate intervention as soon as possible to enable the best possible outcome for critical cases. Horse owners are the gatekeepers of equine care in a similar way to the parents of young children (Shaw *et al.*, 2004); they are responsible for recognising signs in their animals and seeking the relevant treatments and advice accordingly. Delays in recognising a problem can lead to late diagnosis and treatment, and as previously mentioned, this can affect prognosis and outcome for critical cases. There may be many reasons that response to a problem is delayed, and lack of understanding or knowledge may be a key factor (Hodgson *et al.*, 2007; Fogle *et al.*, 2008; Lecouturier *et al.*, 2010; Teuschl and Brainin, 2010). Rapid, informed decision making throughout the whole process is key to improving outcomes for patients suffering with abdominal pain.

In human medicine, many public health campaigns are targeted at all stakeholders involved with a disease. The reason for this is to inform everyone who may be part of the process to ensure they are all aware of the symptoms for example, the “FAST” stroke campaign is targeted not only at doctors, but also the general public (Hodgson *et al.*, 2007; Fogle *et al.*, 2008; Fogle *et al.*, 2010; Lecouturier *et al.*, 2010; Dombrowski *et al.*, 2012). The aim being to reach people who will go on to have a stroke and their family members to ensure the condition is recognised as quickly as possible so that appropriate care and treatment can be sought (Hodgson *et al.*, 2007; Lecouturier *et al.*, 2010; Dombrowski *et al.*, 2012). There is very little literature about incorporating multiple stakeholders into evidence-based healthcare advice in veterinary medicine, and once published, it is often only targeted at veterinary surgeons (CEVM, 2017b; CEVM, 2017a; RCVS, 2017a). It is the author’s opinion that it is not possible to improve the health and welfare of equids through interventions without addressing all stakeholders in the process. Scantlebury *et al.* (2014) identified the importance of horse owner views and knowledge from a study of owners with colic experience in the north west of England. Although there was potential bias in the study population (participants were regional, and were previously used by the research group, or had colic experience), the findings of the study remain of interest due to the robust study design. Using a mixed methods approach, a key result was how the individual views and knowledge of the horse owner had a direct impact on the interval between colic recognition and veterinary assessment. Despite the importance and frequency of colic in the horse, Scantlebury *et al.* (2014) is the only published study investigating colic from the owners’ perspective. The baseline knowledge of colic in the general horse owner population requires further investigation, including the motivations for seeking veterinary assistance and responses in different scenarios. This information is essential to identify gaps in current knowledge and decision-making, and inform the development of educational material which can improve recognition and reduce the interval from onset of signs to veterinary assessment.

6.2 Study aim and objectives

The aim of this study was to explore horse owners' knowledge, understanding and experience of colic, and describe factors that affect horse owners' approach to a horse with clinical signs of abdominal pain.

The objectives of the study were:

- To assess horse owners' knowledge of normal parameters in horses, and evaluate how horse owners would respond to variations in clinical and behavioural parameters in their horse.
- To determine whether horse owners understood the term colic by providing an accurate definition.
- To investigate how horse owners would approach a horse with suspected colic, and consider their decision making when provided with different scenarios.
- To determine horse owners' personal experiences and knowledge of colic, and highlight what knowledge or information is lacking.

6.3 Materials and Methods

6.3.1 Sample population

All horse owners were identified as the target population for the study. The sampling frame encompassed all horse owners, with different lengths of horse ownership and levels of experience. ‘Non- traditional’ owners such as those who had a horse on loan or didn’t have a horse at the time of the study were also included. In contrast to the previous questionnaire of common conditions (Chapter 4), it was desirable to acquire as many participants as possible, with differing demographics and a variety of experience. The questionnaire was distributed online, with convenience sampling through equine social media sites. Participants were informed that a postal version of the questionnaire was available upon request by using the contact details provided.

6.3.2 Development of the questionnaire

The questionnaire included an introductory paragraph and compulsory informed consent section (Appendix H) which was constructed using considerations contained within the Data Protection Act (1998), BSA (2002) and BERA (2004).

The framework of the questionnaire was five sections consisting of:

1. Owners’ understanding and recognition of the ‘normal’ horse
2. Owners’ understanding and recognition of colic in the horse
3. Personal experiences of colic
4. Owner rating of their confidence in recognising colic using different case scenarios
5. Owners’ demographic information and their opinion of their working relationship with their veterinary surgeons

Once the questionnaire was developed, feedback was sought from the same researchers as described in Chapter 4. The questionnaire consisted of open and closed questions, using different formats as described in Table 10. A

short introductory paragraph was included at the start of each new section, highlighting the need for participants to answer the questions as honestly as possible, without using resources to assist them. Free text boxes were provided at the end of each section for any further comments, and there was a feedback section at the end of the questionnaire. Participants had the option of providing their email address if they wanted further correspondence about the study and other future work. The questionnaire was initially written in Microsoft Word (2013), and then transferred into the cloud-based internet survey tool SurveyMonkey, California.

Table 10: Question topic and question type developed for the first pilot of an online survey for horse owners about recognising colic in the horse.

Section			Question	Type of question
A	The normal horse	1	What do you think is the normal heart rate range for an average horse at rest? - Definitions provided for range, average horse and heart rate at rest.	Open question. (free text response)
		2	What do you think is the normal respiration (breathing) rate for an average horse at rest? - Definitions provided for range, average horse and respiration rate at rest.	Open question. (free text response)
		3	What do you think is the normal temperature range for an average horse at rest? - Definitions provided for range, average horse and heart rate at rest.	Open question. (free text response)
		4	What do you think are normal gut sounds for an average horse at rest? - Definitions provided for gut sounds and average horse.	Closed question.
		5	Which of the following do you feel confident that you can measure accurately?	Closed question.
		6	How many droppings would you expect an average horse to pass in a 24 hour period? - Definition provided for average horse.	Open question. (free text response)
		7	How would you react to the following changes to a horse's droppings?	Closed question with randomised answers. (multiple response options)

		8	Please indicate for each of these changes whether you would consider them abnormal and what action you would take. Please assume for each 'change' that this is the only one the horse is showing.	Closed question with randomised answers. (multiple response options)
B	Colic in the horse	1	What do you think the term colic means?	Open question. (free text response)
		2	What would you check on your horse if you thought it had colic? Specific answers such as capillary refill time and digital pulses were not defined as there isn't a lay term for these. It was assumed that participants who checked these would know the correct terminology.	Closed question with randomised answers. (multiple response options)
		3	How confident would you be that you could recognise colic in a horse?	Closed question.
		4	If you were not in an emergency situation and wanted to find out more about colic, where would you go for information?	Closed question.
		5	It would be very helpful of you could give us more specific details of where you would go for information (e.g. which people, magazines, forums etc.).	Open question. (free text response)
		6	Thinking about your current knowledge of colic in the horse, where did this information/ knowledge come from?	Closed question.
		7	It would be very helpful of you could give us more specific details of where you would go for information (e.g. which people, magazines, forums etc.).	Open question. (free text response)
		8	We are particularly interested in where the gaps are in the information/ education that is currently available on equine colic for horse owners. Please could you tell	Open question. (free text response)

			us which areas of equine colic you would like more information on? And how would you like this information made available to you?	
C	Personal experiences	1	Thinking about colic in the horse, how many different episodes have you personally seen?	Closed question.
		2	If you have seen horses with colic, please can you give us more details about any personal experiences that you have had with horse that you own or look after.	Closed question.
		3	How often do you read/ research about colic (including reading books/ magazines, looking on the internet, talking to people etc.)?	Closed question.
D	Diagnosis scenarios	1 To 6	Case scenarios based around the following conditions: 1. Rhabdomyolysis 2. Medically responsive colic of unknown cause 3. Pelvic flexure impaction (PFI) 4. A lesion of the gastrointestinal tract requiring surgery 5. Laminitis 6. Grass sickness Participants were not told the theme, but were required to document how likely it was that the horse in each scenario had colic.	Closed question.
E	Demographic information	1	What age category do you belong to?	Closed question.
		2	Are you Male/ Female	Closed question.
		3	How long have you had horses for (owned/loaned/ cared for)?	Closed question.
		4	How many horses do you have (own/ loan/ care for) at the moment?	Closed question.
		5	What is the MAIN activity that you undertake with your horse(s)?	Closed question.

		6	What level do you compete you horse at?	Closed question.
		7	What percentage of time is spent with your horse(s)?	Closed question.
		8	What is the typical management of your horse(s)?	Closed question.
		9	Do you have any formal equine qualifications?	Closed question.
		10	Do you think you know the right time to call a vet out to your horse?	Closed question.
		11	How would you describe your relationship with your vet practice?	Closed question with randomized answers. (multiple response options)

6.3.3 Pilot survey

The survey was piloted with three horse owners (not veterinary surgeons), four veterinary surgeons from the Centre for Evidence-based Veterinary Medicine (CEVM) and four practising equine primary care clinicians. The purpose of the pilot was to highlight any flaws in the wording of the questions or question types and evaluate the question interpretation. Prior to distribution in the public domain, amendments were made (Table 11). The finalised questionnaire (Appendix I) was approved by the Ethics Committee of the School of Veterinary Medicine and Science, University of Nottingham.

Table 11: Details of the amendments made after the first pilot of an online survey for horse owners about recognising colic in the horse, prior to distribution.

Section		**Question**	**Details of amendment**
The normal horse	6	How many droppings would you expect an average horse to pass in a 24 hour period?	• Definition of 'dropping' incorporated in question
	7	How would you react to the following changes to a horse's droppings?	• Question expanded for clarification

	8	Please indicate for each of these changes whether you would consider them abnormal, and what action you would take. Please assume for each 'change' that it is the only one the horse is showing.	• Question divided to make 2 smaller questions with the following headings:
			  ○ Behavioural changes
			  ○ Clinical changes
			• Answers altered for clarification

Colic in the horse	2	What would you check on your horse if you thought it had colic?	• Definitions and descriptions provided for some answer options for clarification
	3	How confident would you be that you could recognize colic in a horse?	• Answers altered so that a descriptor was used to indicate confidence level
Personal experiences	2	If you have seen horse with colic, please can you give us more details about any personal experiences that you have had with horses that you own or look after.	• Additional scenarios added to question

			• Amendment to overlapping answer category
	3	How often do you read/ research about colic (including reading books/ magazines, looking on the internet, talking to people etc.)?	• Answer categories changed
Demographics	3	How long have you had horse for (owned/ loaned/ cared for)?	• Answer categories changed due to overlapping categories
	4	How many horses do you have (own/ loan/ care for) at the moment	• Question type changed to an open question
	6	What level do you compete your horse at?	• Question wording altered to 'top' horse
	7	What percentage of your time is spent with your horse(s)?	• Question changed: "What BEST describes the time you spend with your horse(s)?" • Answer options changed to reflect question change
		Additional question: Where are you based?	• Open question
Feedback		N/A	• Feedback section changed so participants could indicate requirement for future contact without needing to re-enter an email address

6.3.4 Dissemination of the survey

The research group involved with colic research included two doctoral students and a team of three supervisors (with input from undergraduate students). This group was branded “The Nottingham Equine Colic Project”, a title that was used to develop a profile on social media and the internet. Individual accounts were created on social media platforms (Facebook and Twitter) to support the initial distribution of the questionnaire and to promote future outputs from the study and other research conducted by the research group (Figure 24, Figure 25). Links to the survey were posted on the social media platforms by the researcher on a daily basis during the first week of distribution, with weekly reminders for the subsequent nine weeks. Interim updates of other activities undertaken by the research group including conferences and television programmes were shared to raise the profile of the group, and therefore the questionnaire, across social media. In addition, the questionnaire was sent to The University of Nottingham media and relations office for distribution in May 2014. The time frame for data collection for the study was 16 weeks, ranging from May 2014 until September 2014. From 30th August 2014, reminders were disseminated across social media to inform people the survey would close on 3rd September 2014, and encourage further participation and distribution of the survey. The survey remained online for a week after the posted closing date to accommodate any late responses, with final closure on 10th September 2014.

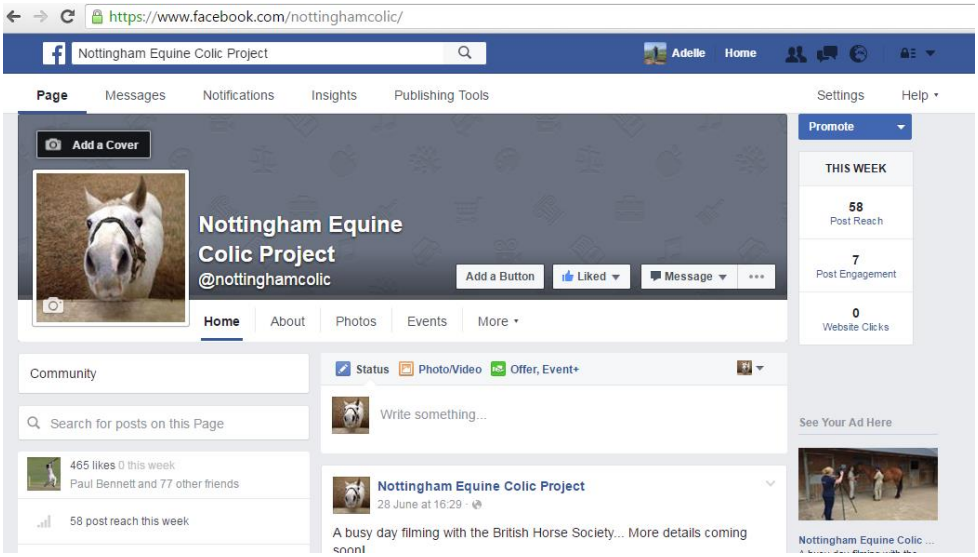


Figure 24: Screen shot of the Nottingham Equine Colic Project Facebook page.



Figure 25: Screen shot of the Nottingham Equine Colic Project Twitter page.

Previous research conducted by the research group included an investigation of the primary presentation of colic in horses (Curtis *et al.*, 2015a). There were one hundred and ninety six veterinary practices registered in the previous study who had consented to further contact from the project team. These were all emailed with details of the survey for horse owners to encourage their clients to participate. The Colic Survey website (UoN, 2017b) that was previously designed for the primary assessment of colic study was updated to

provide a central website for the whole research group with more detailed information about the aims of the collective research. Two hundred and fifty flyers (Figure 26) were printed and distributed at fifteen local show centres, pony club events and livery yards in the east midlands. The flyers included brief details of the study, the website address, and QR code linking directly to the questionnaire.



Figure 26: Copy of the promotional flyer used for the horse owner colic study and the Nottingham Equine Colic Project research group.

6.3.5 Data sorting

Responses were saved both to a computer hard drive and external storage at weekly intervals throughout the study period to ensure data were secured should an error occur with either the computer or survey. A password encrypted database of participants' contact details was updated weekly, whilst a copy of consent email (Appendix J) was distributed to all participants who provided an email address. A record of incorrect email addresses was kept in case of contact by participants. To ensure complete anonymity and privacy, email correspondence was sent using blind carbon copying, thus preventing exposure of participants to other correspondence addresses. Once the survey was closed, all data collected during the study period were exported into

Microsoft Excel (2013) spreadsheets and a statistical programme (SPSS Statistics Version 24, IBM Corporation, 2016) for data handling and analysis.

6.3.6 Data analysis and statistical testing

Quantitative data were subject to descriptive analysis for preliminary exploration of the data. This included calculation of the mean, median and range for continuous variables, and percentage frequencies and mode for categorical variables. Free text responses throughout the questionnaire were reviewed and categorised enabling ranking based upon the frequency of different themes. Statistical testing was conducted based upon trends in the data from descriptive statistical analysis and plausible interactions combined. A significant effect was considered to be $p< 0.05$. Descriptive analysis of data was performed using Microsoft Excel and statistical analysis was conducted using SPSS V24.0 (SPSS Statistics Version 24, IBM Corporation, 2016).

6.3.6.1 *The normal horse*

To enable comparisons between the values that horse owners considered to be normal with a published normal physiological range for heart rate, respiratory rate and temperature, the ranges needed to be established. Existing literature was consulted including five texts which were available in the University of Nottingham libraries (Colahan, 1999; Smith, 2008; Reece, 2009; Reed *et al.*, 2009; Sjaastad *et al.*, 2010). The widest range from these references was adopted and used in the analysis for each of the normal reference range questions. The normal reference ranges for the purposes of this study were defined as: heart rate between 28 and 44 beats per minute, respiratory rate between 8 and 16 breaths per minute and temperature between 36.5^{o}C and 39^{o}C. These ranges were then used to allow a comparison with the owner reported values. Plausible interactions that may affect knowledge of normal reference ranges were considered for statistical

testing. Chi squared statistical analysis compared whether knowledge of normal reference ranges was affected by:

- The experience of the horse owner, quantified by the length of horse ownership. Specifically whether they had kept horses for less than or more than five years.
- The age of the owner.
- Whether the owner held qualifications at college level (minimum) or not.
- The contact time owners spent with their horses, whether it was a daily occurrence or less frequently.

The second part of 'the normal horse' section considered how owners would respond to changes in their horse (behavioural, clinical and changes to droppings). Owners were provided with different response options including: not concerned, monitor or observe, look on the internet/other resource, call a friend/other person, call the vet, or wouldn't know how to interpret this sign. Responses were reviewed and percentage frequencies for each behavioural/clinical/dropping change were calculated. Following descriptive analysis, behavioural changes were subject to statistical testing to determine whether the owner factors (described previously for knowledge of normal reference ranges) affected the reaction of the horse owner if they were faced with the individual behavioural changes described within the question. In addition to the owner factors, reactions of horse owners were also tested against other plausible interactions including whether the owner had recent experience of a colic case, or if they had previous experience of a critical case of colic (where the animal either didn't survive or required significant medical or surgical intervention for recovery). Statistical testing was conducted using chi squared analysis.

6.3.6.2 *Colic in the horse*

Participants were asked to provide a definition of colic, however to determine whether they were accurate in their provided responses, colic needed to be pre-defined. Colic was defined as abdominal pain (Hillyer *et al.*, 2001), however during analysis it emerged that some owners provided a more detailed explanation. Therefore, the retrospective classification was abdominal pain, but where an explanation was provided, the response needed to demonstrate understanding of colic as a condition.

Participants were required to rate their confidence in recognising a case of colic based on a description. The descriptions used were:

- I would recognise every case in different horses with different presentations and severities
- I would recognise most cases unless it was a very odd presentation or an unfamiliar horse
- I could recognise it in some cases but not in all cases/ all severities
- I wouldn't recognise it unless very severe/ obvious
- I wouldn't recognise it at all

To determine plausible interactions that could have affected participants' confidence in recognising colic in horses, statistical analysis was performed using chi squared tests. The reported confidence of participants was tested against owner experience, age, qualifications and contact time (as described previously) and whether they had previous experience of a case of colic in the preceding year or had any experience of a critical case of colic.

Participants were asked about the types of colic they had experienced including quantification of the time frame when they last had each experience. The categories included:

- The horse recovered with no need for veterinary treatment
- The horse was treated by the vet on the yard and got better
- The horse had to be treated in hospital and got better

- The horse was treated by a vet on the yard/ at hospital but had further problems with colic
- The horse had surgery and got better
- The horse died
- The horse was treated (medically of surgically) and then died (without being euthanased/ put to sleep)
- The horse was euthanased (put to sleep) before treatment
- The horse was treated (medically or surgically) and then was euthanased (put to sleep)

The time frames provided included: No experience, experience within the preceding 6 months, experience within the preceding year, experience within the preceding 2 years, experience in the preceding three to five years, experience in the preceding six to ten years or experience more than ten years previously.

6.3.6.3 *Diagnosis scenarios*

The third section of the survey focused on participants' identification of colic in the horse based upon six different scenarios. Participants were provided with each of the scenarios and were asked how likely it was that the horse in the scenario had colic (abdominal pain). Participants were not asked to provide a diagnosis as the purpose was to assess their colic recognition. The scenarios represented six case types and were constructed so that they would be clearly recognisable to a newly qualified veterinary surgeon as colic or not upon careful reading. Three of these scenarios were conditions that can have some similarities in presenting clinical signs compared to colic, and therefore are commonly referred to as 'false' colic. For these scenarios the 'false' colic conditions were: laminitis (a condition affecting the feet of the horse); grass sickness (a neurological condition of the intestines); and rhabdomyolysis (a muscle condition). The 'true' colic scenarios in which a horse was displaying signs of abdominal pain comprised a lesion of the intestines that would require

surgery, a medically responsive intestinal problem of unknown cause, and pelvic flexure impaction of the large colon of the horse.

6.4 Results

There were 2,306 people who consented to participate in the survey. Seven hundred and forty two people didn't answer any questions within the survey and were therefore removed from the analysis. There were therefore 1,564 participants who gave responses, with 1,331 completing the survey in full (85% completion rate). The survey was identified by other organisations and was further distributed on social media (Facebook and Twitter) by BEVA, RCVS knowledge, the British Horse Society, World Horse Welfare, SEIB insurance, The Horse Trust, Equus magazine and Horse and Hound magazine. The latter also included an article on their website about the project. The demographics of the study will be presented first in the results to provide an overview of the study population. In the online questionnaire this was the final part completed by participants.

6.4.1 Demographic information and the owner-veterinarian relationship

The modal age of participants was between 40 to 44 years old (n=178/1,424) (Figure 27). The distribution of participants was between 9% and 15% for all age categories except those under 16 years old and over 60 years old (1% and 5% respectively). Study participants were 75% United Kingdom based (n=1,059/1,373), and 25% from the rest of the world (n=314/1,373). 98% of participants were female (n=1,356/1,387).

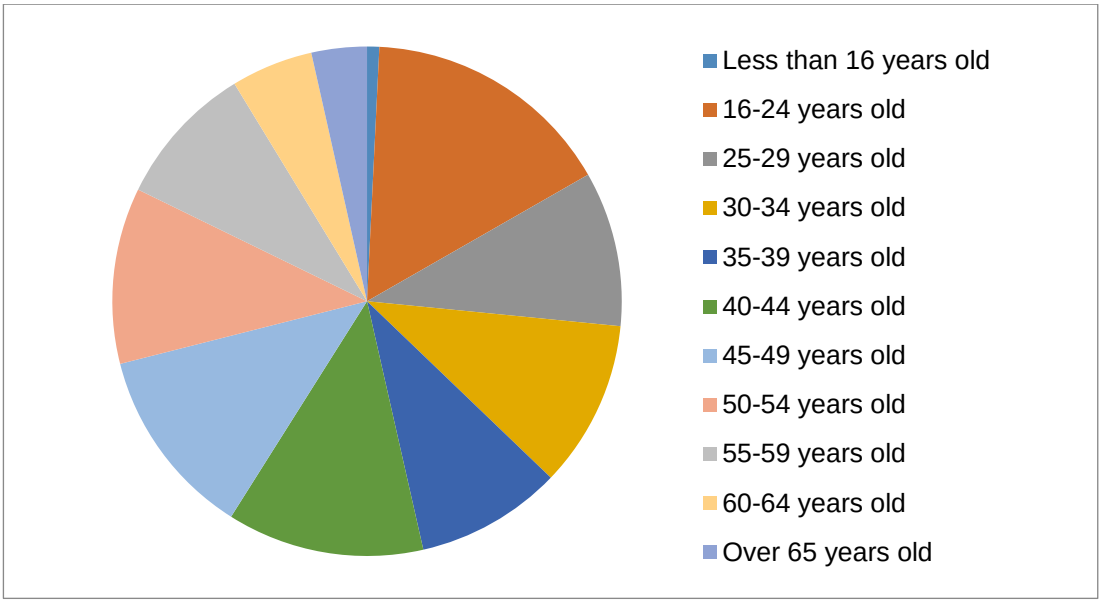


Figure 27: The distribution of ages of participants (n=1,424) in an online survey of horse owners' knowledge and understanding of colic.

50% of participants (n=710/1,359) had no formal equine qualifications, whilst the other 50% varied in the formal equine qualifications they held (Table 12).

Table 12: The highest level formal equine qualifications held by participants (n=1,359) in an online survey of horse owners' knowledge and understanding of colic.

Highest level qualification held by participants	Percentage of participants*	Number of participants
No formal qualifications	50%	710
Pony Club tests	10%	135
College course	9%	110
BHS qualifications	17%	232
Equine undergraduate degree	8%	99
Equine postgraduate qualifications	1%	16
Veterinary/ medical training	5%	57

*Expressed as a percentage of the number of participants that answered the question.

Over 90% of participants (n=1,284/1,420) had kept horses for more than 5 years. The modal categories were 11 to 20 years (28%, n=403/1,420) and 21

to 30 years (22%, n=313/1,420). The majority (77%) of participants (n=1,098/1,421) kept between 1 and 4 horses (Table 13). Horses (n=1,331) were used for 15 different activities, most commonly hacking or leisure riding (39%, n=549/1,331). The population of horse owners (n=1,356) mostly competed at local shows (35%, n=/1,356) or never attended competitions with their horses (33%, n=/1,356).

Table 13: The number of horses kept by participants (n=1,421) at the time of participating in an online survey of horse owners' knowledge and understanding of colic.

Number of horses kept	Percentage of participants*	Number of participants
No horses	2%	32
Between 1 and 4	77%	1,098
Between 5 and 9	11%	159
Over 10 horses	8%	131

*Expressed as a percentage of the number of participants that answered the question.

The amount of contact time participants (n=1,415) spent with their horses varied, with most attending their horse on a daily basis for up to 3 hours on weekdays and more at weekends (38%, n=538/1,415). The management of the horses kept by participants (n=1,350) was largely DIY livery (61%, n=858/1,350) followed by grass livery (16%, n=237/1,350), full livery (9%, n=126/1,350) and assisted DIY livery (8%, n=111/1,350) respectively. Few horses were kept on working livery (2%, n=33/1,350) or competition livery (2%, n=21/1,350), whilst 2% (n=21/1,350) of participants owned their own yard which was run as a business.

When asked to nominate their approach to calling a vet (n=1,380), the majority of participants either felt they generally called the vet at the right time (51%, n=705/1,380) or always called the vet when they were needed and knew when they were not needed (37%, n=510/1,380). In regard to the veterinary-client relationship, 72% (n=1,012/1,396) of participants felt they got on well with their vets and could ring them directly for advice. There were 120 free text

responses provided when asked for further comments on the demographics and owner-veterinary relationship section. Twelve themes were identified from the comments, personal experiences and positive owner-veterinary relationships were most commonly mentioned.

6.4.2 The normal horse

The first section of the survey evaluated participants' knowledge of the normal, healthy horse, addressing objectives 1 and 2 of the study. There were 1,540 individuals who responded to the question about normal heart or pulse rate ranges for the horse. The values provided for lowest normal heart rate and highest normal heart rate were combined for analysis. There were 28% (n=431/1,540) of participants that were unsure what the normal range was and therefore didn't provide a value. The normal reference range for heart or pulse rate (28-44 beats per minute) based on current textbook literature is depicted by the red highlighted area (
Figure 28). From the combined responses, 45% (n=693/1,540) of answers fell within the normal reference range, therefore 27% (n=416/1,540) of answers provided were outside of the range. Values provided ranged between 6 and 250 beats per minute.

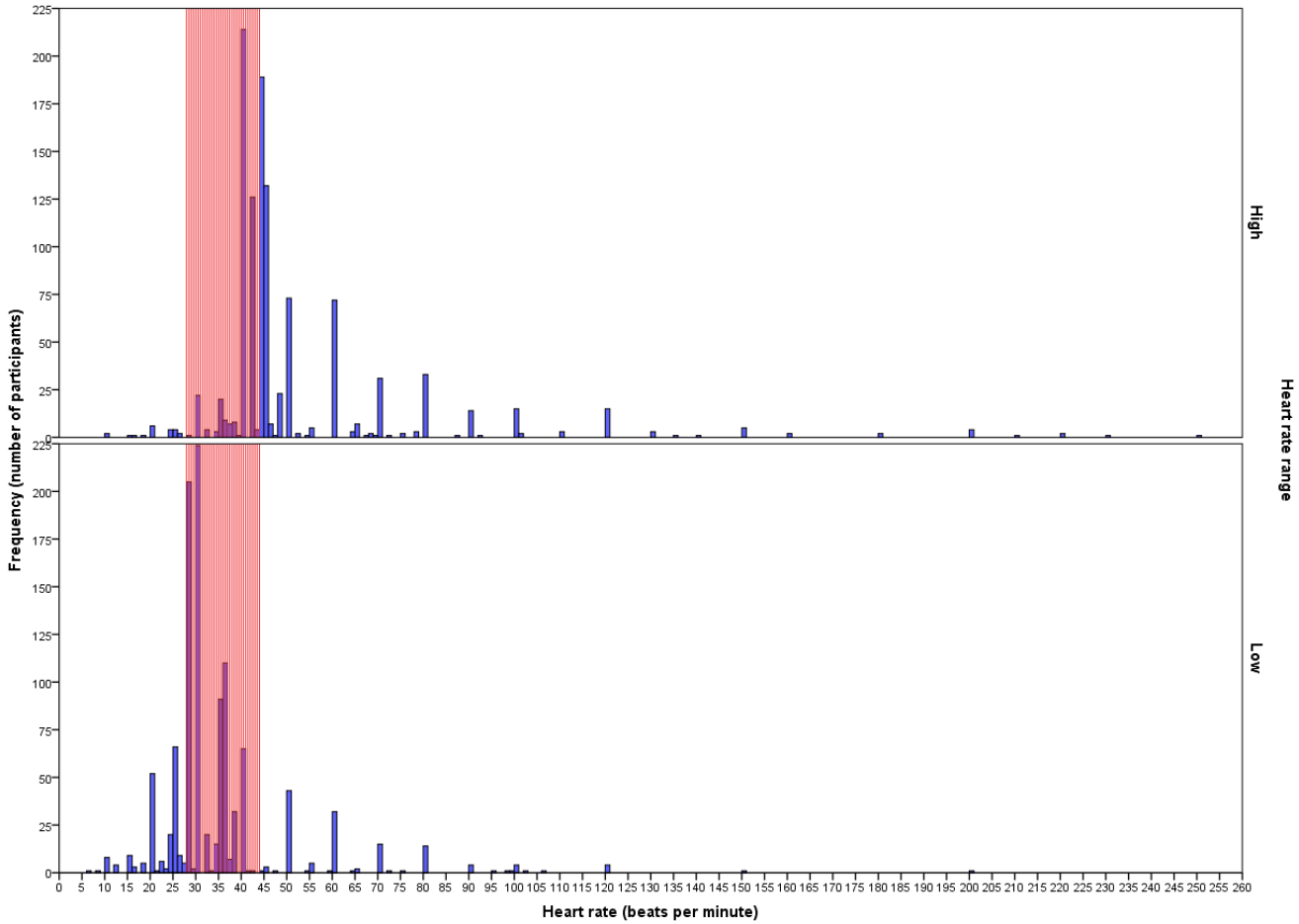


Figure 28: Responses of participants (n=1,540) when asked to provide the low and high values for the normal reference range for heart rate in horses in an online survey of horse owners' knowledge and understanding of colic. The values given by participants for the highest end of the range are shown in the top histogram, whilst the bottom histogram shows the values given for the lowest end of the range. The red highlighted area depicts the normal reference range (28-44 beats per minute).

The values provided for lowest and highest normal respiratory rate were combined for analysis. There were 30% of participants (n=462/1,541) who were unsure of the normal range and didn't provide an answer. The normal respiratory rate range based on current textbook literature was 8-16 breaths per minute, depicted by the red highlighted area on the graph (Figure 29). From the combined responses, 45% (n=694/1,541) of answers fell within the normal reference range, therefore 25% (n=385/1,541) of answers provided were outside of the range. Values provided ranged between 2 and 300 breaths per minute.

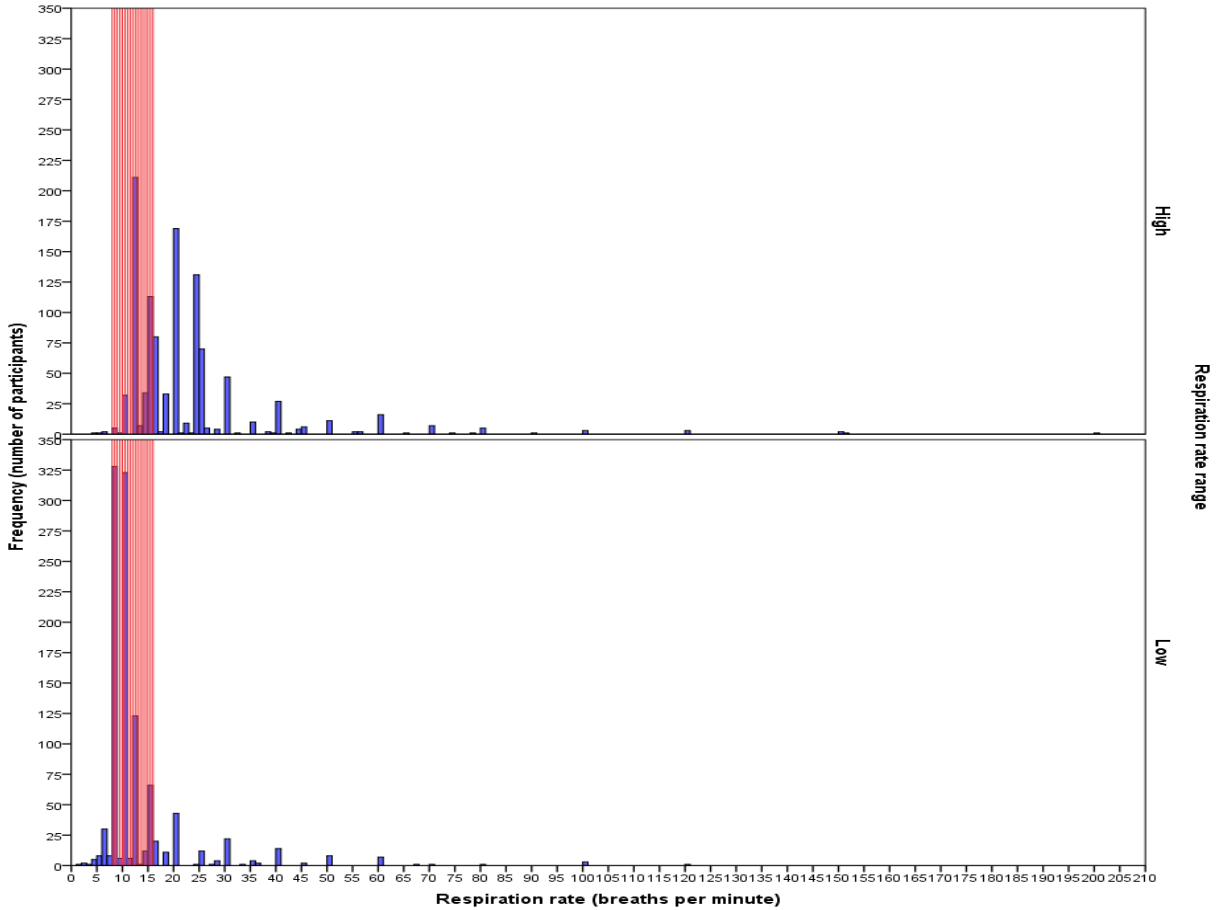


Figure 29: Responses of participants (n=1,541) when asked to provide the low and high values for the normal reference range for respiratory rate in horses in an online survey of horse owners' knowledge and understanding of colic. The values given by participants for the highest end of the range are shown in the top histogram, whilst the bottom histogram shows the values given for the lowest end of the range. The red highlighted area depicts the normal reference range (8-16 breaths per minute).

Participants were also asked to provide normal range values for body temperature. The number of participants unsure of the range, and therefore not providing a value was 21% (n=322/1,534). There were 67% (n=1,028/1,534) responses provided within the normal reference range, and 12% (n=184/1,534) were outside. Values provided ranged between 16^{o}C and 80^{o}C.

Chi squared analysis compared the relationship between the level of qualification held by participants with whether the values provided were within the normal range or not. There was a significant difference with knowledge of normal heart rate ($p<0.01$), respiratory rate ($p<0.01$) and temperature ($p<0.01$) when considering participants who held equine specific college qualifications as a minimum. Age, experience and contact time had no bearing on participants' knowledge of normal values ($p>0.05$).

Participants selected the normal health parameters they believed they could measure accurately in their horse from a list that was provided (Figure 30). The majority of participants believed they could accurately measure gum colour (80%, n=1,238/1,547), temperature (73%, n=1,133/1,547), gut sounds (65%, n=1,007/1,547), respiration rate (62%, n=966/1,547), skin tenting (54%, n=841/1,547) and heart or pulse rate (53%, n=823/1,547), 7% (n=106/1,547) of participants did not feel they could measure any of the given parameters accurately.

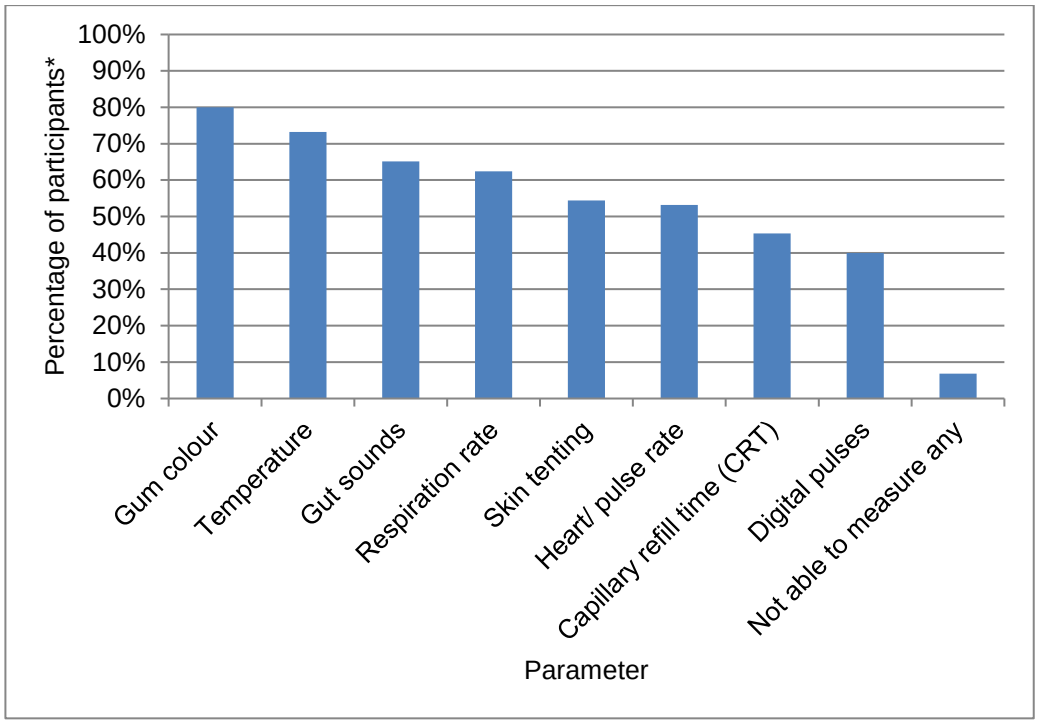


Figure 30: The parameters that participants (n=1,547) considered that they could accurately assess in their horse in an online survey of horse owners' knowledge and understanding of colic.
*Expressed as a percentage of the number of participants that answered the question.

Participants were then asked how they would respond in different circumstances that affected their horse. Firstly, they were asked what action they would take if they observed specific changes in their horse(s). The 'changes' were divided into three sections: changes to a horse's droppings, behavioural changes and clinical changes. Participants were asked what their responses would be to various changes to their horse's droppings would be if everything else remained 'normal'. The most frequently selected responses were that participants stated they would monitor or observe their horses for the following changes in droppings: colour (74.8%, n=1,163/1,554); consistency, if drier (85.1%, n=1,317/1,554) or wetter but with some form remaining (84.7%, n=1,314/1,554); or if the number of droppings had increased (74.9%, n=1,161/1,554) or decreased (84.6%, n=1,310/1,554). The majority of participants would call a vet if there was blood in the droppings

(85.0%, n=1,317/1,554) or if their horse(s) had very wet droppings which were watery, possibly projectile and had no form (51.6%, n=800/1,554).

Participants were then asked how they would respond to isolated behavioural changes in their horse (Table 14). The majority of participants said they would monitor or observe horses that were quiet or depressed (83%, n=1,280/1,552), fence or box walking (79%, n=1,220/1,552), weight shifting (70%, n=1,075/1,552) or pawing the ground (60%, n=914/1,552). Veterinary assistance would be sought by the majority of participants for horses that were rolling for an extended period or multiple times (90%, n=1,390/1,552), restlessly lying down and getting up (88%, n=1,358/1,552), lying down and getting up multiple times (65%, n=1,002/1,552) or kicking at the abdomen (64%, n=999/1,552). Chi squared analysis of the data found that the decision to monitor a horse or call a vet was significantly associated with at least one variable if a horse was displaying signs of weight shifting, pawing at the floor, rolling for more than 5 minutes or multiple times (4+) in 30 minutes, or lying down and getting up (2-3 times in 30 minutes). Tested variables included experience of colic in the previous year, experience of a critical case of colic, age of the owner, whether the owner held qualifications at college level or higher, experience of the owner based upon whether they had kept horses for a period of time greater than five years or whether they had daily contact with their horse.

There were some behavioural signs that had participants divided in their response indicating there was no single action that would be adopted by the majority. In horses that were flank watching 45% of owners would monitor the horse (n=689/1,552, whilst 50% (n=770/1,552) would call for veterinary assistance. Whereas, inappetant horses would reportedly be monitored by 51% of participants (n=789/1,552) whilst 42% would call a veterinary surgeon (n=648/1,552). Other behavioural signs did not stimulate participants to call a veterinary surgeon; 44% of participants (n=675/1,552) were not concerned about a horse that was lying down quietly whereas 51% (n=798/1,552) would monitor a horse in this situation. If a horse was rolling for a short period of time (less than 5 minutes), 31% (n=472/1,552) wouldn’t be concerned and 56% (n=857/1,552) would monitor the horse.

Table 14: Horse owner's opinions (n=1,552) of how they would react to specific, isolated changes in and behaviour in their horse in an online survey of horse owners' knowledge and understanding of colic.

Behavioural changes	Number of respondents	Monitor or observe horse*	Call a veterinary surgeon*	Alternative response*	Decision significantly associated with
Quiet/depressed	1,543	83% (n=1,280)	12% (n=178)	5% (n=85)	
Fence/Box walking	1,544	79% (n=1,220)	8% (n=127)	13% (n=197)	Age of the owner ($p<0.01$) or experience of a colic case in the previous year ($p<0.01$)
Weight shifting from one foot to another	1,546	70% (n=1,075)	16% (n=241)	24% (n=230)	
Pawing at floor (not in response to food or other stimulus)	1,538	59% (n=914)	31% (n=484)	10% (n=140)	Previous experience of a critical case ($p=0.025$)
Rolling > 5 minutes or multiple times (4+) in 30 minutes	1,552	6% (n=99)	90% (n=1,390)	4% (n=63)	If owner had qualifications of college level or higher ($p=0.048$)

Restlessly lying down and getting up (4+ times in 30 minute period)	1,548	9% (n=134)	88% (1,358)	3% (n=56)	
Lying down and getting up (2-3 times in 30 minutes)	1,546	29% (n=451)	65% (n=1,002)	6% (n=93)	Previous experience of a critical case (p=0.043)
Kicking at abdomen (no obvious external stimulus e.g. flies)	1,546	30% (n=467)	65% (n=999)	5% (n=80)	
Flank watching	1,547	45% (n=689)	50% (n=770)	5% (n=88)	
Inappetant	1,547	51% (n=789)	42% (n=648)	7% (n=110)	

*Expressed as a percentage of the number of respondents to each behavioural change.

Participants' reactions were divided between monitoring their horses and seeking veterinary advice when faced with a variety of clinical changes in their horses (Table 15). Clinical changes where there was a definitive response of calling a veterinary surgeon were straining to urinate or defecate (78%, n=1,203/1,550) and if the horse had a distended abdomen (64%, n=984/1,550).

Table 15: The nominated reactions of participants (n=1,550) to specific, isolated clinical changes if the horse was otherwise normal in their horse in an online survey of horse owners' knowledge and understanding of colic.

Clinical changes	Number of respondents	Monitor or observe horse*	Call veterinary surgeon*	Alternative response*
Diarrhoea	1,543	59% (n=911)	33% (n=515)	8% (n=117)
Weight loss	1,550	56% (n=863)	34% (n=534)	10% (n=153)
Unexpected sweating	1,548	48% (n=741)	41% (n=635)	11% (n=172)
Increase in respiration rate	1,541	53% (n=813)	37% (n=563)	10% (n=165)
Decrease in respiration rate	1,545	53% (n=812)	32% (n=488)	15% (n=245)
Increase in heart rate	1,542	49% (n=763)	37% (n=562)	14% (n=217)
Decrease in heart rate	1,540	49% (n=757)	32% (n=494)	19% (n=289)
Increase in body temperature	1,544	45% (n=698)	44% (n=682)	11% (n=164)
Decrease in body temperature	1,543	53% (n=815)	32% (n=494)	15% (n=234)
Straining to urinate/ defecate	1,545	15% (n=224)	78% (n=1,203)	7% (n=118)
Abdominal distension	1,545	26% (n=395)	64% (n=984)	10% (n=166)

*Expressed as a percentage of the number of respondents to each clinical change.

There were 518 free text responses provided when participants were asked for any further comments on the 'normal' horse section of the questionnaire. There were twenty themes identified. The most frequently mentioned were in

response to the changes from normal questions incorporated in the questionnaire. These included:

- participants monitoring animals for a period but if signs were prolonged or there was deterioration, they would call a veterinary surgeon
- participants using various lay treatments prior to calling a vet
- participants stating they would call a vet immediately if the signs were severe, or if there were a combination of signs
- Participants stating they would call a vet for advice over the phone

6.4.3 Colic in the horse

The second section of the survey focused on colic in the horse, specifically around participants' understanding of colic, and their personal experiences. The first question in this section explored owners' understanding of colic, 1,393 participants provided a free text response when asked for a definition or understanding of the term 'colic'. A total of 42 themes were identified from the responses. Pain attributed to a variety of sources was commonly mentioned, as was a problem associated with different abdominal organs. There were twenty different causes of colic mentioned within the comments, most regularly impaction, torsion, spasmodic and gas. The correct definition and explanation of colic was given by 20.4% (n=284/1,393) of participants.

When asked which parameters they would measure prior to contacting anyone else if they suspected colic in their horse(s), the majority of participants selected defecation (76.2%, n=1,131/1,486), gut sounds (75.4%, n=1,113/1,486), respiration rate (65.1%, n=967/1,486) and heart or pulse rate (53.6%, n=797/1,486). The most common additional free text responses were; checking behaviour or demeanour changes, checking if there had been a change in eating and drinking habits, and checking whether the horse was sweating. Of the participants, 18.0% (n=268/1,486) wouldn't check anything themselves prior to contacting a veterinary surgeon, and would call for veterinary assistance immediately upon suspecting colic in their horse(s).

To gauge confidence in recognising cases of colic in horses, participants were asked to select the description which they believed reflected their own to recognise different cases of colic. Participants were confident in their recognition with the majority (61%, n=916/1,490) reporting they would be able to recognise most cases of colic unless it was a very odd presentation or an unfamiliar horse. A further 29% (n=436/1,490) believed they would recognise some cases but wouldn't recognise all cases or varying severities. There were 7% (n=99/1,490) of participants that believed they could recognise every case of colic including colic in different horses and of differing severities. Some participants were less confident and stated they would only recognise very severe or obvious cases (2%, n=35/1,490) or not recognise any cases of colic (<1%, n=4/1,490). Participants' nominated confidence in their colic recognition from the descriptors provided was tested using chi squared analysis against their experience of colic and horse ownership. Degree of confidence recognising colic was significantly associated with the owners having previous experience of a critical case ($p<0.01$), experience of a case of colic in the previous year ($p<0.01$), length of horse ownership ($p<0.01$) and equine qualifications at college level or higher ($p<0.01$). There was no evidence of association between confidence in colic recognition and whether the owner had daily contact with their horse ($p=0.08$) or the age of the owner ($p=0.3$).

6.4.3.1 *Use of information and resources*

Participants were asked to select all sources of information that they would use if they wanted to find out more about how to recognise and deal with colic if they were not in an emergency situation. The majority of participants identified that they would ask veterinary surgeons (83%, n=1,233/1,486) and use the internet (73%, n=1,151/1,486). Other commonly identified resources included books (50%, n=740/1,486), yard owners or trainers (39%, n=583/1,486), friends and family (31%, n=455/1,486), and paraprofessionals (30%, n=449/1,486). The least frequently used resources were Pony Club information (6%, n=84/1,486), phone apps (6%, n=91/1,486) and posters (4%, n=53/1,486). Analysis of free text responses (n=979) detailing specific

resources identified one hundred and nineteen different answers. Specific magazines (21 titles) and the internet (11 websites) were most frequently mentioned. The most commonly identified magazines and websites were: Horse and Hound, and Your Horse magazines, and google and thehorse.com websites. Books (21 titles) and resources from veterinary practices or organisations (websites and fact sheets) were also commonly mentioned. Fifteen equine non-veterinary organisations or charities were also named, along with twenty different forums. The Horse and Hound forum was most commonly identified.

When asked how often they accessed information, the most frequently identified category was that participants read about or researched colic once every six months (32%, n=428/1,356). Common answers for 'other' responses (n=149) included reading about colic when coming across material on it, or if there had been a recent episode. The two sources of information nominated by the majority of participants as contributing to their knowledge (prior to answering the questionnaire) were personal experiences (86%, n=1,271/1,482) and conversing with veterinary surgeons (73%, n=1,088/1,482). The least frequently nominated resources were again posters (2%, n=26/1,482) and phone apps (<1%, n=10/1,482). Common answers for specified 'other' responses (n=188) included college or university courses, personal experiences and owner education programmes run by veterinary practices. Free text analysis detailing specific information sources (n=923) identified eighty two different categories. Personal experience was most frequently mentioned. Other common resources included equine focussed degrees or college courses, specific magazines (21 titles), resources from non-veterinary equine organisations or charities and owner education programmes and fact sheets from veterinary practices.

Participants were then asked to nominate what the knowledge gaps were in the general horse owner population, and what areas were lacking in information on equine colic (n=940 responses). Participants also were asked how they would like information delivered and disseminated. The analysis was divided into two headings: gaps in knowledge and dissemination of information. Twenty two themes were identified for gaps in knowledge, most

frequently around the presentation and recognition of colic, different causes of colic (Table 16). There were thirty four different dissemination methods identified by participants, predominantly via the internet or through leaflets and fact sheets.

Table 16: Areas where information is lacking on colic in the horse, identified by horse owners (n=940) in their horse in an online survey of horse owners' knowledge and understanding of colic.

Areas identified by participants where information is thought to be lacking on colic in the horse
Presentation/ recognition of colic
Different types/ causes of colic
What to do whilst a horse is colicking
Prevention of colic
Normal ranges and gut sounds
When to call a vet
Treatment of colic
Early or subtle symptoms of colic
All colic information
Information on surgery for colic

6.4.3.2 *Personal experiences of colic*

There was a wide distribution of owners' experience of colic in horses (Figure 31). A small proportion of participants had never seen an episode of colic (3.7%, n=54/1,464). The modal category for number of colic episodes experienced was 3 or 4 episodes (20.1%, n=294/1,464), whilst 8.3% (n=122/1,464) had experienced more than 30 separate episodes of colic.

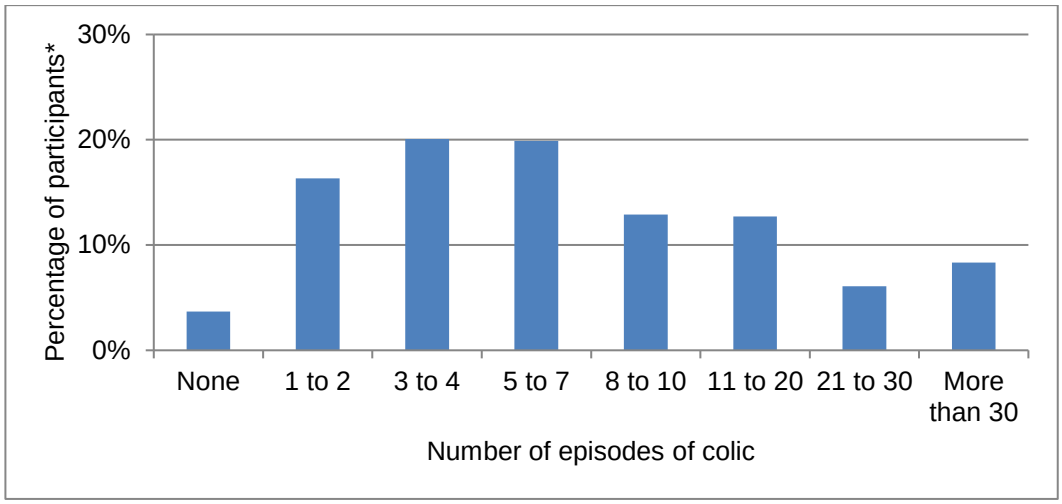


Figure 31: Number of episodes of colic personally experienced by participants (n=1,464) in an online survey of horse owners' knowledge and understanding of colic.
*Expressed as a percentage of the number of participants that answered the question.

Owners were asked for more details about the types of colic that they had experience of. This ranged from horses recovering without needing veterinary treatment, through to critical cases requiring surgery, euthanasia and death of horses (Figure 32). The most common scenarios experienced by participants were a horse being treated by a veterinary surgeon on a yard and recovering (91%, n=1,228/1,433), and a horse recovering from a bout of colic without needing veterinary treatment (74%, n=954/1,433). The majority of participants also had experience of a horse dying from colic (54%, n=648/1,433) and a horse requiring hospitalisation for treatment (51%, n=611/1,433). A horse being treated either medically or surgically before dying without being euthanased was experienced by 18.8% (n=218/1,433) of participants.

One hundred and sixty seven free text comments were provided when asked for further comments on the colic in the horse section of the questionnaire. There were eleven themes identified, predominantly details of participants personal experiences.

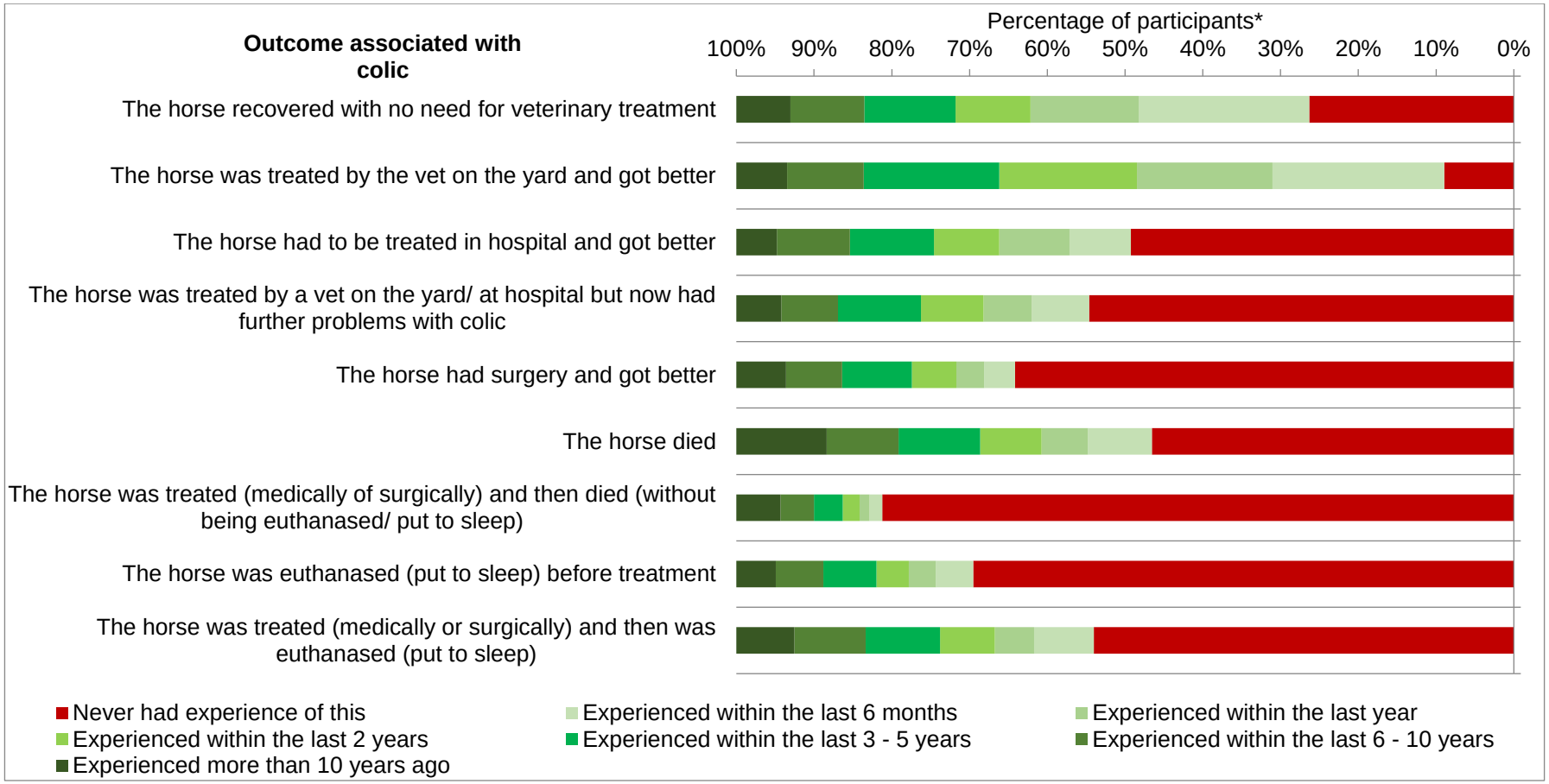


Figure 32: The specific colic experience of participants (n=1,433) categorised by the outcome associated with colic in an online survey of horse owners' knowledge and understanding of colic. The red area on the bar indicates no prior experience, whilst the green represents experience of the case outcome with lighter shades of green demonstrating more recent experience.

*Expressed as a percentage of the number of respondents for each case outcome.

6.4.3.3 *Diagnosis Scenarios*

The third section of the survey focused on participants' identification of colic in the horse when provided with the diagnosis scenarios for colic (a surgical colic scenario, a pelvic flexure impaction and a medically responsive colic) or conditions that may present similarly to colic (grass sickness, laminitis and rhabdomyolysis) (Figure 33). For the surgical colic scenario, 94% (n=1,340/1,433) of participants identified the horse as having colic. For the medical colic scenario, 68% (n=982/1,434) identified that the horse had colic, while 20% (n=284/1,434) were unable to distinguish whether the horse had colic or not and the remaining 12% (n=168/1,434) didn't think the horse had colic. For the colic caused by a pelvic flexure impaction, 44% (n=626/1,433) identified that the horse had colic, while 27% (n=390/1,433) were unable to distinguish whether the horse had colic or not and the remaining 29% (n=417/1,433) didn't think the horse had colic. Almost half (49%, n=700/1,433) of participants stated they were definitely sure that the horse in the surgical colic scenario had colic, whereas fewer participants were so definitive about the horses having colic in the medical scenario (10%, n=138/1,434) and the pelvic flexure impaction scenario (9%, n=131/1,433).

When owners were faced with the 'false colic' scenarios, there was more uncertainty over whether the horses had colic or not. For the laminitis scenario, 52% of participants (n=740/1,427) correctly identified the horse did not have colic, 34% (n=482/1,427) were unsure whether the horse had colic or not, and 14% (n=205/1,427) thought the horse had colic. For the grass sickness scenario, 47% of participants (n=667/1,432) identified the horse did not have colic, 32% (n=459/1,432) were unsure whether the horse had colic or not, and 21% (n=306/1,432) thought the horse had colic. For the rhabdomyolysis scenario, 69% of participants (n=993/1,432) identified the horse did not have colic, 25% (n=351/1,432) were unsure whether the horse had colic or not, and 6% (n=88/1,432) thought the horse had colic. Only a small number of participants stated they were definitely sure that the horses did not have colic in the scenarios for laminitis (6%, n=89/1,627), grass sickness (8%, n=114/1,432) and rhabdomyolysis (17%, n=237/1,432).

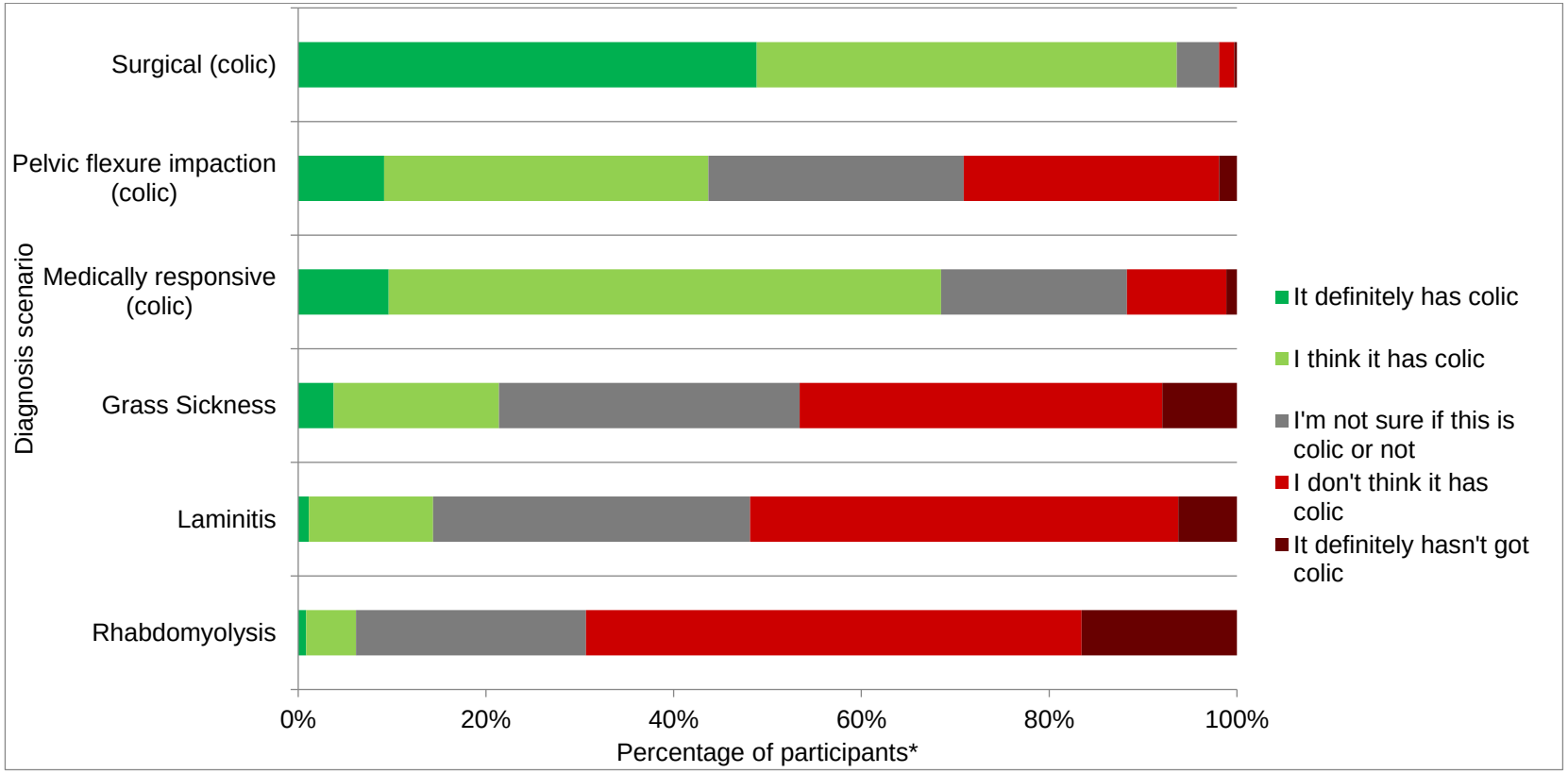


Figure 33: Participants' certainty that a horse had colic or not when provided with different scenarios in an online survey of horse owners' knowledge and understanding of colic (n=1,427 to 1,434). Participants were provided with the scenario and asked how likely they thought it was that the horse in the scenario had colic. The red area on the bar indicates it doesn't have colic, whilst the green represents a horse with colic. The darker shades demonstrate a greater certainty.

*Expressed as a percentage of the number of respondents for each case outcome.

6.5 Discussion

This is the first study to describe horse owners' knowledge, understanding and experience of colic. Answers were provided by 1,564 horse owners with 1,131 completing the survey in full. The results of the survey demonstrated that the majority of participants were unsure of the normal reference values for heart rate, respiratory rate and temperature. There was also obvious confusion over the definition of colic. Further investigation highlighted the knowledge gaps of horse owners in the survey, including the presentation/recognition of colic, different underlying causes of colic and many other aspects about colic in horses. Participants were confident in their ability to recognise colic, however this was incongruent when compared with their responses to diagnosis scenarios. When horse owners were provided with scenarios where a horse had either colic or a colic mimicking condition, they were less certain in their decision of whether the horse definitely had (or didn't have) colic.

The intention of the survey was to capture opinions from as many horse owners as possible with a variety of different demographics. It is not possible to provide an estimate of the proportion of the horse owner population, as the total population that was sampled from is unknown. The results of the survey are therefore not considered to be representative of the horse owner population, and are likely subject to a degree of bias, as convenience sampling was used. The survey was distributed via an online platform and was disseminated largely via social media. This may have resulted in a bias towards a computer literate population with access to the internet and social media channels in particular, although the age distribution of participants was reassuring that a broad range were included. The survey was also lengthy as it took approximately 20-30 minutes to complete, but the main drop out was immediately after the consent section (32%). It is possible that potential participants were deterred after seeing the length of the survey, or the considerations outlined in the consent section and thus didn't answer any of the questions. Overall the completion rate was very good, once people started the survey, the vast majority (85%) completed the survey, and the general feedback received about the survey was very positive. Colic was identifiable

as the focus of the survey from the title, however the study information dissemination material and questions were carefully worded to avoid biasing people in their responses. People with extensive previous experience, bad experiences, or particularly strong feelings about colic as a topic may have been more likely to self-select as they may have been more likely to find the survey through online searches for colic, or they may have been more motivated to complete the survey. This reasoning for bias has also been hypothesised within other horse owner studies (Ireland *et al.*, 2011a; Ireland *et al.*, 2012a; Ireland *et al.*, 2013; Scantlebury *et al.*, 2014). It is particularly relevant in the study by Scantlebury *et al.* (2014) as that study population was horse owners with experience of recurrent colic in their horses, thus meaning they will have vast experience and are more likely to be emotionally and financially invested in the condition. As colic is an emotive subject for many horse owners, some of the questions may have been subject to a degree of recall bias, with participants accounting for their own experiences when answering certain questions. The demographics of the study population were similar to other owner focused studies in the literature (Scantlebury *et al.*, 2011; Scantlebury *et al.*, 2014; Slater, 2014; Murray *et al.*, 2015) with an even spread of ages and a strong female bias to the study population. There was a slight skew towards owners who had owned horses for a number of years and spent time with their horses on a daily basis. This could mean participants had detailed knowledge of their own horse's condition and behaviour, and therefore may notice small changes in their horses. The majority of participants also stated that they would phone a veterinary surgeon directly for advice, suggesting the majority have a strong professional relationship with their veterinary surgeons. There was a range of qualifications held by participants, with half of participants having no formal equine qualifications. The study population held lower level qualifications in comparison to another study (Murray *et al.*, 2015), however this may be due to the fact that the participants in the study by Murray *et al.* (2015) had self-enrolled on an equine nutrition course, suggesting a more educated sampling frame.

Participants' knowledge of normal reference ranges for adult horses was poor compared to the data within reference textbooks. Between 20% and 30% of

participants stated that they didn't know what the normal reference ranges were, whilst over a quarter of participants provided a value outside of the normal range for either heart or respiratory rates. This means that between 40% and 50% of participants did not know what the normal physiological parameters for a horse were, identifying a significant knowledge gap that may have affected participants' interpretation of the case scenarios included in the questionnaire. This potentially means that participants' true interpretation of the scenarios as colic or not may actually be worse than reported. Participants holding formal equine qualifications were significantly associated with having an improved knowledge of normal parameters which is to be expected, particularly if knowledge of normal parameters was required to obtain the qualification. A lack of knowledge of normal parameters, particularly with respect to heart and respiratory rate can be translated as an inability to recognise abnormal values. This is concerning, particularly as a horse owners said they would assess these parameters if they were concerned about their horse. The interpretation of normal values and the action taken by owners are separate entities, and therefore this does not mean that horses requiring veterinary attention would not receive it. Rather a sound knowledge of normal ranges may assist horse owners if they were to measure certain parameters and highlight a need for veterinary assessment when values were abnormal. An increase in respiratory rate may be indicative of respiratory disease or pain, whilst an increased heart rate is a measure for pain, shock, and is an important predictor of surgical causes of abdominal pain. More horse owners were aware of the normal reference range when considering the temperature of the horse; a few reasons for this can be speculated. Firstly, the normal reference range for temperature was very variable in the literature, and the widest range was used for analysing the question which may have given a wider margin for error. In addition, participants, are likely to know the normal human temperature range which would have been within the reference range used in the analysis. Also, it may be more commonplace for a horse owner to take a horses' temperature as thermometers are readily available. Although this would pose a question why knowledge of respiratory values was poor when no equipment is required to take a respiratory rate. There are no comparable studies available in the current equine literature as this was the

first study to specifically quantify horse owner knowledge of normal ranges. It could be argued that a knowledge of normal parameters is necessary to meet the requirements of the Animal Welfare Act (2006). This is of particular importance when considering whether a failure to act is responsible for unnecessary suffering, and in the context of the question, whether the responsible person should have a sound knowledge of normal parameters to prevent unnecessary suffering. It is the legal responsibility of the pet owner to ensure the needs for the wellbeing of the animal are met, including keeping the animal protected from pain, injury, suffering and disease (Animal Welfare Act, 2006). Interestingly, the latest Pet Animal Welfare (PAW) report (PDSA, 2017) found that only 39% of owners are familiar with the Animal Welfare Act. Although 78% felt informed of the five welfare needs of pets contained within the Animal Welfare Act (2006), this was a self-evaluation (PDSA, 2017). Ultimately, recognition of disease is important within any animal owner population, and it is not unreasonable that horse owners should be able to identify an elevated respiratory rate or temperature. Furthermore, identification of abnormalities in behaviour or clinical parameters should prompt veterinary assessment. Barriers to pet owners seeking veterinary advice or examination of their animals is an area that warrants further investigation.

Participants reported a surprisingly high confidence in their ability to assess a wide range of parameters on their horses. Regardless of actual ability, it is questionable how useful being able to accurately assess a respiratory rate is, without knowing whether it is elevated or not. It is also quite disconcerting if owners see themselves as confident identifying and measuring things, but they are not actually capable of doing so. Furthermore, the results obtained for the parameters they would check on their horse if they suspected colic were incongruent when compared with their self-declared ability. For example, more participants said they would check the gut sounds of a horse that they believed to have colic (75%) compared to the number who said that they could accurately assess gut sounds (65%). It is possible there was a skew in the results with participants reporting what they thought they should check, rather than what they would actually do. It is also not possible to infer that the results would be the same in a “real-life” situation as what owners said they would

check in a colicking horse may be different to what they would actually do when presented with the genuine scenario. An important finding of this study is that horse owners know or believe they know what they could check, however they are not able to accurately assess parameters themselves, highlighting a significant training need. Owner assessment and reporting of disease has been found to be unreliable previously, with owners underreporting disease in the same horses that were subsequently assessed by a veterinary surgeon (Ireland *et al.*, 2012a). A great concern is whether horse owners are delaying veterinary attendance, particularly in horses with a surgical underlying cause of colic, especially as only a small percentage of respondents would seek immediate veterinary assistance. Delaying veterinary assessment may be due to lay treatments, other interventions or even checking parameters (Scantlebury *et al.*, 2014) which could potentially affect the prognosis as early intervention is of paramount importance in surgical causes of colic (Proudman *et al.*, 2002a). There are many studies investigating colic in horses; however, these are mainly focused on the veterinary approach to colic, including risk factors (Reeves *et al.*, 1996; Tinker *et al.*, 1997b; Cohen *et al.*, 1999; Kaiser *et al.*, 2000; Traub-Dargatz *et al.*, 2001; Goncalves *et al.*, 2002; Hillyer *et al.*, 2002; Mehdi and Mohammad, 2006; Archer *et al.*, 2008; White, 2009; Scantlebury *et al.*, 2011; Curtis *et al.*, 2014), diagnosis (Datt and Usenik, 1975; Delgado *et al.*, 2009; Kaya and Iben, 2009; Arguelles *et al.*, 2010; Forbes *et al.*, 2011; Yamout *et al.*, 2011), treatment (Mair and Edwards, 1998; Boom and Velden, 2001; Archer, 2004; Johnson and Keller, 2005; Mair and Smith, 2005; Fehr, 2007b; Archer, 2009; Southwood *et al.*, 2010; Freeman and Grosche, 2012) and prognosis of different causes of colic (Archer *et al.;* Proudman *et al.*, 2005a; Proudman *et al.*, 2005b; Suthers *et al.*, 2013), often based on a referral population (Proudman *et al.*, 2001; Mair and Smith, 2005; Southwood *et al.*, 2010; Archer *et al.*, 2011). There are two published studies focused on the owners' perspective. The first of these concentrated on stereotypies and owner perception of behavioural traits as risk factors for colic, rather than owner understanding and decision making in colic (Malamed *et al.*, 2010). The second of the studies comprised an in depth investigation into horse owner decision making in the management of colic, using a mixed methods approach

(Scantlebury *et al.*, 2014). The main objective of the study by Scantlebury *et al.* (2014) was to characterise horse owner decision making and the contributory factors. Other elements of colic that were addressed were the observed behaviours that were attributed to colic, and signs that warranted veterinary attention. The current study had a complimentary yet different objective: to assess horse owners' knowledge of colic, and identify how owner's opinion of their knowledge compared to published information and decision-making in case scenarios. Evaluating horse owners' confidence in recognising colic has not previously been quantified, whilst the use of scenarios to assess horse owners' recognition of disease is a novel method of evaluating the difference between actual and nominated confidence. The responses participants provided when faced with the diagnosis scenarios were particularly interesting when compared with their declared confidence in recognition of colic. Participants were much better at recognising a surgical lesion causing severe colic than the pelvic flexure impaction or medically responsive milder colic. This conflicts with their declared confidence in recognising colic, suggesting that participants may be less accurate at recognising a horse with colic than they believe. This could be because determining whether a horse has colic or not from a scenario requires assimilation of clinical information and the ability to understand the manifestations of abdominal pain. The free text responses may provide some reasoning for the discrepancy between self-reported confidence recognising colic and interpretation of the scenarios. Many horse owners believed they would be surer of the diagnosis scenarios if they had been provided with a video of the animal, or if the conditions were present in 'real life' animals that were familiar to them. There was greater uncertainty with the colic mimicking scenarios, with a greater proportion of the study population unsure whether the horse was colicking. For the grass sickness scenario in particular, opinion was divided between whether participants thought the horse had colic or did not have colic. Grass sickness causes dysmotility, often associated with small intestinal distension and impactions in the acute phase, therefore producing colic signs associated with these gastrointestinal problems. A reassuring outcome from the free text was the suggestion for veterinary attention in all of the scenarios as whether the horse had colic or not, all of the conditions

presented needed veterinary assessment and treatment. This study has highlighted significant variations in horse owners' approach and knowledge of colic cases, and in their ability to assess abnormalities in their horses. These findings highlight key areas for further education and guidance, particularly recognition of colic and the importance of early veterinary intervention.

In order to further understand horse owner decision making, participants indicated how they would respond to certain behavioural and clinical abnormalities in their animals. This section was developed based on findings from the Scantlebury *et al.* (2014) study, in an effort to further develop the evidence on horse owner decision making. Monitoring the horse, or seeking veterinary assistance were most common actions taken by owner, which is unsurprising and consistent with the findings of a previous, qualitative study of horse owner decision making in colic (Scantlebury *et al.*, 2014). A limitation of the current study was that no option was provided for lay treatment as a response; this was a further category that had been identified by the qualitative methods used by Scantlebury *et al.* (2014). Additionally, many participants quantified the length of monitoring in the free text, with frequent comments that this would be followed by a veterinary assessment. The lengths of time spent monitoring the horse differed between participants, another finding consistent with Scantlebury *et al.* (2014). An in depth qualitative study using interviews or focus groups would be valuable in order to investigate the monitoring and reactive behaviours of horse owners further. A potential problem with these questions was that participants may have selected what they believed they should do, rather than what they would actually do if presented with the situation. The question did capture what signs concerned horse owners and would prompt them to consider contacting a veterinarian so has highlighted some of the triggers. When asked about clinical changes, it is perhaps reassuring that participants were more divided in their decisions between monitoring and calling a veterinarian, since it is not under the remit of the horse owner to interpret such changes. This was emphasized by the lack of knowledge of the horse owner population completing the survey; many horse owners were not able to give a normal heart rate, therefore would not know whether it was increased or not, and

therefore their reactions to clinical changes are less valid than for the behavioural and dropping changes. There were consistencies in the results of the study with those of Scantlebury *et al.* (2014) when considering observations that would prompt veterinary assistance. The majority of participants across both studies considered that a distended abdomen, getting up and down, kicking at the abdomen and a horse that was thrashing around warranted veterinary assistance. The current study identified some additional signs that would prompt seeking veterinary attention, including blood in the droppings, very wet droppings and straining to urinate or defecate.

Participants were asked to provide a definition of the term colic, with approximately a fifth providing an appropriate answer. Although this percentage seems relatively low, it may over-represent the actual numbers who knew the correct definition, as participants may have referred to educational material prior to answering the question. A common theme that was observed throughout the free text comments was gastrointestinal causes of colic. The understanding of colic being a gastrointestinal malfunction is consistent with the study by Scantlebury *et al.* (2014). Although colic is primarily caused by gastrointestinal issues, it refers to abdominal pain and this can be caused by diseases of other abdominal organs (White and Edwards, 1999b; Hillyer *et al.*, 2001; Southwood, 2008; Southwood and Wilkins, 2014). Understanding and perception of disease is an area of research that is better documented in human medicine and sociology. The umbrella term of ‘lay epidemiology’ was first introduced by Davison *et al.* (1991) to encompass and define interpretation of illness by non-medically qualified individuals, accounting for beliefs and experiences that contribute to their knowledge and perceptions of a condition (Davison *et al.*, 1991; Frankel, 2006; Conrad and Barker, 2010). When applied in the context of this study, lay epidemiology provides a possible explanation for the diversity of responses provided by the participants when defining colic. The most regularly mentioned causes of colic (impactions, torsions, spasms and gas) are either commonly seen problems or traumatic experiences which may explain the reason for these being mentioned most frequently (Tinker *et al.*, 1997a; White and Edwards, 1999b; Hillyer *et al.*, 2001; Proudman *et al.*, 2001; Southwood and Wilkins, 2014).

Impactions and torsions were highlighted previously by owners when describing colic in the study by Scantlebury *et al.* (2014). It is important to note the vast difference between a simple impaction and a large colon torsion. A primary impaction is relatively common, where food builds up at an anatomical narrowing in the horses' large colon and is often treatable fairly straightforwardly with medical management. A large colon torsion however, is relatively uncommon and requires surgery for resolve. They are often fatal and have a poor prognosis. The difference between these 2 conditions demonstrates why it is vital that owners appreciate that there is an array of underlying conditions that can cause abdominal pain, and any signs of colic should initiate veterinary assessment. Free text accounts of lay treatments being administered without a diagnosis and understanding of the cause of colic is particularly concerning; lunging horses with surgical lesions or delaying seeking veterinary treatment may have negative impact on prognosis for the horse, as well as affecting welfare (Proudman *et al.*, 2001; Animal Welfare Act, 2006; Scantlebury *et al.*, 2014; Curtis *et al.*, 2015a). A key finding of this study is the need for clarity of information about colic for owners, from all aspects such as what colic actually is, what normal parameters in the horse are, and the need for veterinary diagnosis and early intervention to improve prognosis, especially in critical cases of colic (Curtis *et al.*, 2015a).

The information seeking behaviour of horse owners has been previously investigated; horse owners used a variety of resources, and the majority sought information from more than one type of resource (Hockenhull and Creighton, 2013; Gemmill *et al.*, 2016). In the current study, participants were most likely to ask a veterinarian if they wanted to know more about colic. It was beyond the scope of the question to determine whether participants would ask at a visit or over the phone and whether they would expect to pay a fee for the veterinary surgeons time (as it may increase the pressure on the veterinary surgeon by adding to an already full workload). Interestingly, Hockenhull and Creighton (2013) found that veterinary or farriery advice was most commonly sourced when researching equine health. The incorporation of owner education sessions into the services offered by veterinary practices may be a realistic method of passing information to owners. Books and the

internet were also common resources that would be used. Potential issues with these sources are that the information may be outdated, or the internet, including forums in particular may be an unreliable, unmoderated source of information. The majority of participants' current knowledge was obtained from personal experience and information from veterinary surgeons, therefore this knowledge is likely to vary due to different individual personal experiences. Experience is not necessarily a reliable source for gaining information and knowledge on colic. Colic can be a stressful, pressured experience, and therefore any knowledge gained may be insufficient, misinterpreted, skewed or lack understanding. Personal experience is however an imperative factor when considering horse owner decision making in colic (Scantlebury *et al.*, 2014), and it is particularly interesting that experience of critical cases and recent colic experience (in the previous year) significantly affected owners' confidence in colic recognition. Aside from veterinary surgeons, other sources of knowledge that were likely to provide accurate information were degrees and college courses, both of which were mentioned in the free text comments. It is not possible to conclude whether participants' knowledge was comprehensive and accurate at the time of answering at the questionnaire. A remarkable finding was that participants were likely to research after a trigger such as experiencing an episode of colic. The numerous themes identified from the free text comments when asked for areas lacking in information was particularly interesting as it inferred that there is a need for an encompassing colic resource for horse owners. A multifaceted approach to dissemination including the internet and fact sheets would provide a rapidly accessible accurate resource with reliable information.

6.5.1 Recommendations for future work

The greatest finding from this study has been the apparent training need for an educational campaign for horse owners to educate them about colic. There needs to be a reliable, free, public resource that is available in multiple different formats covering: what colic is, how to recognise it, and the different causes; what a vet is likely to do if a horse has colic; the importance of early

intervention in certain cases of colic; and what and owner should do if a horse has colic. It is paramount that the focus is on education to improve the recognition of colic, particularly in the early stages to reduce the interval between identification and veterinary assessment. This could help to improve prognosis in certain animals, whilst also improving welfare due to earlier intervention. Emphasis needs to be on the necessity of veterinary intervention in all cases of colic.

6.6 Conclusion

This is the first study to investigate horse owners' knowledge and understanding of colic. As a condition, colic is poorly understood with much confusion and associated knowledge gaps. Additionally, the disparity between horse owners' confidence and ability to recognise colic is concerning. Horse owners are the proxies in the care of their animals in a similar way to parents acting in the interests of their children. For this reason, it is vital that horse owners' recognise when there is a problem with their animals and seek appropriate veterinary attention, particularly given the importance of early intervention on prognosis in critical cases of colic. Although the lack of colic knowledge is disappointing, they are not necessarily representative of the horse owner population as an entity. An important and encouraging finding is that horse owners are keen to be involved with monitoring their horses' health, and ultimately, want to make the best decisions for their animals. An owner focussed educational campaign is necessary in order to inform owners about colic, dispel some of the lay myths and promote early assessment and intervention by veterinary surgeons.

Chapter 7 Final discussion

The aim of the work contained within this thesis was to determine an area of equine veterinary practice where intervention through knowledge dissemination would have the greatest impact on equine health and welfare. The thesis investigated both veterinary practitioners' approaches and horse owners' opinions to determine which area had a major impact on equine welfare, and to gain insight into equine owners' perspectives. Colic was highlighted early in the thesis as a focus for further work, when it was nominated by experienced owners as the most common emergency condition that also caused the greatest concern (Chapter 4). This finding was supported by the study of 'out of hours' equine conditions, where it was identified as the most common condition attended during out-of-hours veterinary practice (Chapter 3). Previous literature has described colic as a major cause of morbidity and mortality in the horse (Tinker *et al.*, 1997a; Ireland *et al.*, 2011b). The work within this thesis adds to the evidence from primary care practice by capturing horse owners' opinions, knowledge and experiences, and quantifying how it is represented in first opinion equine 'out of hours' work.

For evidence-based research to have a measurable impact on improving equine health and welfare, it must be developed and implemented effectively. Studies are often targeted at influencing veterinary surgeons and their approach to different diseases (Sweeney *et al.*, 2005; Fehr, 2007b; Southwood *et al.*, 2010; Wylie *et al.*, 2011; Freeman and Grosche, 2012). It is questionable whether such methods are likely to result in the greatest impact since veterinary assessment of a horse must first be instigated by an owner or other person who has responsibility of care for that animal. For this reason, horse owners are integral to ensuring equine welfare and therefore it can be argued that implementation of evidence-based strategies and dissemination of resources should instead be targeted at all persons who are involved in the care of a horse (Shaw *et al.*, 2004; Hodgson *et al.*, 2007; Fogle *et al.*, 2008; Fogle *et al.*, 2010; Dombrowski *et al.*, 2012). To accurately pitch evidence-based materials at any target audience, it is necessary to first determine the

baseline knowledge of that population (Wilne *et al.*, 2007; Wilne *et al.*, 2012). This thesis is the first study to identify gaps in the knowledge of horse owners about general health and colic, whilst also demonstrating an incongruence between their nominated confidence in colic recognition and their applied ability when assessed through scenario responses.

Rapid decision making in horses with colic is necessary to ensure there is minimal impact on the animal's welfare (Thoefner *et al.*, 2000; Proudman *et al.*, 2001; Archer, 2004). The horse owner acts as a proxy for their horse (Leckie, 2001; Hotchkiss *et al.*, 2007; Birke *et al.*, 2010), and it is the joint responsibility of owner and veterinary surgeon to adopt a collaborative approach to ensure the animals' needs are accommodated efficiently (Frankel, 2006; Adams and Frankel, 2007). For this reason, it is necessary to undertake studies that investigate a disease from both perspectives as described within this thesis. The veterinary approach to colic was investigated through interrogation of 'out of hours' case records, whilst the owner recognition and understanding was evaluated through a mixed methods questionnaire (Chapter 5 and Chapter 6). This is important as the horse owner needs to recognise colic in the horse and ensure that early intervention is sought from a veterinary surgeon. If horse owners are not able to recognise the early or mild signs of abdominal pain in horses, there could be delays in treatment which may have a vital influence on the prognosis of the individual (Thoefner *et al.*, 2000; Proudman *et al.*, 2001; Scantlebury *et al.*, 2014). Late recognition is a particular concern in critical cases of colic due to the associated significant welfare implications and the extensive interventions required for survival. The study reported in Chapter 6 demonstrated that horse owner recognition of colic was poor, with owners unable to recognise less common or mild, clinical and behavioural signs that may be exhibited by horses with abdominal pain.

The requirement for further educational material about colic for horse owners was highlighted in Chapter 6. The novel use of an owner informed approach to aid the development of scientifically underpinned educational resources is unique to the veterinary research within this thesis. Resources for horse owners are often developed without consultation with stakeholders (veterinary

surgeons, horse owners and equestrian organisations and charities) (AHT, 2017; EGSF, 2017; THN, 2017), thus making an assumption of what is required and how to disseminate it. The Talk About Laminitis is an initiative that provides a freely accessible online resource for the general public (Boehringer Ingelheim, 2017). It is well constructed and has a simple and easy-to-use format with clear, concise information on laminitis and other associated conditions however the underpinning evidence-base of the material and resources is unclear. It cannot be deduced what provided the impetus for the initiative, nor whether there was a consultative process in the development of the resources. The study (Chapter 6) determined a baseline level of knowledge, and then asked horse owners about their opinions on resources and dissemination methods. Materials were developed using a transparent process, ensuring the underpinning scientific studies were referenced accordingly. The greatest legacy from this thesis is the holistic approach to developing, disseminating and implementing evidence-based materials applicable to other areas of veterinary medicine, incorporating all stakeholders involved in equine care rather than focusing on veterinary practice. It is the hope of the author that the methodology used in the development of these materials can be used and applied in other areas of equine practice and more widely in veterinary medicine, to improve animal welfare.

7.1 Overall study design and limitations

The study design and limitations discussed within this section refer to factors affecting the thesis as a whole; limitations of individual studies are discussed within the separate chapters. In any survey-based investigation it is possible that data and results are not representative of the wider population and as such further studies are needed to validate or confirm the findings reported in this thesis. There were common limitations from the chapters investigating ‘out-of-hours’ veterinary practice due to the shared methodology that was used to collect the original data. An ideal study design would have been large scale qualitative interviews of horse owners with ethnographic observations of

veterinary surgeons for the corresponding horses. The obvious problem would be the practicality of conducting a study in this manner as colic cases are sporadic and it would have required extensive time commitments and finances. The surveys followed a mixed methods design to allow for free text capture of some of the rich qualitative data that may have resulted from using an interview technique. The 'out of hours' work would have ideally followed a prospective cohort study design, however the cost, time implications and feasibility rendered this inappropriate for this thesis. Due to the preliminary nature of the 'out of hours' studies, it is not possible to draw conclusions about the generalisability of the results as further work would be required to determine the prevalence of 'out of hours' conditions across equine veterinary practice as a whole.

'Out of hours' practice was identified as the area of veterinary medicine to investigate within the thesis. From the inception of the PhD to this date, there are no available studies that investigate 'out of hours' work in primary care equine practice. Outside of normal working hours, decisions must be made under pressure, both from an owner and veterinary perspective as the conditions are likely to be critical in nature, with a higher potential mortality rate and limited support available. Other morbidities encountered in equine practice are unlikely to require such rapid decision making. For example, in a case of equine lameness where the inciting cause is not an emergency, decisions about the diagnostic approach and response to treatment can be made over hours, days and even weeks in some circumstances. In a case of large colon volvulus however, the prognosis is adversely affected by the smallest delays in treatment as minutes can make a difference in terms of survival due to the critical nature of the condition (Suthers *et al.*, 2013). Similarly, in human critical care medicine, early, targeted treatment had a significant impact on the severity of clinical signs and mortality rate of patients with sepsis (Rivers *et al.*, 2001). In the study by Rivers *et al.* (2001), all patients admitted to a hospital with suspected sepsis or septic shock were assigned to one of two treatment groups: standard therapy or early goal directed therapy. The improved clinical presentation and mortality rate associated with the early goal-directed therapy demonstrates how, in critical

conditions, minor alterations in approach can have a significant impact on outcomes (Rivers *et al.*, 2001). In equine veterinary practice, both the owner and veterinary surgeon have limited access to personnel and resources at the point of care (Wild *et al.*, 2017), exacerbating the challenge of making timely, evidence-based decisions particularly in critical cases. Although there is a difference between emergency caseload and out-of-hours caseload, a large percentage of conditions attended out-of-hours are emergencies. In emergency cases, there is the greatest opportunity for a positive impact associated with interventions, the scale and success of which could be determined using outcome measures.

As this thesis evolved, the studies became owner focused due to the important role the owner plays in the overall incorporation of evidence-based veterinary medicine in equine care, especially as this area had not previously been researched. The work contained within this thesis was conducted alongside other research studies including another PhD, undergraduate student projects and a Masters of Research programme, thus these studies collectively provide the best overall picture of work conducted. The other PhD by Laila Curtis (Curtis, 2016) evaluated and developed the evidence-base on colic and investigated the primary assessment of colic cases using a prospective cohort study.

At the inception of this thesis, the initial aim was to undertake the development of resources for both owners and veterinary surgeons in parallel, however due to the paucities in previous research (Holmes, 2007a; Vandeweerd *et al.*, 2012a; Vandeweerd *et al.*, 2012c) it became apparent that this was beyond the scope of a single PhD thesis. The review of different methods of incorporating evidence in veterinary practice had already been undertaken as this was necessary prior to developing veterinary resources. Following this, funding was obtained for a Masters of Research project to conduct the consensus process for veterinary surgeons and determine the best method of dissemination of resources to the veterinary profession. This Masters ran during the last year (year 4) of the PhD thesis, hence the studies had already been completed.

The experience and understanding of EBM of this author evolved throughout the work involved in this PhD thesis. It is a particularly confusing subject, exacerbated by many different opinions and points of view (Ashcroft, 2004; Hannes *et al.*, 2005; Timmermans and Mauck, 2005; Vandeweerd *et al.*, 2012c; Varma *et al.*, 2012), ranging from alternative definitions to how it should be conducted in practice and all subjects that fall in between (Sackett, 1997a; Holmes, 2007a; Vandeweerd *et al.*, 2012b; Vandeweerd *et al.*, 2012c; Vandeweerd *et al.*, 2012d). As mentioned previously, the first step towards a collaborative evidence-based process is the horse owner. Once veterinary care has been instigated, it is crucial that vets are able to underpin their decisions with scientific evidence and communicate this with the horse owners to ensure, wherever possible informed, shared decision making is undertaken.

7.2 The role of the horse owner in ensuring the welfare of the horse

Domesticated horses live in an environment that is controlled and dictated by any persons responsible for their management and care (Leckie, 2001; Hotchkiss *et al.*, 2007; Birke *et al.*, 2010). These include horse owners, yard owners, members of the veterinary profession and other paraprofessionals such as farriers and physiotherapists. It is the duty of these stakeholders to act as proxies on their behalf, ensuring their welfare needs are accommodated. In order to do this, owners must be able to determine normal behaviours and clinical signs in their horses and distinguish those attributed to disease or injury. It is not necessarily the owner who will recognise signs of disease, particularly when considering chronic conditions that are subtle in nature (Ireland *et al.*, 2011a; Ireland *et al.*, 2012a), but their role in recognising that there may be a problem is essential (Scantlebury *et al.*, 2014). The animal owner is in an equivalent position to the parents of children (Shaw *et al.*, 2004). In childhood brain tumours, vague, non-specific signs are common clinical manifestations of the disease described by their parents (Dixon-Woods *et al.*, 2001). In order to reach a diagnosis and pursue suitable care, it is the responsibility of the parents of a child to seek appropriate medical attention, and re-present their child for assessment when the clinical signs fail to

improve, or deteriorate (Dixon-Woods *et al.*, 2001). Upon recognition of a problem, horse owners will commonly adopt one of three possible approaches: seeking veterinary assistance, monitoring the animal or attempting lay treatment (Scantlebury *et al.*, 2014). Due to differing actions of horse owners in response to horses with colic (Scantlebury *et al.*, 2014), it is advisable that owners always seek veterinary assistance upon recognition of a problem to ensure that the animal is appropriately assessed. The veterinary surgeon is trained to recognise clinical signs of disease, and therefore upon veterinary assessment of the horse, clinical conditions may become apparent even when they are not necessarily the primary aim of a visit or consultation (Ireland *et al.*, 2012a; Robinson *et al.*, 2015). It is particularly important when the animal is suffering from an acute injury or disease that any issues are recognised promptly by those responsible for the care of the horse (such as the horse owner) so that appropriate care can be sought and treatment can be administered, resulting in the best possible outcome (Thoefner *et al.*, 2000; Proudman *et al.*, 2001).

It could be proposed that conditions that are more easily identifiable to horse owners are those that are commonly attended by veterinary surgeons outside of normal working hours e.g. wounds, severe lameness or an inability to stand (Ireland *et al.*, 2012a; Ireland *et al.*, 2013). The horse owner is responsible for contacting the veterinary surgeon in these situations and therefore assessment of the horse by a clinician first requires the identification of the problem by the horse owner. If a condition presents with more severe clinical signs, the owner is more likely to opt for veterinary assessment when compared with an animal with milder clinical signs (Scantlebury *et al.*, 2014). Interestingly, the most common conditions seen ‘out of hours’ in veterinary practice correlated with what yard owners believed to be the most common emergency conditions. This provides evidence from two different perspectives (owners’ opinions and veterinary practice records) that conditions such as colic, lameness and wounds are common problems that occur outside of normal working hours. Identification of a wound may be more straightforward than recognising other conditions as this is based on visual observation. Identification of the other commonly attended conditions may be more

complex; lameness can present on a scale from mild to unable to bear weight, and colic has multiple clinical and behavioural manifestations ranging in severity. It cannot be determined from this study whether horse owners are able to identify certain conditions more easily than others, however it has identified key diseases that are attended 'out of hours'. The detail of how common conditions present 'out of hours' warrants further investigation.

In colic cases specifically, the results detailed in Chapter 6 imply that horse owners identify more overt, severe signs of abdominal pain more easily than milder, unusual, or less obvious signs, which is consistent with the findings by Scantlebury *et al.* (2014). Analysis of the colic cases that were attended outside of normal working hours did not demonstrate that the severity of the behavioural signs exhibited by horses with colic was equivalent to the underlying pathology. This finding is consistent with other outputs from the horse owner workshops and consensus process that were undertaken during other parallel work to this thesis: not all horses will show classic signs of colic, particularly in certain breeds where they are characteristically stoic in nature (Ashley *et al.*, 2005). Instead of the behavioural signs, it was the clinical parameters that had the greatest significance on whether a case was likely to be critical in nature or not. Clinical parameters are objective rather than subjective measures and would require veterinary assessment, emphasizing the argument that regardless of the manifestations of a colic case, early assessment should be sought by a veterinary surgeon. It is therefore of paramount importance that horse owners are astute in assessing their horses behaviour to identify any changes from normal. Furthermore, regardless of the severity of the behavioural signs exhibited by horses, veterinary attention must be sought without delay in order to ensure prompt treatment for the welfare of the animal. If a horse owner is able to identify mild, subtle signs that could be attributed to colic, they are able to ensure they are assessed as soon as possible. Previous work (Sutton *et al.*, 2011; Sutton *et al.*, 2013a; Sutton *et al.*, 2013b) attempted to develop behavioural pain scores for horses with acute colic in order to enable the assessment of the severity of the pain experienced by the horse. The behavioural pain scores were developed using a clinimetric approach combining the mathematical and judgemental assessment of

abdominal pain followed by a Delphi consensus process and validation study to aid in the assessment of behavioural signs and determine the correlation with the severity of colic (Sutton *et al.*, 2013a; Sutton *et al.*, 2013b). Behavioural pain scores have the potential to assist the owner with recognition of colic, however the studies described by (Sutton *et al.*, 2011; Sutton *et al.*, 2013a; Sutton *et al.*, 2013b) were conducted using veterinary surgeons and therefore it is unclear how transferrable the tool would be for use in the lay population, or whether they would assist in the early recognition of colic. A potential problem with owners using behavioural pain scoring is that they may delay veterinary assessment if they subjectively or inaccurately attribute a low score to their animal. Early intervention is of paramount importance in horses with colic as there is an improved prognosis associated with early intervention for critical cases, particularly if the underlying pathology requires surgery for resolution (Thoefner *et al.*, 2000). Alternatively, for cases that respond to straightforward medical treatment the consequence would be a decreased length of discomfort and thus improved welfare (Proudman *et al.*, 2001; Southwood *et al.*, 2009).

There are many decisions that must be made in the chain of events from an animal displaying clinical signs of illness or injury through to the treatment of the problem. Once an injury or problem has been identified, the horse owner must first decide whether to seek veterinary advice. A mixed methods study by Scantlebury *et al.* (2014) investigated horse owners' reactions once colic had been identified in their horse. The work showed that reactions of horse owners could be grouped into three categories: 1) do nothing but monitor or observe the animal to assess whether there was any change or deterioration in clinical signs, 2) administer lay treatments, or 3) seek veterinary advice (Scantlebury *et al.*, 2014). It is interesting that upon noticing clinical signs in their animals, not all owners immediately sought veterinary attention, thus potentially delaying necessary treatments (Scantlebury *et al.*, 2014). This was also a feature of the results of the study described in Chapter 6. The approach of horse owners in the study (Chapter 6) varied between monitoring horses or seeking veterinary assistance when confronted with different behavioural and clinical signs.

There have been many small studies that have investigated factors that influence whether pet owners seek veterinary advice or pursue alternative approaches. Previous experience of a condition or clinical sign is one factor that affects the decision to call a veterinary surgeon (Boland *et al.*, 2014; Stoewen *et al.*, 2014). Specifically, how the previous experience affected the owner's perception on how the animal's welfare and quality of life (including level of pain) were affected by the condition (Boland *et al.*, 2014; Scantlebury *et al.*, 2014; Stoewen *et al.*, 2014). Other factors that may influence their decision to seek veterinary advice include (Klingborg and Klingborg, 2007; Coe *et al.*, 2008; Coe *et al.*, 2009), the owner-pet relationship (Christiansen *et al.*, 2013; Christiansen *et al.*, 2016) and the relationship with their veterinary surgeon (Adams and Frankel, 2007; Scantlebury *et al.*, 2014; Christiansen *et al.*, 2016). In addition to these factors, owners often draw upon their own medical knowledge and experience when making decisions on behalf of their animals (Belshaw *et al.*, 2015). The studies mentioned above involve multiple species and diseases which suggests that there are common themes and components to owner decision making that are independent of these factors (species and disease).

Decision making of horse owners is an inherently complex process that warrants further investigation in the future to gain a better understanding of how they manage conditions and make decisions about their horse's health and welfare. One factor that is likely to have an impact is the difference in stakeholder populations as highlighted by Scantlebury *et al.* (2014). Ideally, regardless of background or type, all stakeholders involved in equine welfare would base their health and care decisions on available scientific evidence. This is not however a straightforward process, due to a lack of accessible studies, the layperson's inability to appraise the quality of the studies, and the use of complex veterinary and scientific terminologies within the script. Scientifically based educational resources for multiple stakeholders including doctors and patients are already commonplace in human medicine (Hodgson *et al.*, 2007; Fogle *et al.*, 2008; Wall *et al.*, 2008). There are many examples where evidence has been collated, and resources have been developed using input from patients, parents, and other non-medically trained stakeholders

(Dixon-Woods *et al.*, 2001; Wilne *et al.*, 2007; Wilne *et al.*, 2010a; Wilne *et al.*, 2012). Reliable, educational material is freely available to any member of the medical profession or public alike for a variety of conditions including for example children's brain tumours (Headsmart, 2017), meningitis (Meningitis Now, 2017), stroke (ActFAST, 2017) and sepsis (The UK Sepsis Trust, 2017). Human medical educational resources and marketing campaigns are usually centred either on emergency conditions (e.g. sepsis) or where early intervention can have a measurable effect on survival and prognosis (e.g. prostate cancer) in order to have the greatest impact. The marketing material that is produced is disseminated widely, via many channels in order to reach and affect the broadest audience. There have been some campaigns previously which adopt similar strategies in certain diseases within veterinary medicine including laminitis (Talk About Laminitis (TAL) (Boehringer Ingelheim, 2017)) and grass sickness (Equine Grass Sickness Fund (EGSF, 2017)). These campaigns have been centred on the dissemination of information rather than describing the processes involved in the development and validation of the evidence on the resources were based. Veterinary medicine should aspire to its medical counterpart by including stakeholders in the development of evidence-based resources and ensuring such materials are disseminated in an accessible manner to the lay population. Ultimately, it is a collective responsibility of all stakeholders that illnesses are recognised promptly and diagnosed and treated rapidly using evidence as the basis of decision making to ensure the animal's welfare.

7.3 Improving horse owner recognition of colic

Abdominal pain (colic) in the horse is a symptom of many underlying pathologies that most commonly affect the gastrointestinal system, but may also be due to disease of other abdominal organs (White and Edwards, 1999b; Southwood and Wilkins, 2014). There are a plethora of clinical signs that can be shown by horses suffering from colic ranging from very mild, vague signs that can be difficult to identify, to severe, overt signs of pain accompanied by obvious distress and discomfort (Ashley *et al.*, 2005). There

is not always a clear correlation between the severity of the underlying pathology that is causing the abdominal pain and the clinical signs exhibited by the animal; a horse with a severe pathological lesion requiring surgery may not display obvious signs of discomfort whilst an animal with a mild, easily treatable problem may present in great distress. Early intervention is of paramount importance in determining the prognosis of horses that require surgical intervention to address the pathology that underlies the colic episode. Achieving an early diagnosis of colic facilitates the rapid referral of these critical cases, thus improving the prognosis of a successful outcome (Tinker *et al.*, 1997a; Proudman *et al.*, 2001; Southwood *et al.*, 2009). In order to safeguard the welfare of the horse in these scenarios, it is the role and responsibility of the horse owner and the veterinary surgeon in combination to ensure the horse is attended and assessed promptly. The horse owner must recognise colic in their animal and seek timely veterinary advice to enable the veterinary surgeon to assess the animal and decide whether surgical intervention is necessary. The work within this thesis has emphasised the importance of colic in the horse as a common emergency condition that is a concern to horse owners. Different owner typologies can have different priorities and considerations with respect to decision making in colic (Scantlebury *et al.*, 2014). Although decisions vary between populations of horse owners, the findings of Chapter 5 demonstrate that despite the differences in demographics, experiences and qualifications, colic remains poorly understood.

There are many different resources available to owners, particularly online (Hockenhull and Creighton, 2013). It can be confusing for horse owners to determine whether information on websites and forums is evidence-based (for example www.thehorse.com) or anecdotal, and therefore interpretation is necessary in order to determine whether the information is suitable and transferrable to their individual situations. Determining the trustworthiness of information sources can be somewhat challenging, particularly when the content of different resources may provide conflicting advice. Scientific literature would be the most robust evidence that horse owners could use for researching conditions (Arlt and Heuwieser, 2016). There are problems with accessing

current scientific evidence however, as it is often not available without journal subscriptions, or owners may not know how to search databases to find open access publications. Even when open access publications are available, it is likely they have been written with a veterinary educated audience as a target and therefore they may contain inappropriate veterinary and medical terminology that means the literature is not translatable to the lay population (Davison *et al.*, 1991). It is likely that owners will face the same difficulties as veterinary surgeons when interpreting evidence: the need to be able to critically appraise the study design (Sackett *et al.*, 1996; Sackett, 1997b). To ensure horse owners make informed decisions about colic in their horses, they should ideally be making their choices on a basis of scientific evidence. It is the responsibility of the veterinary surgeon to remain current and up to date with developments in research (RCVS, 2013), however these must also be communicated to the animal owner, especially where it may affect the clients' decision making (Everitt, 2011; Vandeweerd *et al.*, 2012e; Scantlebury *et al.*, 2014). The collaboration of health care professionals with patients is recognised as an important aspect of medical care in the human field. This approach has been found to provide the best outcome for patients, rather than the medical professionals working in isolation, particularly where there are proxies involved in the patients care, such as the parents of young children (Shaw *et al.*, 2004). This collaborative approach should be adopted in veterinary medicine in order to maximise patient benefits. In critical cases of colic, targeting all stakeholders within the process could improve the timely recognition and decision making that is required to optimise patient outcomes (Furr and White, 1990; Thoefner *et al.*, 2000; Proudman *et al.*, 2001; Southwood *et al.*, 2009). The work contained within this thesis has identified the need for improved education of horse owners about colic.

A requirement for a collaborative, scientifically-based educational campaign was identified from the studies within this thesis, and other work conducted by the Nottingham Equine Colic Project. The work involved in the development of the scientific resources was a laborious, time consuming process involving multiple research students (2 PhDs, 1 masters and multiple undergraduate student projects) and staff from the BHS and University of Nottingham. Horse

owner resources were informed and developed using multidisciplinary stakeholder input with the aim of improving equine owner understanding and recognition of colic. The full development process is detailed in Appendix K. This was developed into the 'REACT now to beat colic' campaign in collaboration with The British Horse Society. REACT was the acronym developed to market a range of online and hard copy educational resources (website, information leaflets, posters, emergency plans and videos). The 'REACT' resources (Appendix L) were developed and disseminated over a one year period, whilst owners were encouraged to develop an emergency plan accounting for their situation to ensure delays were minimised should their horse require intensive treatment or intervention. The intention was to reduce the time between owner recognition of colic and veterinary assessment, thus improving equine welfare. Dissemination of the materials was successful, with positive feedback from the equine owner population. The reach on Facebook alone amounted to 400,000 people in the first eight months of the campaign, whilst 20,000 packs (hard copies of the information leaflets, posters, and emergency plan templates) were produced for distribution in the first year. REACT was promoted to the veterinary sector through the veterinary press and presentations to veterinary surgeons at the 12th International Equine Colic Research Symposium and British Equine Veterinary Association congress. Dissemination was targeted at horse owners through the BHS stands at many equestrian events, in the lay press and via client education evenings held through veterinary surgeries. The 'REACT now to beat colic' campaign was awarded the 2017 Veterinary Record Evidence Award in recognition of the major contribution to evidence-based medicine in veterinary practice. Future work is necessary to determine whether the educational material has altered horse owners' approach to colic and their decision making when approaching and dealing with horses with abdominal pain. REACT represents the first transparent, evidence-based equine health campaign informed by horse owners designed to have a measurable, positive impact on the health and welfare of horses.

7.4 Recommendations for future work

Several opportunities for future work have been identified within this thesis, with specific areas highlighted in each of the individual chapters where there is scope for further development. The requirement for evidence-based resources about abdominal pain in equines was introduced and emphasized in the two surveys of horse owners, whilst the development and dissemination of REACT has been discussed within this chapter. Some of the main recommendations to emerge from the work contained within this thesis have already been actioned during further related postgraduate studies. The assimilation and presentation of evidence that was discussed during the second of the case workshops was subject to a similar online consensus survey as for the development of the REACT materials. The second workshop and consensus process was however specifically directed at equine veterinary surgeons as it contained subject matter that would have been inappropriate for lay personnel to comment on such as diagnostic tests and treatment options in colic cases. Subsequently, the consensus process was analysed, and a further study about dissemination methods to the veterinary profession was conducted to determine the best method of distributing evidence-based colic materials to the veterinary profession. The resulting conclusion of this work was the development of VetREACT (UoN, 2017a), an open access online resource for veterinary surgeons to obtain evidence-based information on colic that is underpinned by scientific studies. A suggestion to progress this work further, and to improve the accessibility of the material would be the generation of a smart phone app to allow the materials to be viewed at the horse side, particularly as smart phones are now commonplace (Franko and Tirrell, 2012; O'Neill and Brady, 2012; I.V. Wild *et al.*, 2017; Wild *et al.*, 2017). The development of such a resource would aid evidence-based shared decision making at the point of care, and may be particularly useful for the early differentiation of critical and non-critical cases thus reducing the interval between primary assessment and appropriate treatment. In addition to aiding access to resources, an application could also contain a colic case assessment form such as the one used by Curtis *et al.* (2015a). A colic assessment form would facilitate detailed yet straightforward recording of

cases and could be linked to the clinical history as well as potentially contributing to a national colic database. A colic database was previously suggested for colic surgery cases (Mair and White, 2008; Mair, 2009), however if an assessment form were developed for use at primary and subsequent assessments in the field, a more complete picture of the prevalence of colic in first opinion practice could be obtained. A colic database would allow further research, including comparisons of diagnostic tests used and treatment options (both medical and surgical), whilst also facilitating multi-centre clinical trials.

There were other areas highlighted for future research from the work contained within this thesis. It is unknown whether the prevalence of the conditions seen by the two practices in Chapter 3 are representative of equine first opinion practice as a whole. Further research and investigation is necessary, possibly using a data mining technique to allow more rapid assessment of a large number of cases. These data could provide a rationale for the direction of future research, either by identifying common conditions that lack a robust literature base, or identifying conditions that have a grave prognosis and warrant further investigation. Another population that requires further investigation is the population of cases that are euthanased or die 'out of hours'. These are un-researched cases, possibly because once they are euthanased or die, the outcome cannot be affected. The 'non-survivors' are arguably an important population that warrant further research as these animals are likely to have the worst welfare prior to death.

Finally, decision making of horse owners needs to be further explored. There have already been studies that have assessed decision making behaviour of horse owners when their horse has colic (Scantlebury *et al.*, 2014), however that study has limitations that have been discussed previously within this thesis. It is also unknown whether the factors and circumstances (such as finances, emotion, knowledge) that affect decision making in colic that were highlighted are applicable and transferrable to different conditions and situations. It is unknown whether the factors that affect owner decision making vary dependent on whether they are in an emergency situation or less urgent circumstances (Ireland *et al.*, 2011a; Ireland *et al.*, 2011b). Finally, factors that

influence the owner’s decision to euthanase a horse need further investigation as these are directly relevant to the investigation of the euthanased population of horses. Equine owner decision making is a complex, multifactorial process that remains poorly understood; better comprehension is necessary, possibly using a combined sociological approach, given the integral role that horse owners undertake in the care and welfare of their animals.

7.5 Overarching conclusions

The studies within this thesis have demonstrated how evidence can be incorporated into veterinary practice, ensuring the acknowledgement of the different stakeholders involved in equine care. Colic as a condition had been studied previously, however much of the data concerned referral hospital populations. The importance of investigating primary care practice has been demonstrated in this thesis; the conditions and outcomes encountered in first opinion veterinary medicine may not correlate with the caseload of a referral hospital. For this reason, the results of referral studies may not be applicable or transferrable to the wider equine population. The majority of colic cases attended for primary assessment were either treated in the field or euthanased prior to referral, thus affecting the referral population of horses with colic. Future research must be targeted at animals that are relevant to the client and primary care clinician to ensure that the findings have the greatest generalisability, allowing for greater impact across a wider population of animals. Decisions in equine care are made by owners and vets both independently and combined, sometimes together with other stakeholders during shared decision making. Recognition of the importance and significance of the horse owner and other stakeholders in equine health and care is necessary to improve outcomes and equine welfare in colic as they play a crucial role in the recognition and early assessment of disease.

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Appendix A Copy of the bespoke data capture form used for recording cases seen 'out of hours'

Horse information	ID number:	Age:	Breed:	Sex:	Insured:

Previous history (within last year)		
Recent relevant history		
Preventative health care	Vaccinations:	Routine Dental:
Concurrent conditions:		
Current medications:		
Presenting condition:		

Clinical signs and presentation:	Clinical sign present:	Details:
Change in demeanour		
Increased heart rate		
Murmur/arrhythmia		
Increased respiratory rate		

Pyrexia				
Abnormal mucous membranes				
Abnormal CRT				
Abnormal coat				
Colic/ abdominal pain		Rolling	Kicking	
		Pawing	Flank watching	
		Stretching	Lying down	
		Box walking	Other	
Lameness/ abnormal movement				
Abnormal neurological exam				
Wound	Size			
	Location			
	Cause			
Swelling	Size			
	Location			
Other				

Diagnostic tests	Test performed	Details and results
Bloods		
Abdominal auscultation		

Urine		
Faeces		
Rectal		
NGT		
Ultrasound		
Radiography		
Abdominocentesis		
Other		

Treatment:	Treatment given:	Specific
NSAID		
Steroid		
Sedation		
Spasmolytics		
Oral fluids		
IV fluids		
Antibiotics		
Surgery – limb		

Surgery – abdominal		
Hospitalised		
Joint medication		
Specific drug (e.g. PPID)		
Anthelmintics		
Hot/ cold therapy		
Exercise		
Box rest		
Other		

Outcome:	Details:

Definitive diagnosis:		

Any follow up/ recurrence:		

Complications?		

Duration of vet care/treatment until recovery/death/ euthanasia		

Other details important to case:	

Appendix B Categories for presenting complaints and definitive diagnosis used in the data capture form

Primary division (system)	Secondary division (complaint/disease)
Musculoskeletal system	Wound-chronic Wound-septic synovitis Wound-foot penetration, simple Wound-limb, simple Wound-head Wound-neck/body Lameness-cellulitis Lameness-soft tissue Lameness-muscle Lameness-joint, non-septic Lameness-bone Lameness-back/pelvis Lameness-foot Lameness-unknown cause Laminitis Joint luxation/dislocation Fracture-axial skeleton Fracture-appendicular skeleton Fracture-skull/mandible Muscular pathology Other
Gastrointestinal system	Dental abnormalities Tongue Choke/oesophageal trauma Colic-spasmodic Colic-undefined/ unknown cause (medical) Colic-undefined/ unknown cause (surgical) Colic-gastric impaction Colic-gastritis/enteritis Colic-SI simple obstruction Colic-SI strangulation Colic-other SI Colic-PFI Colic-Right dorsal displacement Colic-Left dorsal displacement Colic-Other displacement Colic->360° torsion Colic-other colon Colic-small colon Colic-ruptured viscus Diarrhoea/colitis GI ulceration Peritonitis Inflammatory bowel disease

	Liver disease Weight loss (unknown cause) Neoplasia Other
Nervous system	Central nervous system dysfunction Equine dysautonomia Cervical vertebral malformation Ataxia (cause unknown) Seizures (cause unknown) Sensory nervous system dysfunction Other
Cardiovascular system	Heart-arrhythmia Heart-valvular insufficiency Heart-cardiomyopathy Heart-murmur (unknown cause) Heart-other Vasculitis Bacteraemia/septicaemia Other
Respiratory system	Sinus-primary sinusitis Sinus-cyst Sinus disease (unknown cause) Epistaxia (unknown cause) Ethmoid haematoma Gutteral pouch-empyaema Gutteral pouch-mycosis Airway collapse (DDSP, RLN, EE etc.) Upper respiratory tract infection Lower respiratory tract infection Laryngeal disease Tracheal dysfunction Lung-RAO/IAD Lung-bronchopneumonia Lung-EIPH Other

Urinary system	Bladder-rupture Bladder-patent urachus Bladder-cystolithiasis Bladder-cystitis Bladder-other Kidney-failure Kidney-pyelonephritis Ureters Urethra Other
Special senses	Eye-corneal ulcer Eye-corneal penetration Eye-neoplasia Eye-uveitis Eye-keratitis Eye-cataracts Eye-other Cranial nerve dysfunction-“head shaking” Cranial nerve dysfunction-other Other
Reproductive system	Penis-neoplasia Penis-paraphimosis/priapism Penis-other Testicles-routine castration Testicles-cryptorchid castration Castration complication Testicular torsion Testicles-other Uterus-torsion Perineal laceration Ovaries-ovariectomy Ovaries-neoplasia Reproductive failure Venereal disease Foaling difficulty Pregnancy issue Retained placental membranes Mastitis Post-foaling problem – other Neonatal condition Other

Integument	Sarcoids Pruritis Alopecia Other neoplasia Ectoparasites Pyoderma Allergic Cellulitis (no lameness) Other
Lymphatic/immune	Lymphangitis Lymphoma Pyrexia of unknown origin Notifiable disease Poisoning Other
Endocrine	PPID EMS Other

Appendix C Cover letter for horse owner's opinions of common equine conditions questionnaire

Dear yard owner,

My name is Adelle Bowden and I am writing to request your assistance with some research I am undertaking at the moment. I am a vet and am currently studying for a PhD at the University of Nottingham. My research involves looking at common equine conditions, particularly emergency conditions and determining what is important from a horse owner's perspective.

My reason for contacting you is that you are registered as an approved yard with the British Horse Society and therefore I would like to ask for 10 minutes of your time in order to fill out a questionnaire on common equine and emergency conditions. The rationale for choosing BHS approved yards is that this will target the group of people who have experienced the most diverse and greatest number of equine conditions- you!

The second phase of my research will involve using the conditions identified by this first questionnaire as important or worrying to the equine owner population. These conditions will be examined in greater detail and a nationwide questionnaire will be distributed to gain insight from horse owners with the most diverse range of backgrounds possible. The aim of this research is to determine gaps in the equine owner population where intervention via education will have maximal impact.

I would really appreciate your help with this study so that together we can help to maximise owner awareness and equine welfare across the country. As mentioned, this study will take 10 minutes of your time, is online and is completely confidential. If you would be able to help, the questionnaire is accessible via this link:

https://www.surveymonkey.com/s/horse_owner_survey_1

If you have any further questions or would like to contact me regarding my survey please email: svxab4@nottingham.ac.uk. Alternatively you may contact my supervisor Dr Sarah Freeman (svzslf@nottingham.ac.uk). Many thanks for your help in advance.

Yours Sincerely,

Adelle Bowden

Appendix D Copy of the horse owner's opinions of common equine conditions questionnaire

Veterinary conditions

2. There are many reasons vets are called out to horses. What do you consider to be the most common reasons a horse requires veterinary care (not including routine treatments such as vaccinations and dental care)?

1.
2.
3.

3. There are also a number of critical conditions which may require emergency treatment by the vet. What do you consider to be the 3 most common CRITICAL (life threatening) conditions that vets are called to horses for?

1.
2.
3.

4. Which 3 veterinary conditions are the most concerning to you as a horse owner?

1.
2.
3.

5. If your horse was in a CRITICAL (life threatening) condition, which factors would most influence your decision making with regards to whether you were going to treat a horse or euthanase it.

Please rank these in order, with 1. being the most likely to influence your decision making.

- [ ] Financial cost of veterinary care and treatment
- [ ] Whether the horse is insured for that specific condition
- [ ] The likelihood the condition was to resolve with treatment.
- [ ] The amount of pain/ suffering the horse was experiencing.
- [ ] How sick was the horse at the time of treatment.
- [ ] Age of the horse
- [ ] Any other problems/ illnesses that the horse may have already
- [ ] Whether the horse could recover enough to be used for breeding.
- [ ] Whether the horse would recover enough to go back to its previous level of work.
- [ ] Whether the horse would recover enough to have a good quality of life even if it could not work or be used for breeding

6. Are there any other factors that would influence your decision making? If so, please mention them briefly below.

Emergency calls

7. Have you ever had to call a vet in an emergency?

- ◯ Yes
- ◯ No

8. If you answered YES to question 7, please complete the rest of this page, If you answered NO, please skip to page 4.

What have been the condition(s) that have affected your horse(s) in the situations when you have called the vet in an emergency?

This list of emergency conditions has been compiled from veterinary correspondence and is very comprehensive. Please do not be concerned if you have not experienced all of these but simply tick ALL of the conditions that are relevant to you personally.

- ☐ Wound
- ☐ Soft tissue inflammation - cellulitis
- ☐ Soft tissue inflammation - lymphangitis
- ☐ Joint luxation/ dislocation
- ☐ Fracture with open wound
- ☐ Fracture with no evident wound
- ☐ Joint or tendon sheath infection/ penetration
- ☐ Ligament rupture/ laceration
- ☐ Tendon rupture/ laceration
- ☐ Rhabdomyolysis (azoturia/ tying up/ Monday morning disease)
- ☐ Other myopathies (clostridial myopathy, atypical myopathy, post anaesthetic myopathy, fibrotic myopathy etc.)
- ☐ Nerve injury (neuropathy)
- ☐ Epistaxis (severe nose bleed)
- ☐ Severe haemorrhage from sites other than nose
- ☐ Foot problems - Laminitis
- ☐ Foot problems - Penetrating injuries
- ☐ Foot problems - Abscess
- ☐ Poisoning (including ragwort, lead, acorns etc.)

- [ ] Infectious disease - Strangles
- [ ] Infectious disease - notifiable diseases (African Horse Sickness, Contagious Equine Metritis, Equine Infectious Anaemia, Equine Viral Arteritis)
- [ ] Septicaemia (Systemic Inflammatory Response Syndrome)
- [ ] Cardiac conditions
- [ ] Ataxia (unsteady, uncoordinated gait not caused by weakness)
- [ ] Seizures
- [ ] Collapsed horse
- [ ] Respiratory conditions (acute breathing problems and distress)
- [ ] Colic
- [ ] Choke
- [ ] Grass Sickness
- [ ] Urological conditions (emergency caused by kidney/ bladder problems)
- [ ] Neonatal conditions (disease in a foal less than a week old)
- [ ] Post castration bleeding/ infection
- [ ] Problems with mare in pregnancy (e.g ruptured abdominal wall/ prepubic tendon etc.)
- [ ] Problems whilst foaling (foal stuck, haemorrhage, overly lengthy foaling etc.)
- [ ] Problems after foaling (bleeding/infection)
- [ ] Eye conditions - melting ulcers
- [ ] Eye conditions - uveitis (recurrent equine uveitis, moon blindness, periodic ophthalmia, recurrent iridocyclitis etc.)
- [ ] Eye conditions - penetrating injury

Other (please specify)

9. In the emergency situations mentioned above, do you feel the vet was called out soon enough?

- ◯ Yes
- ◯ No

10. If you answered NO to the previous question, please briefly comment on why the vet was not called soon enough.

11. How easy do you find it knowing the right time to call the vet?

- ◯ Very easy
- ◯ Quite easy
- ◯ Quite difficult
- ◯ Very difficult

12. When you've had to call a vet in an emergency situation previously, how traumatic have you found the experience?

- ◯ Very traumatic
- ◯ Quite traumatic
- ◯ No strong opinion either way
- ◯ Not very traumatic
- ◯ Not traumatic at all

13. If you would like to comment further on your experiences of emergency situations, please use the box below.

Background information

14. What age category do you belong to?

- ◯ under 18
- ◯ 18 - 24
- ◯ 25 - 34
- ◯ 35 - 44
- ◯ 45 - 54
- ◯ 55 - 64
- ◯ 65 +

15. Are you

- ◯ Male
- ◯ Female

16. How long have you kept horses for?

- ◯ less than 6 months
- ◯ 6months - 1 year
- ◯ 1 year - 2 years
- ◯ 2 - 5 years
- ◯ 5 - 10 years
- ◯ 10 - 20 years
- ◯ 20 - 30 years
- ◯ 30 years +

17. How many horses do you have responsibility of care for at the moment?

- ◯ 1 - 4
- ◯ 5 - 9
- ◯ 10 - 14
- ◯ 15 - 19
- ◯ 20 - 24
- ◯ 25 - 29
- ◯ 30 - 39
- ◯ 40+

18. What discipline are the horses in your care predominantly used for?

- ◯ General purpose (local shows, hacking, schooling)
- ◯ British Show Jumping Association (BSJA)
- ◯ British Dressage (BD)
- ◯ British Eventing (BE)
- ◯ Hunting
- ◯ Endurance
- ◯ Showing (national level- if local only please choose general purpose)
- ◯ Horseball
- ◯ Polo
- ◯ Racing (Flat)
- ◯ Racing (National Hunt)
- ◯ Point to point
- ◯ Driving

Other (please specify)

19. At what level do the horses in your care compete at?

- [ ] Amateur
- [ ] Professional
- [ ] Unsure
- [ ] Not applicable (Hunting/ General purpose)

20. What is the management of the horses on your yard?

- [ ] DIY
- [ ] Full livery
- [ ] Assisted livery
- [ ] Working livery
- [ ] Competition livery
- [ ] Riding school horses cared for by yard staff

Other (please specify)

21. Who cares for the horses on your yard most of the time?

- [ ] Yourself
- [ ] Family member
- [ ] Friends
- [ ] Staff

Other (please specify)

22. Do you have any equine qualifications? (BHS, pony club, veterinary nursing, college course, degree etc.)

If you have more than 1 qualification, please state the highest level of qualification.

- ◯ Pony club tests
- ◯ College course (NVQ etc.)
- ◯ BHS qualifications up to and including BHSAI
- ◯ BHS qualifications from BHSAI to BHSII
- ◯ BHS qualifications greater than BHSII
- ◯ Undergraduate degree
- ◯ Postgraduate qualifications (Masters/ PhD)
- ◯ Veterinary nursing qualifications
- ◯ Veterinary medicine qualifications

Other (please specify)

23. How would you rate your level of experience with regards to horse care?

- ◯ Very experienced
- ◯ Quite experienced
- ◯ Average
- ◯ Quite inexperienced
- ◯ Very inexperienced

Advice

24. Where would you usually seek advice from with regards to the health of the horses in your care? Please tick all that apply.

- [ ] Friends/ Family
- [ ] Trainer
- [ ] Vet
- [ ] Physiotherapist
- [ ] Farrier

Other (please specify)

25. Please comment on who you would seek advice from in the first instance.

- ◯ Always go to trainer first
- ◯ Always go to friends first
- ◯ Always go to physiotherapist first
- ◯ Always call farrier for foot related problems/ Vet for other conditions without seeking prior advice
- ◯ Always call vet first regardless of condition

Other (please specify)

Future research

Thank you very much for your participation in this survey, your help is much appreciated.

26. If you would like to be informed of the results of this survey and would be happy to participate in future research on this subject, please fill out your email address in the box below.

Appendix E Introduction and consent section for the horse owner's opinions of common equine conditions questionnaire

Dear Participant,

My name is Adelle Bowden. I am a vet currently undertaking research at the School of Veterinary Medicine and Science at the University of Nottingham. The first phase of my research involves looking at common equine conditions and determining what is important from a horse owner's perspective. The second phase will examine in more detail the conditions identified by this first questionnaire. I would like to ask if you would be willing to help with this first phase. This questionnaire should take no longer than 10 minutes to complete.

Participation in this research is entirely voluntary and there is no obligation to take part. Please note if you are under 16, you must have parental consent to take part.

This study has been approved by the School of Veterinary Medicine and Science's ethics committee. The information I collect will be presented in my PhD thesis and possibly used for publication and research presentations at conferences or meetings. Your details and the information you provide will be anonymised, and all data will be securely stored by the researcher.

Your help is very important to the success of this study, so we would appreciate your time and interest. Further information about the study can be obtained by contacting Adelle Bowden or Sarah Freeman.

All responses will be anonymous and no contact details will be passed on to any other persons or third party organisations.

Should you wish to contact myself or my supervisor with regards to this study, please email:

Researcher: Adelle Bowden - svxab4@nottingham.ac.uk Supervisor: Sarah Freeman - svzslf@nottingham.ac.uk

Many thanks in advance for your help with this study.

Adelle Bowden

Consent:

This consent form is a formal way of indicating that you agree to participate in this study and that you understand that any information collected by the researchers:

- will be used for a research study
- may be written in a report for publication
- may be presented at research conferences or meetings
- will be anonymised and treated confidentially
- will only be accessed by research colleagues or examiners
- that you can request to see a copy/summary of the completed study
- that you can request to see any information written down/kept during the process of data collection.
- The researchers have explained that any comments you make will be anonymous so that in the final study write up, it will not be possible to identify you

* 1. If you are willing to participate in this study please complete the following consent section.

□ I have read and understood the relevant information regarding consent and agree to the terms laid out for my participation in this study

Appendix F SNOMED adapted equine classification of emergency conditions from the adapted human SNOMED classification.

Diagnosis	Code
Wound	01
Soft tissue inflammation*	02
Luxation/ Fracture/ Tendon sheath/ Joint injury *	03
Tendon/ ligament injury*	04
Muscle injury*	05
Nerve injury (neuropathy)	06
Vascular injury*	07
Foot problems*	08
Poisoning (including ragwort, lead, acorns etc.)	09
Infectious disease*	10
Septicaemia (SIRS)	11
Cardiac conditions	12
Neurological conditions*	13
Respiratory conditions (acute breathing problems and distress)	14
Gastrointestinal conditions*	15
Urological conditions (emergency caused by kidney/ bladder problems)	16
Neonatal conditions (disease in a foal less than a week old)	17
Reproductive conditions*	18
Ophthalmological (eye) conditions*	19

*sub analyses of conditions

Sub analyses of adapted SNOMED equine conditions

Diagnosis	Sub analysis	Code
Soft tissue inflammation	- Cellulitis - Lymphangitis	1 2
Luxation/ Fracture/ Joint injury	- Joint luxation/ dislocation - Fracture with open wound - Fracture with no evident wound - Joint or tendon sheath infection/ penetration	1 2 3 4
Tendon/ ligament injury	- Ligament rupture/ laceration - Tendon rupture/ laceration	1 2
Muscle injury	- Rhabdomyolysis (azoturia/ tying up/ Monday morning disease) - Other myopathies (clostridial/ atypical/ post anaesthetic/ fibrotic etc.)	1 2
Vascular injury	- Epistaxis (nose bleed) - Severe haemorrhage from sites other than nose	1 2
Foot problems	- Laminitis - Penetrating injuries - Abscess	1 2 3
Infectious disease	- Strangles - Notifiable diseases (African Horse Sickness, Contagious Equine Metritis, Equine Infectious Anaemia, Equine Viral Arteritis)	1 2
Neurological conditions	- Ataxia (unsteady, uncoordinated gait not caused by weakness) - Seizures - Collapse	1 2 3
Gastrointestinal conditions	- Colic - Grass sickness - Choke	1 2 3
Reproductive conditions	- Post castration bleeding/ infection - Problems with mare in pregnancy (ruptured abdominal wall/ prepubic tendon etc.) - Problems at foaling (foal stuck, haemorrhage, overly lengthy foaling etc.) - Problems after foaling (bleeding/infection)	1 2 3 4
Ophthalmological (eye) conditions	- Melting ulcers - Uveitis (recurrent equine uveitis, moon blindness, periodic ophthalmia, recurrent iridocyclitis etc.) - Penetrating injuries	1 2 3

Appendix G Univariable analysis for clinical variables from 941 horses on primary assessment for clinical signs of abdominal pain

Table 17: Univariable analysis for clinical variables from 941 horses on primary assessment for clinical signs of abdominal pain, categorised as critical or not critical on the basis of case outcome. Clinically significant variables are shown in bold typeface.

		Coefficient	**Odds ratio**	**95% CI**	**p value**
Continuous Variables	**Heart rate** (beats per minute)	0.08	1.09	1.07-1.10	**<0.01**
	Respiratory rate (breaths per minute)	0.08	1.07	1.06-1.11	**<0.01**
	Age (years)	0.06	1.06	1.04-1.08	**<0.01**
	Temperature (^{o}C)	-0.18	0.83	0.61-1.14	0.26
Categorical Variables		**Coefficient**	**Odds ratio**	**95% CI**	**p value**
Breed	Donkey/Mule	Ref			
	Small Ponies	-1.16	0.31	0.07-1.47	**0.14**
	Large Ponies	-1.08	0.34	0.08-1.45	**0.15**
	Arab type	-0.38	0.69	0.14-3.35	0.64
	Cob type	-1.11	0.33	0.08-1.43	**0.14**
	TB type	-1.92	0.15	0.03-0.64	**0.01**
	Irish/WB type	-1.65	0.19	0.05-0.81	**0.02**
	Heavy horses	0.29	1.33	0.17-10.25	0.78
Sex	Mare/Filly	Ref			
	Gelding	0.26	1.30	0.91-1.83	**0.14**
	Stallion/Colt	-0.45	0.64	0.12-2.46	0.42
Previous history of colic	No/not recorded	Ref			
	1 episode in previous year	0.24	1.27	0.78-2.06	0.34

	2 episodes in previous year	-0.90	0.41	0.16-1.05	**0.06**
	3 or more episodes in previous year	0.16	1.17	0.48-2.82	0.73
Concurrent conditions	No	Ref			
	Yes	1.25	3.48	2.00-6.07	**<0.01**
Recent relevant History	No/not recorded	Ref			
	Yes	0.26	1.29	0.91-1.83	**0.15**
Change in demeanour	No/not recorded	Ref			
	Restless/agitated	0.99	2.70	1.75-4.16	**<0.01**
	Dull/depressed	0.69	1.98	1.20-3.28	**<0.01**
	Aggressive	0.17	1.18	0.13-10.69	0.88
	Recumbent on exam	1.84	6.31	3.77-10.56	**<0.01**
	Other	0.27	1.31	0.48-3.62	0.60
Murmur/arrhythmia	No/not recorded	Ref			
	Yes (either/both)	0.14	1.15	0.53-2.51	0.72
Categorical Variables (ctd.)		**Coefficient**	**Odds ratio**	**95% CI**	**p value**
Abnormal mucous membrane colour	No/not recorded	Ref			
	Yes	2.65	14.21	8.63-23.41	**<0.01**
Detail abnormal mucous membrane colour	No/not recorded	Ref			
	Pale	2.37	10.70	6.24-18.33	**<0.01**
	Capillary vasodilation	3.40	30.04	12.42-72.70	**<0.01**
	Tacky (normal colour)	1.46	4.29	1.42-12.97	**0.01**
Abnormal Capillary Refill Time (CRT)	No/not recorded	Ref			
	Yes	2.45	11.54	4.64-28.69	**<0.01**

Sweating	No/not recorded	Ref			
	Yes	1.33	3.77	2.02-7.05	**<0.01**
Colic signs (any)	No/not recorded	Ref			
	Yes	0.63	1.87	1.38-2.53	**<0.01**
Colic signs (kicking)	No/not recorded	Ref			
	Yes	0.10	1.102	0.53-2.30	0.80
Colic signs (rolling)	No/not recorded	Ref			
	Yes	0.98	2.66	1.79-3.96	**<0.01**
Colic signs (pawing)	No/not recorded	Ref			
	Yes	0.06	1.06	0.54-2.08	0.86
Colic signs (stretching)	No/not recorded	Ref			
	Yes	1.16	3.20	0.45-22.86	0.25
Colic signs (box walking)	No/not recorded	Ref			
	Yes	-0.23	0.80	0.09-7.15	0.84
Colic signs (flank watching)	No/not recorded	Ref			
	Yes	0.04	1.04	0.54-1.97	0.91
Colic signs (lying down)	No/not recorded	Ref			
	Yes	0.57	1.77	1.28-2.47	**0.01**
Colic signs (other)	No/not recorded	Ref			
	Yes	0.41	1.51	1.00-2.29	**0.05**
Abdominal distension	No/not recorded	Ref			
	Yes	-0.389	0.678	0.193-2.379	0.54
Bloods	Normal	Ref			
	Abnormal	0.46	1.58	0.86-2.94	**0.14**
Abdominal auscultation	Normal	Ref			
	Absent in 1 or more quadrants	3.39	29.52	14.34-60.77	**<0.01**
	Reduced in 1 or more quadrants	1.04	2.83	1.56-5.12	**0.01**
	Increased in 1 or more quadrants	-0.27	0.76	0.38-1.51	0.43
	Sound descriptor	-0.19	0.83	0.26-2.64	0.75

CI = Confidence Interval

Appendix H Introduction and consent section for equine owners' knowledge and approaches to abdominal pain (colic) in horses questionnaire

Hello,

My name is Adelle Bowden. I am a vet currently undertaking research at the School of Veterinary Medicine and Science at the University of Nottingham. The first phase of my research involved looking at common equine conditions and determining what is important from a horse owner's perspective. This second phase is examining in more detail the conditions identified. We are trying to find out what the baseline knowledge that typical horse owners have about the potential signs of colic and what action to take. I would like to ask if you would be willing to help by completing a short questionnaire. It has been trialled, and should take between 5 and 15 minutes to complete.

Participation in this research is entirely voluntary and there is no obligation to take part. Please note if you are under 16, you must have parental consent to take part.

This study has been approved by the School of Veterinary Medicine and Science's ethics committee. The information I collect will be presented in my PhD thesis and possibly used for publication and research presentations at conferences or meetings. All responses will be anonymised and no contact details will be passed on to any other persons or third party organisations. All data will be securely stored by the researcher.

Your help is very important to the success of this study, so we would appreciate your time and interest. Further information about the study can be obtained by contacting Adelle Bowden or Sarah Freeman.

Should you wish to contact myself or my supervisor with regards to any aspect of this study, please email:

Researcher: Adelle Bowden - svxab4@nottingham.ac.uk

Supervisor: Sarah Freeman - svzslf@nottingham.ac.uk

Many thanks in advance for your help with this study.

Adelle Bowden

Consent:

This consent form is a formal way of indicating that you agree to participate in this study and that you understand that any information collected by the researchers:

- will be used for a research study
- may be written in a report for publication
- may be presented at research conferences or meetings
- will be anonymised and treated confidentially
- will only be accessed by research colleagues or examiners
- that you can request to see a copy/summary of the completed study
- that you can request to see any information written down/kept during the process of data collection.

* 1. If you are willing to participate in this study, please complete the following consent section.

□ I have read and understood the relevant information regarding consent and agree to the terms laid out for my participation in this study.

2. Please leave an email address in order that confirmation of consent can be provided. This email address will be used only for this purpose unless otherwise agreed to by you.

Appendix I Copy of Equine owners' knowledge and approaches to abdominal pain (colic) in horses questionnaire

The 'normal' horse

This questionnaire is not a test. Please answer the following questions as honestly as possible, as this will provide us with the most beneficial information. We are not judging responses. There are no right or wrong answers. We are most interested in which aspects people find difficult, so we can try and develop guidance to help with this. Please do not use books/ phones/ internet to assist you in answering questions. Many thanks.

3. What do you think the normal heart rate range is for an average horse at rest?

(Heart rate at rest is the number of beats per minute when not under stress or exercise.
Range is defined as the lowest and highest values considered to be normal.
An average horse is 500kg, 16hh fit general purpose horse.)

If you don't know please insert a "?" in the answer field.

Lowest value

Highest value

4. What do you think the normal respiration (breathing) rate range is for an average horse at rest?

(Respiration rate at rest is the number of breaths per minute when not under stress or exercise.
Range is defined as the lowest and highest values considered to be normal.
An average horse is 500kg, 16hh fit general purpose horse.)

If you don't know please insert a "?" in the answer field.

Lowest value

Highest value

5. What do you think the normal temperature range is for an average horse at rest?
Please indicate the units used (e.g. celsius/ farenheit) if you know them.

(Range is defined as the lowest and highest values considered to be normal.
An average horse is 500kg, 16hh fit general purpose horse.)

If you don't know please insert a "?" in the answer field.

Lowest value

Highest value

Units

6. What do you think normal gut sounds are for an average horse at rest?

(Gut sounds are the sounds that a horse's intestines make that can be heard over the abdomen with a stethoscope or by placing your ear to the flank.
An average horse is 500kg, 16hh fit general purpose horse.)

- ◯ No sounds present at all
- ◯ Some tinkling and occasional quiet gurgles
- ◯ Some tinkling and regular gurgles, some quite loud, lasting around 3 seconds
- ◯ Constant tinkling sounds and gurgles, very loud and can be heard very easily without stethoscope
- ◯ Don't know

7. Which of the following do you feel confident that you can measure accurately?
Please tick ALL that apply

- ☐ Heart/ pulse rate
- ☐ Respiration rate
- ☐ Temperature
- ☐ Gut sounds
- ☐ Gum colour
- ☐ Capillary refill time (CRT)
- ☐ Skin tenting
- ☐ Digital pulses
- ☐ None of the above

8. How many droppings would you expect an average horse to pass in a 24 hour period?

(A dropping is a pile of nuggets which is normal for that horse or appropriate for the size and breed of horse.
An average horse is 500kg, 16hh fit general purpose horse.)

If you don't know please insert a "?" in the answer field.

From _____

To _____

9. We would like some information on how you decide what is normal for your horse.

How would you react to the following changes to a horse's droppings? Please interpret this as if it were the only change to your horse.

	Not concerned	Monitor or observe	Look on the internet/ other resource	Call a friend/ other person	Call the vet	Wouldn't know how to interpret this
Mucous covered droppings (normal consistency)	○	○	○	○	○	○
Blood in droppings (normal consistency)	○	○	○	○	○	○
Worms in droppings (normal consistency)	○	○	○	○	○	○
Change in colour of droppings (normal consistency)	○	○	○	○	○	○
Drier droppings than normal	○	○	○	○	○	○
Wetter droppings than normal (cow pat consistency - still have some form)	○	○	○	○	○	○
Very wet dropping (watery consistency, may be projectile, no form to dropping)	○	○	○	○	○	○
Fewer droppings than normal	○	○	○	○	○	○
More droppings than normal	○	○	○	○	○	○

10. Please indicate for each of these behavioural changes whether you would consider these abnormal and what action you would take. Please assume for each 'change' that this is the only one the horse is showing.

	Not concerned	Monitor or observe	Look on the internet/ other resource	Call a friend/ other person	Call the vet	Wouldn't know how to interpret this sign
Horse is flank watching (turning head towards belly)	○	○	○	○	○	○
Horse is lying down quietly	○	○	○	○	○	○
Horse is lying down and getting up (2-3 times in 30 minute period)	○	○	○	○	○	○
Horse restlessly lying down and getting up (4+ times in 30 minute period)	○	○	○	○	○	○
Horse is rolling (for less than 5 minutes)	○	○	○	○	○	○
Horse rolling for more than 5 minutes or rolling multiple times (4+) in a 30 minute period	○	○	○	○	○	○
Horse pawing at floor (not in response to food or other stimulus)	○	○	○	○	○	○
Horse kicking at belly (no obvious external stimulus e.g. flies)	○	○	○	○	○	○
Horse not eating/ gone off food	○	○	○	○	○	○
Fence/ box walking	○	○	○	○	○	○
Quiet or depressed	○	○	○	○	○	○
Shifting from one foot to the other	○	○	○	○	○	○

11. Please indicate for each of these clinical changes whether you would consider these abnormal and what action you would take. Please assume for each 'change' that this is the only one the horse is showing

	Not concerned	Monitor or observe	Look on the internet/ other resource	Call a friend/ other person	Call the vet	Wouldn't know how to interpret this sign
Unexpected sweating	◯	◯	◯	◯	◯	◯
Increase in respiration (breathing) rate	◯	◯	◯	◯	◯	◯
Decrease in respiration (breathing) rate	◯	◯	◯	◯	◯	◯
Increase in heart rate	◯	◯	◯	◯	◯	◯
Decrease in heart rate	◯	◯	◯	◯	◯	◯
Increase in body temperature	◯	◯	◯	◯	◯	◯
Decrease in body temperature	◯	◯	◯	◯	◯	◯
Straining to urinate/ defecate	◯	◯	◯	◯	◯	◯
Distended belly	◯	◯	◯	◯	◯	◯
Diarrhoea	◯	◯	◯	◯	◯	◯
Weight loss	◯	◯	◯	◯	◯	◯

12. Please use this box to add any further comments on any of the questions so far if you wish. A text box will be available for comments at the end of each section.

Colic in the horse

13. What do you think the term 'colic' means?

14. What would you check on your horse if you thought it had colic before contacting anyone else? Please tick ALL that apply.

- [ ] Heart/ pulse rate
- [ ] Respiration (breathing) rate
- [ ] Rectal temperature
- [ ] Ear temperature
- [ ] Hoof temperature
- [ ] Nasal discharge
- [ ] Ocular (eye) discharge
- [ ] Lymph nodes (glands)
- [ ] Gut sounds (listening with stethoscope to abdomen)
- [ ] Gum (mucous membrane) colour
- [ ] Capillary refill time (time for colour to return after pressing on gums)
- [ ] Digital pulses (pulses felt near fetlocks)
- [ ] Skin tenting (recoil of skin when pulled)
- [ ] I wouldn't check anything myself, I would call someone more experienced (not a vet) to check the horse over
- [ ] I wouldn't check anything myself, I would call a vet and get them to come and check the horse over
- [ ] Urination
- [ ] Defecation (faeces)

Other (please specify)

15. How confident would you be that you could recognise colic in a horse?

- ○ I would recognise every case in different horses with different presentations and severities
- ○ I would recognise most cases unless it was a very odd presentation or an unfamiliar horse
- ○ I could recognise it in some cases but not in all cases/ all severities
- ○ I wouldn't recognise it unless very severe/ obvious
- ○ I wouldn't recognise it at all

16. If you were NOT in an emergency situation and wanted to find out more about how to recognise and deal with colic, where would/do you go for more information?
Please tick ALL that apply.

- [ ] Ask a vet
- [ ] Ask another professional (farrier, physio etc)
- [ ] Ask friends/ family
- [ ] Ask yard owner/ trainer
- [ ] Look on the internet
- [ ] Search phone app
- [ ] Look at a poster
- [ ] Look at a factsheet
- [ ] Look in a book
- [ ] Look in magazines
- [ ] Look at forums
- [ ] Look at Pony Club information
- [ ] Look at British Horse Society (BHS) information
- [ ] Look to another professional organisation for information

Other (please specify)

17. It would be very helpful if you could give us more specific details of where you would go for more information in the box below.
(e.g. which people/ magazines/ forms etc.)

18. Thinking about your current knowledge of colic in the horse, where did this information/ knowledge come from?

Please tick ALL that apply.

- [ ] Reading a factsheet
- [ ] Talking to a vet
- [ ] Talking to another professional (farrier, physio etc)
- [ ] Talking to friends/ family
- [ ] Talking to your yard owner/ trainer
- [ ] Personal experience
- [ ] Looking at the internet
- [ ] Using a phone app
- [ ] Reading a poster
- [ ] Reading books
- [ ] Reading magazines
- [ ] Using forums
- [ ] Looking at/ using Pony Club information
- [ ] Looking at/ using British Horse Society (BHS) information
- [ ] Information/ course from another professional organisation
- [ ] Not sure

Other (please specify)

19. Again, it would be very helpful if you could give us more specific details of where you got your knowledge from in the box below.
(e.g. which people/ magazines/ forms etc.)

20. We are particularly interested in where the gaps are in the information/ education that is currently available on equine colic for horse owners.

Please could you tell us which areas of equine colic you would like more information on?

How you would like this information made available to you?

Personal experiences

This section is designed to help us understand the experiences of different horse owners. Again, this is not a test so please answer as honestly as possible.

21. Thinking about colic in the horse, how many different episodes have you personally seen?

- ◯ None
- ◯ 1 - 2
- ◯ 3 - 4
- ◯ 5 - 7
- ◯ 8 - 10
- ◯ 11 - 20
- ◯ 21 - 30
- ◯ 30+

22. If you have seen horses with colic, please can you give us more details about any personal experiences that you have had with horses that you own or look after.

	Never had experience of this	Within the last 6 months	Within the last year	Within the last 2 years	Within the last 3 - 5 years	Within the last 6 - 10 years	Experienced more than 10 years ago
The horse recovered with no need for veterinary treatment	◯	◯	◯	◯	◯	◯	◯
The horse was treated by the vet on the yard and got better	◯	◯	◯	◯	◯	◯	◯
The horse had to be treated in hospital and got better	◯	◯	◯	◯	◯	◯	◯
The horse was treated by a vet on the yard/ at hospital but now had further problems with colic	◯	◯	◯	◯	◯	◯	◯
The horse had surgery and got better	◯	◯	◯	◯	◯	◯	◯
The horse died	◯	◯	◯	◯	◯	◯	◯
The horse was treated (medically of surgically) and then died (without being euthanased/ put to sleep)	◯	◯	◯	◯	◯	◯	◯
The horse was euthanased (put to sleep) before treatment	◯	◯	◯	◯	◯	◯	◯
The horse was treated (medically or surgically) and then was euthanased (put to sleep)	◯	◯	◯	◯	◯	◯	◯

23. How often do you read/ research about colic (including reading books / magazines, looking on the internet, talking to people etc.)?

- ◯ Once a week
- ◯ Once a month
- ◯ Once every 6 months
- ◯ Once a year
- ◯ Once every 2 - 3 years
- ◯ Very rarely (less than every 3 years)
- ◯ Never

Other (please specify)

24. Please use this box for any comments you have about any questions in this section, if you wish.

Diagnosis scenarios

This section is about trying to decide whether a horse has colic or not. We have given you a series of 'scenarios' to look at, and decide if you think the horse in that scenario has colic or not.

Please remember that there are no right or wrong answers, and we are most interested in which aspects people find difficult, so we can try and develop guidance to help with this. Therefore, please answer the questions as honestly as possible.
Many thanks.

25. Scenario 1:

You are out hunting with your friend. She is on her new 6 year old thoroughbred horse that she has owned for 2 weeks. This is the first hunt with her. Two hours into the hunt the horse pulls up and will not move. The horse is sweating and shaking and will not move from where it is stood. There are no obvious cuts or swellings on any of the legs. The horse has a heart rate of 68 beats per minute and a respiratory rate of 28 breaths per minute. The gut sounds are normal. The horse urinates and it looks a dark brownish colour.

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

26. Scenario 2:

It's late spring. You go to get your 7 year old TBx general purpose horse in from the field and find he is covered in mud and sweating. He also seems to be breathing a bit faster than normal. There are 4 other horses in the field which are eating normally and look OK. He is passing quite a lot of wind, has a heart rate of 44, respiratory rate of 24 and temperature of 38.2 degrees Celsius (100.8 Fahrenheit). His gut sounds are increased. He passes a normal looking dropping on the way back from the field, but is quite restless in his stable.

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

27. Scenario 3:

You are tending to your 12 year old intermediate event horse when you notice he seems quieter than usual. He has been on box rest since he got a nasty cut at a competition that needed stitches 8 days ago. Prior to this he spent equal time housed and at pasture, and was exercised twice a day. He hasn't eaten all of his haynet and you've noticed he hasn't drunk as much as normal over the past 3 - 4 days. He keeps stretching and turning his head around, to look at the flank of his injured leg. His heart rate is 28, respiratory rate is 12 and temperature is 37.5 degrees Celsius (99.5 Fahrenheit).

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

28. Scenario 4:

Another owner on your livery yard is distressed when tending her horse first thing in the morning. Her 15 year old arab gelding has a cut eye that is very swollen. He is normally highly strung and on closer inspection there are some other abrasions to both forelimbs, around the head and over the hip bones. He has a swollen right fore leg, is very dirty and has a lot of bedding stuck to his coat. He was last checked about 8 hours ago by the yard owner, who gave him an extra haynet, when he was fine. He's now sweaty and unsettled and is walking around the box and kicking at his belly. He has left half of his haynet and his bed is a mess which is unusual for him. Someone on the yard is a vet nurse and takes his heart rate which is 80 beats per minute, respiratory rate is 28 breaths per minute and gums are pale with a capillary refill time of 2.5 seconds.

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

29. Scenario 5:

An 18 year old pony which has been diagnosed with a condition called Cushings disease is lying down in your neighbour's field and refusing to get up. He is on pills for his Cushings and the vet has said it's under control. It is March and because it has been very wet, he's been in the stable for a few weeks. He has now been on grass for 3 days, with access to shelter. He was fine at 8am this morning (8 hours ago), and ate his feed and medication as normal. Apart from refusing to get up, he seems quite weak and he is a bit sweaty under his mane but there are no obvious cuts on him. He has a heart rate of 44 beats per minute and a respiratory rate of 24 breaths per minute. He has normal gut sounds

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

30. Scenario 6:

Your friend asks you to have a look at her 6 year old Welsh cob as she thinks there is something wrong. She moved to your yard a couple of weeks ago so that you could go hacking together. The horse has been in the field with both of your horses (which are perfectly healthy) since it was wormed last week. The horse seems very quiet and you notice it is very sweaty with twitching muscles. The horse is standing very oddly with its 4 feet very close together and looks very weak as its eyes are half shut. It is not interested in eating, although it has a small amount of what looks like food at both nostrils.

How likely do you think it is that this horse has colic?

- ◯ It definitely has colic
- ◯ I think it has colic
- ◯ I'm not sure if this is colic or not
- ◯ I don't think it has colic
- ◯ It definitely hasn't got colic

31. Please feel free to make any comments regarding the scenario section, should you wish.

Demographics

Finally, could you please provide some information about yourself. This will be treated with the strictest confidence, and will be coded to provide anonymity.

32. What age category do you belong to?

- ◯ Under 16
- ◯ 16 - 24
- ◯ 25 - 29
- ◯ 30 - 34
- ◯ 35 - 39
- ◯ 40 - 44
- ◯ 45 - 49
- ◯ 50 - 54
- ◯ 54 - 59
- ◯ 60 - 64
- ◯ 65+

33. Are you..

- ◯ Male
- ◯ Female

34. Approximately how long have you had horses for (owned/ loaned/ cared for)?

- ◯ less than 6 months
- ◯ 6 months - 1 year
- ◯ 1 - 2 years
- ◯ 3 - 5 years
- ◯ 6 - 10 years
- ◯ 11 - 20 years
- ◯ 21 - 30 years
- ◯ 31 - 40 years
- ◯ 41+ years

35. How many horses do you have (own/ loan/ care for) at the moment?

Number of horses

36. What is the MAIN activity that you undertake with your horse(s)?

- ◯ Hacking
- ◯ Schooling
- ◯ Showjumping
- ◯ Eventing
- ◯ Dressage
- ◯ Showing
- ◯ Breaking and/or training
- ◯ Hunting
- ◯ Endurance
- ◯ Horseball
- ◯ Polo
- ◯ Racing/ Point to point
- ◯ Driving
- ◯ Retired/ companion horse
- ◯ Breeding

Other (please specify)

37. Where are you based?

- ◯ UK
- ◯ Ireland
- ◯ Europe
- ◯ USA
- ◯ Australia

Other (please specify)

38. Please nominate the highest level you compete your (top) horse at.

- ◯ I never compete
- ◯ I compete at local shows only
- ◯ I compete at unaffiliated shows nationally
- ◯ I compete at affiliated shows nationally
- ◯ I compete at affiliated shows internationally

Other (please specify)

39. What BEST describes the time you spend with your horse(s)?

- ◯ I spend all of my time with my horse(s) (At least 8 hours every day, including weekends)
- ◯ I spend most of my time with my horse(s) (between 4 and 7 hours every day, including weekends)
- ◯ I spend a lot of time with my horse(s) (between 2 and 3 hours each day on weekdays and more at weekends)
- ◯ I spend a fair amount of time with my horse(s) (up to 2 hours each day in the week and more at weekends)
- ◯ I spend time with my horse at weekends only
- ◯ I spend time with my horse a couple of times a month
- ◯ I spend time with my horse 3 - 4 times a year
- ◯ I don't really spend time with my horse

40. What is the typical management of your horse(s)?

- ◯ Kept at grass
- ◯ Full DIY (kept at home)
- ◯ Full DIY (kept at yard)
- ◯ Assisted DIY
- ◯ Working livery
- ◯ Full livery
- ◯ Competition livery

Other (please specify)

41. Do you have any formal equine qualifications?
(If multiple, please choose the highest level of qualification)

- ◯ No formal qualification
- ◯ Pony club tests
- ◯ College course (NVQ, National Diploma etc.)
- ◯ BHS stages 1 or 2
- ◯ BHS stage 3 or AI
- ◯ BHS qualifications from BHSAI to BHSII
- ◯ BHS qualifications greater than BHSII
- ◯ Undergraduate degree
- ◯ Postgraduate qualifications (Masters/ PhD etc)
- ◯ Veterinary nursing qualifications
- ◯ Veterinary medicine qualifications

Other (please specify)

42. Please choose what best describes your approach to calling a vet to your horse(s).

(not including routine calls such as vaccinations and dental work)

- ◯ I call the vet out too often but would rather check there is nothing wrong
- ◯ I always call the vet when needed and know when they're not needed
- ◯ Generally, I always call the vet at the right time
- ◯ I'm not sure that I call the vet at the right time all of the time
- ◯ I don't know when I should call a vet out or not
- ◯ There have been quite a few times the vet should have been called sooner

Other (please specify)

43. How would you describe your relationship with your vet practice?
Please tick ALL that apply

- [ ] You get on very well with the vets and can ring them directly for advice
- [ ] You get on well with the vets and would have them for calls but wouldn't ring them directly for advice
- [ ] You don't really know the vets, would call the practice if you needed advice/ an appointment
- [ ] You don't really get on well with the vets so would only contact the practice if absolutely necessary
- [ ] You always get a different vet, so don't feel very confident with them
- [ ] You think the vets are too young and don't feel very confident with them
- [ ] You feel embarrassed to ask the vets questions in case they aren't relevant
- [ ] You feel intimidated by the vets
- [ ] You use the practice website frequently
- [ ] You use the practice fact sheets frequently
- [ ] You would call more often but you worry about the cost of an unnecessary call out
- [ ] You would call more often but you don't want to call the vets out unnecessarily and waste their time

Other (please specify)

44. If you wish to make any further comments that you feel may be relevant to this study, please use the space provided below.

THANK YOU!

I would like to thank you for your participation in this survey, your help is very much appreciated! This study is part of the work being conducted by a team of researchers at The University of Nottingham into Equine Colic. More information is available on the website:

www.colicsurvey.com

45. Please indicate if you would like to be contacted with the results of this study and with details of future research in this area.

The email address provided at the beginning of this study will be used to provide results and further details. Should you wish for this correspondence to go to a different address, please enter it in the text box below.

- ◯ Yes, I would like to be contacted regarding the outcomes of this study and future work.
- ◯ No, I would only like my consent email sent to this address, no further correspondence.

46. Correspondence email (if different from that already provided):

Appendix J Copy of consent email sent to participants in the equine owners' knowledge and approaches to abdominal pain (colic) in horses questionnaire.

Dear Participant,

Many thanks for completing the "Horse owner colic survey". This email is to provide you with a copy of consent. Please note than this will be the only communication sent to this email address, unless agreed to by you at the end of the study. Please find detailed below the terms of consent outlined in the survey, which you've agreed to by marking the consent box:

Participation in this research is entirely voluntary and there is no obligation to take part. Please note if you are under 16, you must have parental consent to take part.

This study has been approved by the School of Veterinary Medicine and Science's ethics committee. The information I collect will be presented in my PhD thesis and possibly used for publication and research presentations at conferences or meetings. All responses will be anonymised and no contact details will be passed on to any other persons or third party organisations. All data will be securely stored by the researcher.

Consent:

This consent form is a formal way of indicating that you agree to participate in this study and that you understand that any information collected by the researchers:

- will be used for a research study
- may be written in a report for publication
- may be presented at research conferences or meetings
- will be anonymised and treated confidentially
- will only be accessed by research colleagues or examiners
- that you can request to see a copy/summary of the completed study
- that you can request to see any information written down/kept during the process of data collection.

Should you wish to contact myself or my supervisor with regards to any aspect of this study, please email:

Researcher: Adelle Bowden - svxab4@nottingham.ac.uk

Supervisor: Sarah Freeman - svzslf@nottingham.ac.uk

Yours Sincerely

Adelle Bowden

PhD Student

University of Nottingham

Sutton Bonington Campus

Sutton Bonington

Leicestershire

LE12 5RD

Appendix K Development of REACT educational materials

The development of educational resources began with workshops to generate consensus statements based upon current available evidence, including systematic reviews of the literature and studies investigating horse owner approach and decision making with respect to equine colic. The scientific research comprised: a systematic review of 83 studies of risk factors for colic, a systematic review of 190 studies of diagnostic tests, data from 1,016 primary veterinary assessments of horses with colic, a survey of 248 veterinary surgeons opinions of diagnostic tests, a survey of 104 yard owners about equine emergencies, a survey of 1,564 horse owners on recognition and knowledge of colic and data from 2,604 equine veterinary out-of-hours assessments. There were two workshops, both of which involved multiple stakeholders including horse owners and veterinary surgeons as well as other representatives from the equine industry. The first of these was focussed on clinical signs of colic and the initial assessment, whilst the second aimed to address the approach to physical examination and diagnostic testing and identify areas where further education/research/training would be beneficial. The first of these workshops had a direct impact on the horse owner population and formed the basis of the current educational campaign, whereas the latter one was directed at the veterinary assessment and is part of a wider project to address veterinary evidence-based decision making specifically in colic cases. The second colic workshop and development of resources will not be discussed further within this thesis. The author of the thesis was involved in the organisation of the workshops and assisted with the running and presentation of some of the results from Chapter 6. The workshop development and results formed part of a PhD by another researcher (Laila Curtis) and a report has been published (Freeman and Curtis, 2015).

Statements relating to owners were produced during the workshops and were streamlined, reworded or combined where there were common or duplicated themes, or the original statement was ambiguous or did not suit a binary (yes

or no) answer. There were 26 consolidated statements generated from the first workshop containing information on a range of clinical signs and behaviours exhibited by horses with colic. In addition, 26 further consolidated statements were formed about clinical signs associated with critical cases of colic, and 32 consolidated statements about information required by veterinary surgeons attending at the initial assessment of colic. These included information about management, management changes, alterations in behaviour, changes in clinical parameters and financial considerations of the owner.

The statements generated at the multi-disciplinary stakeholder workshops were used to create an online consensus survey. A consensus process was conducted to ensure agreement between stakeholders on the statements that arose from the evidence presented at the workshops. The consensus survey was conducted by two student researchers (S. Yeoman and M. Curran) under the supervision of S. Freeman, J. Burford and A. Bowden with advice from Professor D. Walker at the Children's Brain Tumour Research Centre, University of Nottingham. Owners were asked to rank how common clinical and behavioural signs were in horses with colic, and state whether they agreed with the statements or not. They were also asked to identify their preferred type and distribution of educational resources. There were three rounds of the survey to allow modification and redistribution of statements that didn't reach consensus. The initial survey was open to all horse owners, however each subsequent round was distributed to the initial study population only (those who completed the first round). Statements reached consensus if there was 75% agreement or more of participants, and were rejected if they had less than 25% agreement. Any statements that did not meet the criteria for either of these categories were discussed within the research group and amended before being redistributed. After three rounds, statements that failed to reach consensus were rejected. There were 436 horse owners that completed the first round, and 178 completed all three rounds of the consensus process. Fifty eight of the developed statements achieved consensus, two were rejected, and six did not reach consensus.

The basis for the educational campaign included the accepted statements from the consensus process and the common clinical signs exhibited by horses with colic. The desired resources were identified using data from Chapter 6 and also the consensus survey. Discussions were held between S. Freeman, J. Burford and A. Bowden and it was decided that a dedicated website with a combination of resources including fact sheets and videos would best suit the requests of the horse owners. A poster including the main clinical signs was also discussed, along with an emergency plan template containing crucial information that may be required in an emergency. The topics identified from previous research as areas to cover (Chapter 6 and consensus process) were:

- What is colic?
- Recognising the signs of colic.
- Reducing the risk of colic.
- Emergency decision making in colic.
- Normal parameters in adult horses.
- What to do when waiting for the vet to arrive.
- What will the vet do if a horse has colic?
- Rectal examination.
- Nasogastric intubation.
- What happens at referral?

Online resources were easy to develop and relatively inexpensive, however to allow the provision of hard copies of the materials and achieve a greater impact it was decided to approach equine charities and organisations with an outreach to a large number of horse owners. The British Horse Society (BHS) were keen to collaborate on the project and supported the generation of evidence-based materials for horse owners. Furthermore, in the results of the study in Chapter 6, horse owners identified the BHS as a common source that was used to identify and access educational resources and information, whilst websites and the internet were highlighted as a desirable method of dissemination of material. The BHS agreed to front the marketing aspect of

the educational campaign, provide a dedicated space on their website for all of the information (http://www.bhs.org.uk/welfare-and-care/react-now-to-beat-colic) and produce and disseminate the resources once they had been developed. The areas listed above were allocated to a specific individual with research interests or expertise in that area. Persons were from either the University of Nottingham, BHS, or an external specialist (T.Mair and D.Archer). Each individual developed an evidence-based fact sheet which included referenced material that was then distributed throughout the members of the research group and BHS. Once all members had agreed on the content of the educational resources, they were sent to the BHS marketing department for production. A poster was produced by all members of the research group and the BHS collaboratively, and the REACT acronym was created using the most common clinical signs exhibited by horses with colic:

R – Restless or agitated

E – Eating less or droppings reduced

A – Abdominal pain

C – Clinical changes

T – Tired or lethargic

REACT became the title for the collective of educational resources and the tagline “REACT now to beat colic” was created to assist in the marketing and dissemination of the resources. All resources developed for REACT were available free of charge to any member of the general public. This applied to the packs that were produced, website access and all downloadable

The REACT resources (Appendix K) were introduced to the general public following a launch event at the annual BHS welfare conference on 1st September 2016. A presentation was given at the conference by A. Bowden and S. Freeman to provide a background and overview of previous research whilst announcing the variety of resources that had been developed and how they could be used by horse owners. There were two questions included in the conference feedback survey about REACT. The first of these was whether

horse owners had an emergency plan in place for their horse prior to the conference, whereas the second asked for their initial impression of REACT using a 10 point Likert scale. The BHS constructed a press release in timing with the launch to publicise the REACT materials, whilst 5000 individual 'packs' of hard copies of the resources were constructed for distribution to horse owners at horse shows, events and conferences. The dedicated web page (Figure 34) accessible from the BHS website was made live immediately after the conference, and it was initially (for three months) the focal news item of the BHS website home page in order to promote the resources. In addition, details of the REACT campaign were distributed to BHS members. Videos were also created; a short version for circulation on social media, and a long version for incorporation on the BHS website. A. Bowden also recorded an additional video demonstrating how to assess a horses' vital parameters (heart rate, pulse rate, respiratory rate and temperature) to be developed into an additional resource at a later date. The aim of the videos was to promote the campaign, and provide a brief overview of the content of the educational materials. Articles were written for the lay press and also the Veterinary Times and Veterinary Record to introduce and endorse the campaign amongst both the equestrian community and the veterinary profession. The BHS social media platforms (specifically Facebook and Twitter) were used to continually market and promote the REACT materials, beginning with regular, daily posts, with intermittent updates throughout the year that were further distributed by the Nottingham Equine Colic Project accounts. The posts included feedback and case studies, updates about campaign dissemination and reminders of the materials at intervals (such as when there was likely to be a change in management that could increase the risk of colic). The reach of REACT materials and website analytics were monitored, collated and reported at regular intervals by the BHS analytics team.

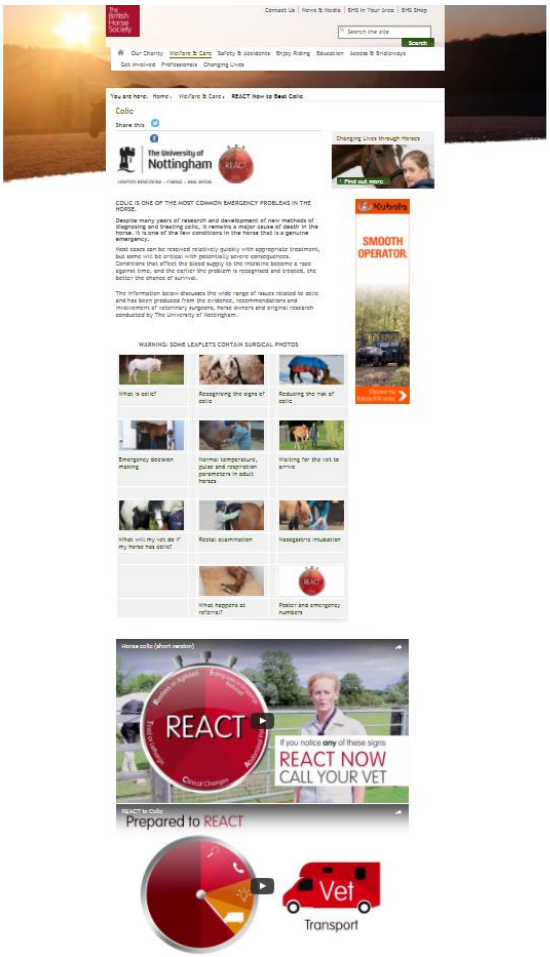


Figure 34: REACT now to beat colic webpage on the BHS website.

The workshops described in this study were undertaken by L. Curtis as part of her PhD (Curtis, 2016). A. Bowden presented results from the studies detailed in Chapter 4 and Chapter 6 at the first of the two workshops and assisted with the organisation, facilitation and running of the first workshop. The statements were condensed by S. Freeman, J. Burford, A. Bowden and L. Curtis. The online consensus survey for horse owners was conducted by M. Curran and S. Yeoman under the supervision of S. Freeman, J. Burford and A. Bowden. Development of REACT materials was undertaken by A. Bowden, J. Burford, S. Freeman, BHS staff and external specialists T. Mair and D. Archer. All resources were checked by A. Bowden, J. Burford and S. Freeman prior to printing or distribution.

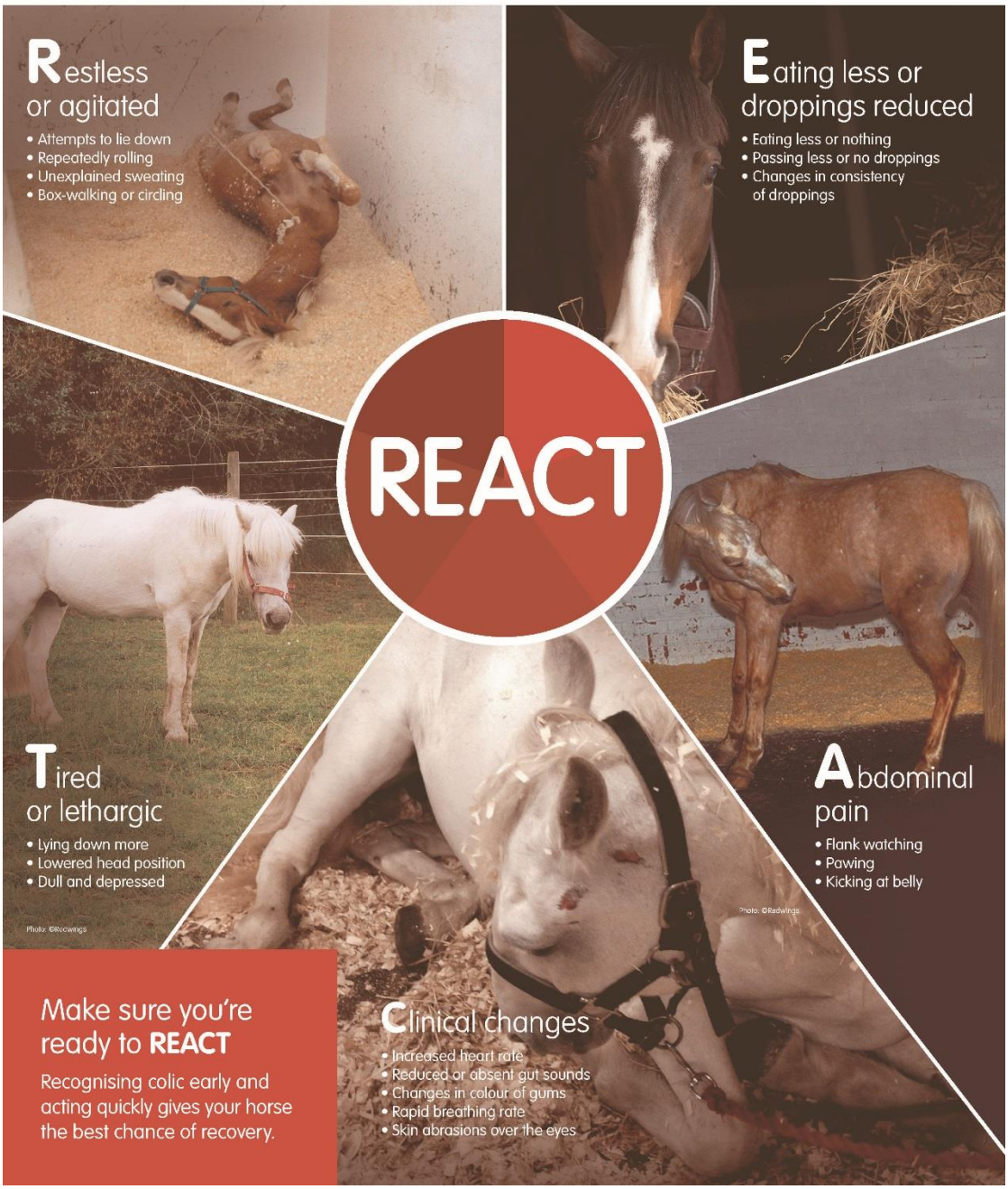
Appendix L Copy of the REACT resources



Figure 35: REACT poster.

Are you ready to **REACT** to colic?

If you notice any change in your horse's behaviour, or your horse is showing signs of distress, **REACT**. Even the most subtle changes could indicate there's a problem. Look out for warning signs like those illustrated below.
If you are concerned for your horse, contact your vet for advice.



Make sure you're ready to **REACT**

Recognising colic early and acting quickly gives your horse the best chance of recovery.

How you can help your horse

Making decisions in an emergency

Understanding what's normal for your horse can help you decide the best course of action to take. If in doubt, don't wait – call for veterinary help right away. Acting quickly is vital when a horse has colic, particularly if it's severe. However, planning ahead and knowing what's normal for your horse will save time, prevent stress and safeguard your horse's welfare.



Waiting for the vet

Waiting for the vet can be difficult. Following these tips could help your horse during this stressful time.

- Provide your vet with clear directions and a contact number – if it's likely to be difficult for them to find your horse, ask someone to wait by a roadside landmark to help direct them.
- Gentle walking can be helpful – but don't force your horse to walk if they resist.
- If your horse is in severe pain, put them in a safe area, such as a well-bedded stable, or in an arena – but keep them in control with a lunge line.
- Remove any feed, hay-nets and water buckets from the stable.
- Allowing your horse to lie down or roll does not make colic worse, or cause a twisted gut.
- If your horse is insured, check it's covered for colic.
- Have transport ready, in case your vet refers your horse for further treatment.
- Remember – a horse with colic can become dangerous to handle. Your safety is paramount!

Know what's normal

Knowing the normal temperature, pulse and respiration rates for your horse(s) means you will recognise if values are abnormal.

Typical heart (pulse) rate

28-44

beats per minute

Typical temperature

37.5–38.5°C

That's 99.5–101.3°F

Typical respiratory (breathing) rate

8-16

breaths per minute

To watch detailed videos demonstrating how to do these measurements, visit **www.bhs.org.uk/video-library**

My horse's heart rate		My horse's temperature		My horse's respiratory rate	
Horse's name	Normal rate	Horse's name	Normal rate	Horse's name	Normal rate

Owner	Vet	Emergency transport
Name:	Name:	Name:
Tel no:	Tel no:	Tel no:

If your horse shows signs of discomfort or illness, don't wait to call the vet, or waste time measuring parameters.
However, if you've recorded what's normal for your animal in advance, it could help your vet once they've assessed your horse.

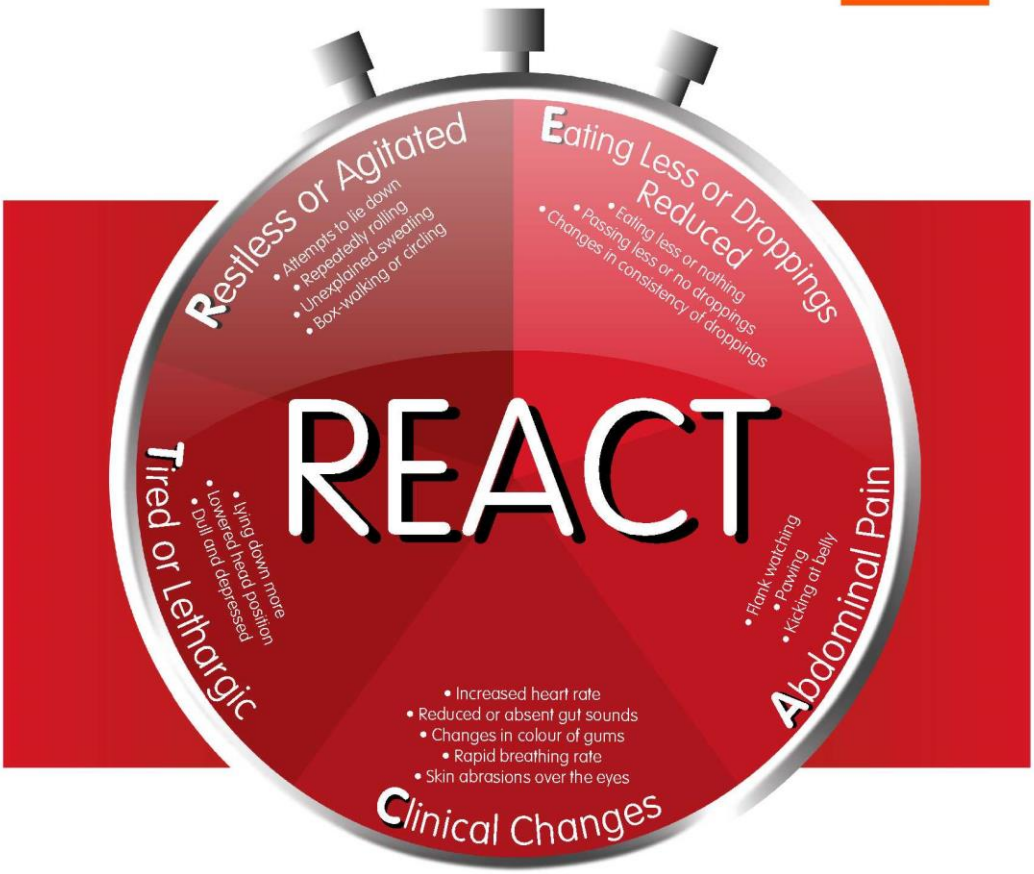
Registered Charity Nos. 210504 and SC038516

Figure 36: REACT pocket guide.

WHAT IS COLIC?

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

The British Horse Society



Colic is used to describe clinical signs of abdominal pain or discomfort in the horse; hence colic is technically a symptom rather than being a disease in itself. Colic is the most common equine emergency and cause of death in horses worldwide[1,2].

Colic can occur in any horse of any age and breed. Studies have identified an increased risk of colic occurring with a recent change in diet or housing, a history of previous colic, increasing age and the Arab breed[3]. As colic is potentially life threatening it should be treated as an emergency in all instances, as any delay in diagnosis could affect the prognosis and potentially prolong pain and suffering[4].

Please be aware this leaflet contains surgical photos

Types of colic

There are many types of colic, each with varying severity and causes. Only a veterinary surgeon should diagnose the type of colic (by the completion of specific tests) and assess its seriousness.

Spasmodic

- Spasmodic is one of the most common types of colic.
- Spasmodic describes the way the symptoms are shown spasmodically, and because it can be difficult to define, there is very little scientific evidence about what 'spasmodic' colic actually is or why it occurs.
- The horse will experience sharp bouts of pain which occur intermittently, presumed to be when a section of the gut spasms.
- Loud gut sounds may be heard.

TYMPANIC also known as flatulent or gas colic

- Tympanic colic occurs when excess gas accumulates in the intestine.
- Gas expansion in the gut causes the intestines to over stretch, resulting in pain, which can range from mild to severe.
- Horses can sometimes look bloated.
- High pitch gut sounds may be heard.

Impaction

- An impaction predominantly occurs in the large intestine (which consists of the caecum, colon and rectum).
- Impactions are caused by a firm, dry ball of solid material, usually ingested food or partially formed faeces, which prevents the normal passage of gut contents.
- The most common site for impactions is a region of the large intestine called the pelvic flexure, where the intestine narrows and turns through 180° which makes it more at risk of blockages.
- Horses usually experience low grade pain for prolonged periods. Colic signs may be more subtle, such as being off their food, or passing fewer or no droppings.
- Most cases recover with appropriate treatment.
- A small number of impactions may require surgery, or can be potentially fatal if the impaction is severe or not treated promptly. Some types of impactions, such as caecal impactions, can be more difficult to treat successfully.

Sand colic

- Sand colic occurs as a result of an accumulation of ingested sand and/or dirt within the gut which may also lead to an impaction.
- The sand and/or dirt leads to irritation of the bowel lining.
- Signs vary, ranging from mild colic as described for impactions, to more marked pain or diarrhoea.
- Sand may be found in the horse's droppings.



Incision into the pelvic flexure (large colon) to remove contents during surgery for a large intestinal displacement and impaction
Photo: Professor Sarah Freeman



Enterolith (sand/concretion) removed from small colon
Photo: Redwings Horse Sanctuary

Displacements

- A displacement within the bowel happens when one section of the gut moves abnormally within the abdomen. This movement can cause an obstruction.
- There are a range of displacements that can occur within the gastrointestinal tract.
- Signs of colic can vary from mild to severe, depending on whether the displacement obstructs the intestine.
- Some displacements can be treated medically but some types of displacement and more severe displacements may require surgery.

Strangulations

A **strangulating** obstruction disrupts or completely cuts off the blood flow to part of the gut.

A **torsion** occurs when parts of the gut rotates around the place where the gut attaches to the abdominal wall and subsequently cuts off the gut's blood supply.

There are a range of different causes of strangulations and torsions. However, both types of colic can be severe and surgery will be required urgently. Horses usually show severe and continuous signs of pain, and/or signs of shock (including sweating, dullness and depression).



Colic surgery for a small intestinal strangulation by a lipoma (fatty mass). The surgeon is holding the lipoma
Photo: Dr John Burford

Colic can also occur due to a range of other causes, including:

- Tumours
- Equine grass sickness
- Worm damage/heavy worm burdens
- Enteritis/enterocolitis – inflammation of the small and large intestine
- Infarction – blockage of a blood vessel to the gut
- Rupture or tear within the digestive tract
- Liver disease
- Pain from the other organs in the abdomen including liver, kidneys and reproductive system.



Parasite (worm) damage identified on the caecum at post mortem examination
Photo: The University of Nottingham

If you have any concerns for your horse's health contact your veterinary surgeon immediately

References

1. Tinker, M.K., et al., Prospective study of equine colic incidence and mortality. Equine Veterinary Journal, 1997. 29(6): p. 448-453.
2. Ireland, J.L., et al., Factors associated with mortality of geriatric horses in the United Kingdom. Preventive Veterinary Medicine, 2011. 101(3): p. 204-218.
3. Blikslager, A. and T. Mair. Trends in management of horses referred for evaluation of colic: 2004-2013. in Eleventh International Colic Research Symposium. 2014. Dublin, Ireland.
4. Proudman, C.J., et al., Modelling long-term survival of horses following surgery for large intestinal disease. Equine Veterinary Journal, 2005. 37(4): p. 366-370.

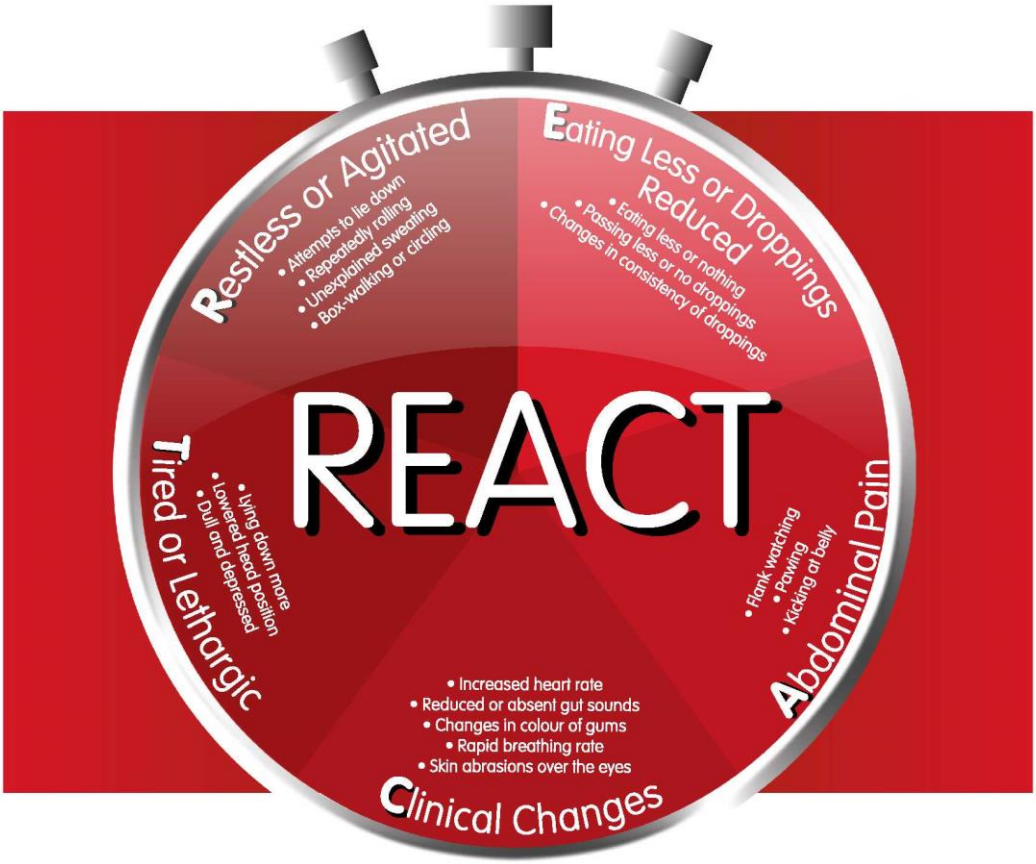
For more information please visit: **bhs.org.uk/colic**

Figure 37: REACT "What is colic?" factsheet.

RECOGNISING THE SIGNS OF COLIC

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

The British Horse Society



Horse owners, or the main person responsible for the care of horses, play a vital role in recognising the early signs of colic. Colic cases can quickly deteriorate so early recognition and prompt veterinary attention is vital to increase the chance of recovery for the horse.

REACT!

If you notice any change in your horse's behaviour or your horse is showing signs of distress, think REACT. Even the most subtle changes could be the only sign from your horse indicating that there is a problem. The signs shown by the horse can be extremely variable and can also be influenced by the severity and type of colic.

The five REACT signs are the most common and important indicators of colic (based on research from The University of Nottingham). The signs include:

Restless or Agitated

- Attempts to lie down
- Repeatedly rolling
- Unexplained sweating
- Box-walking or circling

Eating Less or Droppings Reduced

- Eating less or nothing at all
- Passing fewer or no droppings
- Changes in consistency of droppings

Abdominal Pain

- Flank watching
- Pawing
- Kicking at belly

Clinical Changes

- Increased heart rate
- Reduced or absent gut sounds
- Changes in colour of gums (healthy gums should be a salmon pink colour)
- Rapid breathing rate
- Skin abrasions over the eyes (indicates that the horse has been thrashing around and has caught this prominent area on their face; for example on the walls of the stable)

Tired or Lethargic

- Lying down more than usual
- Lowered head position
- Dull and depressed

Horses may show any of these signs, and it is important that owners/keepers contact their vet if any of these signs are observed or there are any concerns. Nottingham's research showed that classically described signs of colic, such as flank watching and kicking at the belly are not seen in every case, and therefore waiting for these signs to be displayed may delay diagnosing a problem or cause one to be missed completely. Other signs, such as eating less or passing fewer droppings, are more commonly seen and are important in recognising a problem early.

The REACT signs are not an exhaustive list of every possible sign of colic, but instead highlight five key aspects of your horse's health and behaviour that should be considered.

The descriptions for each of the five areas (e.g. flank watching, pawing, kicking at belly for abdominal pain) are listed in order of how common and important they are according to scientific research.

If you have any concerns for your horse's health
REACT NOW - CALL YOUR VET

Photo: Redwings Horse Sanctuary


Skin abrasions


Flank watching


Dark red gums indicate a serious problem


Tired or lethargic

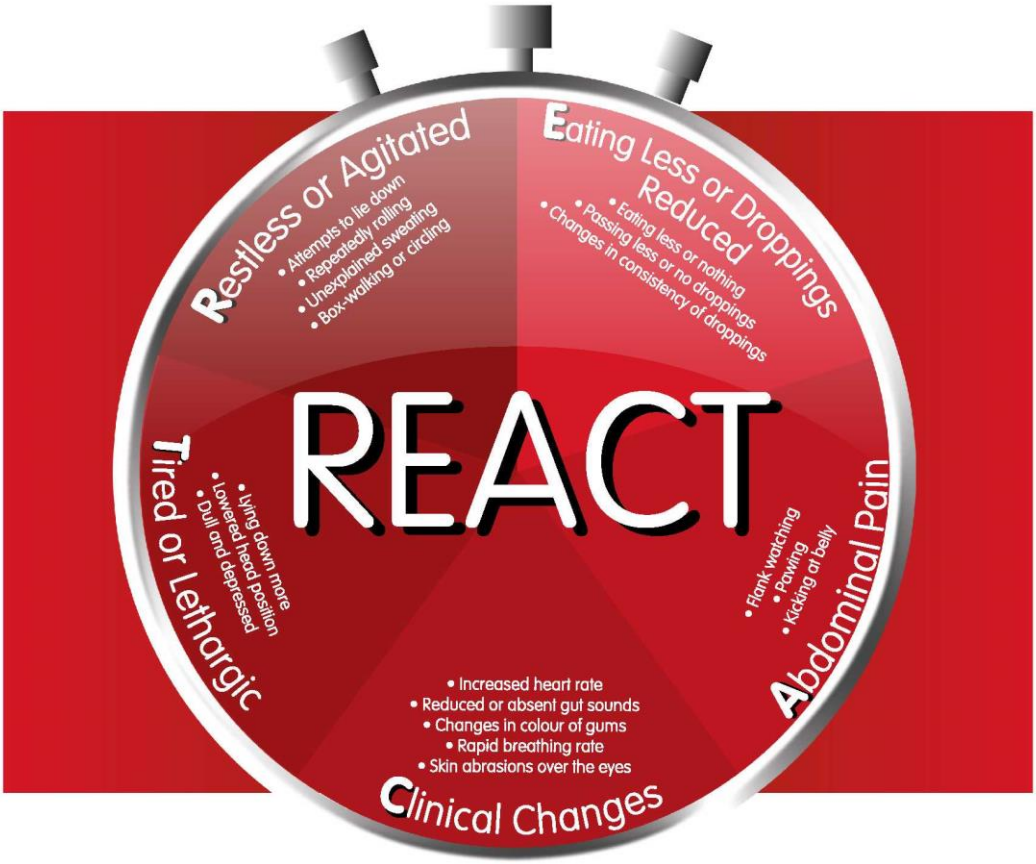
For more information
please visit: **bhs.org.uk/colic**

Figure 38: REACT "Recognising the signs of colic" factsheet.

REDUCING THE RISK OF COLIC

The University of Nottingham
UNITED KINGDOM · CHINA · MALAYSIA

The British Horse Society



Colic can occur at any time of the year in both grass-kept and stabled horses[1]. Studies have shown that the risk of abdominal pain in horses is higher with increasing age, within the Arab breed, following recent changes in diet or housing, and in horses with a history of previous abdominal pain[2].
In some horses, the specific cause of colic may never be determined and is often described as 'unknown origin'. Due to the many potential risk factors for colic there are plenty of simple steps that can be taken to help reduce the risk of it occurring.

For more information please visit: **bhs.org.uk/colic**

Feeding and Watering

Precautionary Measure	Why it Helps
The horse's diet should be predominantly composed of forage (for example, hay, haylage, grass).	The horse is a 'hindgut fermenter', which means its intestine has evolved to process a high fibre forage diet. Feeding a forage diet is vital for a healthy digestive system and maintaining normal gut motility.
Do not make sudden changes to your horse's diet. Ensure new feeds are introduced gradually.	The horse's large intestine contains billions of bacteria which are sensitive to change. Introducing new feeds gradually, ideally over 10-14 days, will help the bacteria acclimatise and adapt. If they do not have time to adapt they will not be able to assist in digesting the food which can lead to blockages or other problems within the gut.
If concentrate feeds are really needed, feed them little and often.	The horse has evolved to eat little and often and has a relatively small stomach. Small concentrate feeds will start to be broken down effectively by the stomach. Large amounts of concentrate food will pass unprocessed through to the large intestine which could lead to gastrointestinal problems.
Ensure a constant supply of clean, fresh drinking water is available when the horse is at rest.	Water is an essential component in the digestive process. It is continually secreted into and reabsorbed from the gut. Changes in hydration can affect the digestive process and how food passes along the gut. This can lead to problems such as impaction colic. If the drinking supply is from a silty natural water source this could lead to sand colic.
Do not allow horses to graze on sandy surfaces e.g. pasture with sparse grazing[3].	This prevents the horse from ingesting particles of sand and dirt which can then accumulate in the gut.
Ensure un-soaked sugar beet or grass cuttings are not fed to horses.	Un-soaked sugar beet can result in a dry ball of solid material being formed which can lead to an impaction. Make sure sugar beet is soaked and, in particular, warn any neighbours that border your horse's fields not to tip their grass cuttings into the paddock, as this can potentially lead to colic.



Routine Healthcare

Maintain a strategic worm control programme

It is important to maintain a strategic worm control programme to reduce the risk of high parasite burdens which can cause significant damage to the digestive tract, including disruption of the blood supply to the gut, ulcerations and perforations. A strategic programme includes pasture management, treatment based on monitoring faecal egg counts, selecting the most appropriate wormers and assessing risks for different groups, such as younger and older horses.

Regular dental checks

Dental checks should ideally be carried out every six to 12 months, by a qualified Equine Dental Technician or veterinary surgeon. Dental problems can affect the horse's ability to chew correctly and effectively, therefore increasing the risk of colic, especially impactions as the swallowed feed will be in larger particles than are ideal[4].



Photo: Dr Jeremy Kemp - Symonds Bransby Horses

Change in Season



Grass growth

Grass is normally more abundant, nutritious and lush for horses to eat during the spring and autumn. If consumed in large quantities this can result in rapid fermentation potentially leading to gas (tympanic) and spasmodic colics. During these periods of grass growth, grazing may need to be restricted to prevent the horse gorging on the grass. This is particularly important for those horses that have been kept stabled or on restricted turnout during the winter as a sudden change in management and diet can also lead to colic.

Cold icy weather can have a major impact on what the horse eats and drinks, especially if they are out at pasture. Make sure fresh water and good quality forage are always available. This may need to be supplementary forage such as hay if the weather conditions prevent the horse from grazing.

Stabling

Stabling horses during the winter but turning them out all summer is common practice at many yards. This change in routine should be completed gradually, as it represents a significant change in the horse's diet and exercise[5]. Horses that are suddenly moved onto box rest are at increased risk of colic, especially impactions[6]. Horses should ideally have access to daily turnout; if this is not possible, horses should be exercised or turned out in a safe arena. A high forage, low concentrate diet should be fed to promote the healthy movement of food through the gut.



Photo: Julie Priestley

Straw bedding

Using straw as bedding material should be used with particular care if the horse is being kept on a restricted diet. A straw bed can become another food source and this can increase the risk of impaction colic.

Exercise

Exercise requirements vary, but any change in intensity or duration must be gradual. Sudden changes to exercise regimes may result in the onset of colic and other problems. Horses should always be appropriately warmed up prior to and cooled down after exercise.

Feeding and watering horses in large quantities prior to hard exercise is not recommended. Similarly, feeding too soon after exercise, before the horse has completely cooled down, also poses the risk of inducing colic. Giving very cold water to a hot horse or large amounts in a single drink is best avoided. Once the horse has cooled down normal watering may be resumed.

Exercise, especially strenuous exercise, alters the status-quo of the horse's hydration and electrolyte status. Electrolyte balance is a vital part of hydration. Horses at maintenance level or in light work will often replace these losses through a balanced diet. Horses performing at a higher level will inevitably produce a greater amount of sweat and therefore lose more electrolytes and fluids. An electrolyte supplement will be beneficial to help replace these essential salts but they should be introduced gradually. Electrolytes can be administered by syringe or added to water or feed although it is imperative that the horse does not become dehydrated if it refuses to drink due to the addition of the electrolytes. Therefore, it is advised additional clean water without electrolytes is also provided.

Natural Predisposition

Displacements

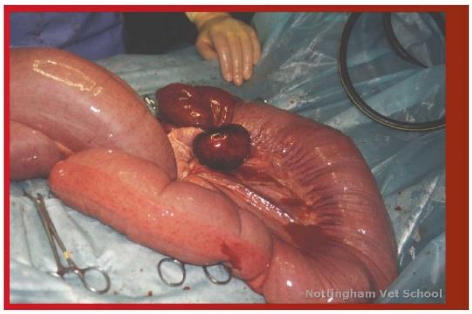
The complex system of twists, turns and suspension of the intestine within the abdomen predisposes the horse to gut health issues. Some types of displacements can be more common in larger horses and in mares after they have foaled. Large bowel displacements can be associated with impactions (and therefore have similar possible causes)[7,8].

Strangulations (also known as twisted gut)

Strangulations occur when a piece of the intestine becomes twisted around a lipoma (fatty lump within the abdomen cavity) or entrapped in other structures within the abdomen[9,10].

Torsions (rotation)

Torsions occur as a consequence of the complex composition of the horse's digestive system. Large colon torsions are more common in larger horses, mares after foaling, and following a change in management[11].



A lipoma (fatty lump) which caused a strangulation of the small colon.

Additional Causes

All horses are individual and can react differently in various circumstances which could potentially lead to colic. This can include:

- A stressful or exciting event – it is important to monitor the horse and ensure that once settled, the horse resumes eating, drinking and passing droppings.
- Windsucking/crib-biting – the management of the horse should be reviewed. Stereotypic behaviour can be a stress relieving mechanism for some horses and the complete prevention of the ability to exhibit such behaviours (for example using a crib collar) could potentially lead to increased stress, in turn leading to colic.
- Sedation can slow down gut function, and therefore, any horses which have been sedated should be monitored carefully following recovery.
- General anaesthetic – the veterinary team will closely monitor the horse following recovery.

Meconium retention in foals (meconium is the first faeces passed by a new born foal) can lead to an impaction. The new born foal should be closely monitored to ensure the first and then regular droppings are passed.

History



Some horses are more prone to colic, and may have recurrent episodes of colic[3]. It is strongly advised that horse owners work closely with their vets for advice on prevention and management if your horse has suffered colic previously.

Horses which had had colic surgery previously are also at an increased risk of colic in the future[12].

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Figure 39: REACT "Reducing the risk of colic" factsheet.

EMERGENCY DECISION MAKING

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Time is of the essence when a horse has colic, especially if the case is severe and referral to a veterinary hospital is required. Any delay could potentially affect the outcome for the horse.

A stressful situation can be further exacerbated if plans have not been put into place beforehand. Creating a list of contacts and having a provisional plan is a lot easier to prepare in advance than during an emergency in the middle of the night.




Photo: Dr John Burford

Colic Surgery

Although a large proportion of colic cases can be treated at the yard, there are certain types of colic which will require surgery. The cost of colic surgery can be £5,000 or more; and this can increase further if complications occur. Sending a horse for colic surgery is a big decision and due to the rapid rate at which horses can deteriorate, a decision needs to be made quickly. There will be factors affecting this decision which include:

- The severity of colic
- The potential prognosis for the horse following surgery
- The cost implications

The thought of having to send a horse for colic surgery is extremely daunting. However having a provisional decision made in advance, should the worst happen, is a strong starting point. A delayed decision could affect the horse's chance of survival, potentially increase the aftercare costs and prolong the suffering of the horse. It is important the horse owner remains as calm as possible so it can be helpful to have a friend or family member ('colic buddy') that you can contact in an emergency to assist and accompany you to the veterinary hospital if you decide to proceed with surgery.

Insurance

Insurance policies for veterinary costs provide a reassuring investment for many horse owners should colic occur. The decision to send a horse for colic surgery can be made easier with the knowledge that the cost will be covered up to the maximum amount stipulated by the policy. However, it is vital that the policy details and small print have been checked and fully understood at the time of purchasing or renewing the insurance. Horse owners should check the maximum amount the policy will pay out per incident and be prepared to pay any additional costs not covered by the policy or those over and above the policy limit. Not all insurance policies cover colic; in particular veteran plans frequently have colic as an exclusion.

It is important not to delay taking a horse to the veterinary hospital if you cannot contact your insurance company. Insurers are used to these instances but request that they are informed of the referral at the earliest opportunity. This is why it is vital to ensure you are aware of the insurance policy cover for your horse, in particular that insurance policies do not cover any condition which pre-existed the policy. If the insurance company declines to support the insurance claim, the outstanding bill will be the responsibility of the owner to pay.

Following a claim for veterinary treatment, the majority of insurance companies will cover the costs of associated treatment for 12 months from the date the condition was first noticed (as long as the maximum amount hasn't already been paid). After this time, insurance companies will normally place an exclusion on the policy which prohibits any further cover for the specific issue and any condition related to it. Therefore, any colic episodes in the future are highly likely to no longer be covered and all associated costs will have to be paid by the owner.

What happens if the owner is not contactable?

In the absence of a horse owner, deciding whether a horse should be referred is almost impossible if no guidelines have been left. Livery yard managers should ensure they obtain the instructions from all owners for what they want to happen with their horses in the event of an emergency. Circumstances can change so any amendments should be communicated to the yard manager. Where possible, close friends at the yard or family members should also be notified of the instructions and be prepared to attend to the horse to represent the owner. In addition, notifying your veterinary practice of your instructions will also greatly assist the visiting vet.

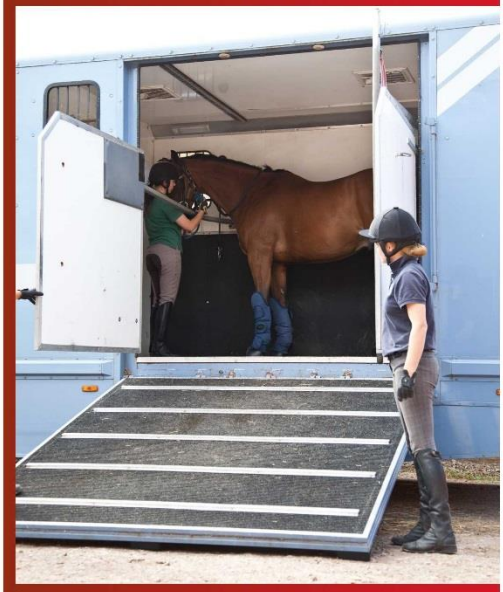
Having thought about emergency plans in advance will ensure the most effective response. Preparing for emergencies and ensuring key people know your plans will help prevent a lot of stress for everyone involved and most importantly safeguard your horse's welfare.

Emergency Transport

Those owners fortunate enough to have their own transport should ensure the vehicle is well maintained so that in the event of an emergency it is ready and safe to use. Where possible, practice loading your horse so should an emergency situation occur, your horse is trained and not resistant to being loaded.

Horse owners who do not have transport are strongly advised to source reliable, experienced transport companies in advance whose operating hours are 24/7. Creating a list of reputable companies will prevent a delay and a panic trying to locate a transporter who is able to attend immediately. The cost of transporting a horse to the veterinary hospital may not be covered by the insurance policy, so the horse owner should be prepared to pay the transport fees.

The law states that the horse's passport should accompany the horse when being transported unless in the event of emergency veterinary treatment. Ideally the passport would travel with the horse but do not delay the horse's journey while you search for it. If necessary somebody else can bring the passport for you later, the veterinary hospital will need to see it. You should, though, keep the passport somewhere that is easily accessible.



For more information please visit: **bhs.org.uk/colic**

Figure 40: REACT "Emergency decision making" factsheet.

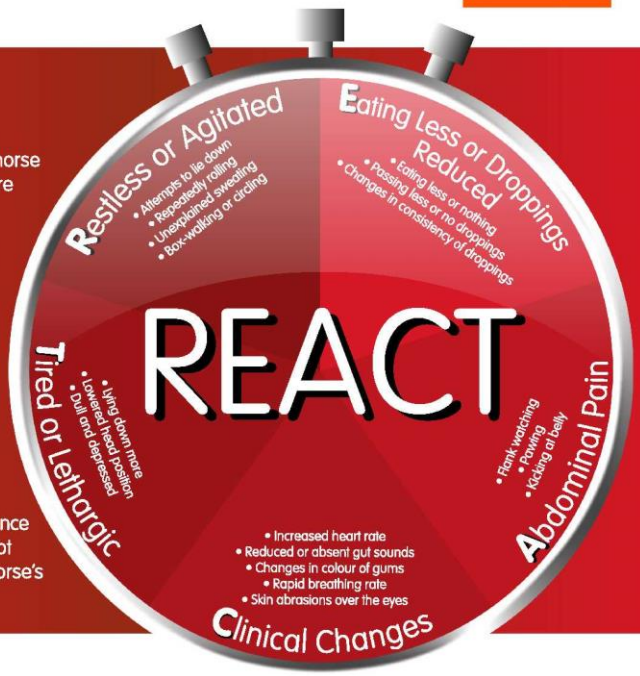
NORMAL TEMPERATURE, PULSE AND RESPIRATION PARAMETERS IN ADULT HORSES

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WHAT IS IMPORTANT?

- Knowing the 'normal' temperature, pulse and respiration rates for your horse means you will recognise if values are abnormal.
- If there is no reason for a change in parameters such as recent stress or exercise, seek veterinary advice.
- If your horse is showing any signs of illness or discomfort despite having normal parameters, or if you have any concerns, veterinary assistance should be sought.
- If your horse is showing signs of discomfort or illness, veterinary assistance should be sought immediately. Do not waste time trying to measure your horse's parameters beforehand.



NORMAL RANGES

HEART (PULSE) RATE
28 – 44 beats per minute

RESPIRATORY (BREATHING) RATE
8 – 16 breaths per minute

TEMPERATURE
37.5 – 38.5°C (99.5 – 101.3°F)

WHAT DO I NEED TO KNOW?

- There will be variation between individual horses and each horse will have a different 'normal' value for them. This is because the value is dependent on age, the size of the horse and the level of fitness. Heart rate and respiratory rate can increase in horses as a result of stress, anxiety, excitement or exercise. Values may also be increased in horses who are experiencing pain for any reason, or when the horse becomes ill.
- Regularly taking your own horse's pulse rate, respiration rate and temperature is important as it will provide you with the knowledge of what is normal for your horse.
- Some horses may have values which are consistently out of the 'normal' range in a similar way to some humans. This may not be any cause for concern. However, in these cases it is advisable to have the horse checked by a veterinary surgeon to ensure there are no underlying conditions.

MEASURING HEART OR PULSE RATE

Taking the horse's heart rate



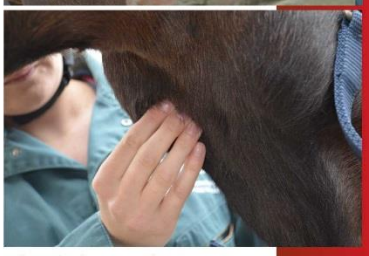
Heart Rate

Using a stethoscope, on the left hand side of the horse apply gentle pressure at the location shown in the picture (against the chest just behind the elbow). In horses with a broad chest or those carrying extra weight, it may be harder to hear the heartbeat. Moving the horse's leg forward may make access easier, improving the clarity of the heartbeat. Each heartbeat has two parts as in a human. It takes practice to learn where to place the stethoscope to hear the heartbeat best.

Pulse Rate

If you do not have access to a stethoscope the horse's pulse can be taken at the facial artery. The facial artery runs over the jaw bone at the bottom of the muscular part of the horse's 'cheek', in between where a noseband and throat lash would sit. The location is also shown on the image provided. The facial artery is approximately 1cm in diameter and feels tube-like, but can be pressed easily. Stabilise the artery with your fingers just on the inside of the jawbone, thumb outside is best (as you will feel your own pulse in your thumb), apply gentle pressure until a pulsing sensation is felt underneath the fingers.

Count either the number of heartbeats or pulse rate for 15 seconds and then multiply the amount by four to calculate the heart rate in beats per minute.



Taking the horse's pulse

MEASURING RESPIRATORY RATE

This can be taken by looking at the abdomen/flank area of the horse to look at the rise and fall. An inhale followed by the exhale equals one breath. Similar to the heart rate, count the number of breaths for 15 seconds and multiply the amount by four to calculate the breaths per minute.

TAKING A HORSE'S TEMPERATURE



Taking the horse's temperature

1. Temperature is taken rectally in horses, using a digital or mercury thermometer.
2. If using a digital thermometer, turn it on and check the display is working. With a mercury thermometer the temperature needs to be lowered and this is done by shaking the thermometer (taking care not to drop it!).
3. Add lubricant to the bulb end of the thermometer.
4. Ask a helper to hold the horse for you.
5. The operator should stand at the side of the horse, near the hindquarters to decrease the risk of being kicked.
6. Take hold of the tail and pull gently towards the side of the hindquarters.
   Gently insert the bulb of the thermometer into the anal sphincter. It is not necessary to insert the whole thermometer, just the narrowed section (approximately 3-4cm).
7. As the thermometer is inserted, angle it to one side so that the bulb rests against the mucous membrane and doesn't end up hitting a ball of faeces which will be colder.
8. Keep hold of the thermometer for at least 30 seconds or until the digital thermometer beeps to indicate it is ready to be removed. Never let go of the thermometer as it can disappear. With the help of the handler continue to reassure the horse.
9. Withdraw the thermometer and check the reading.
10. Ensure the thermometer is cleaned and disinfected ready for future use.

Photos: The University of Nottingham

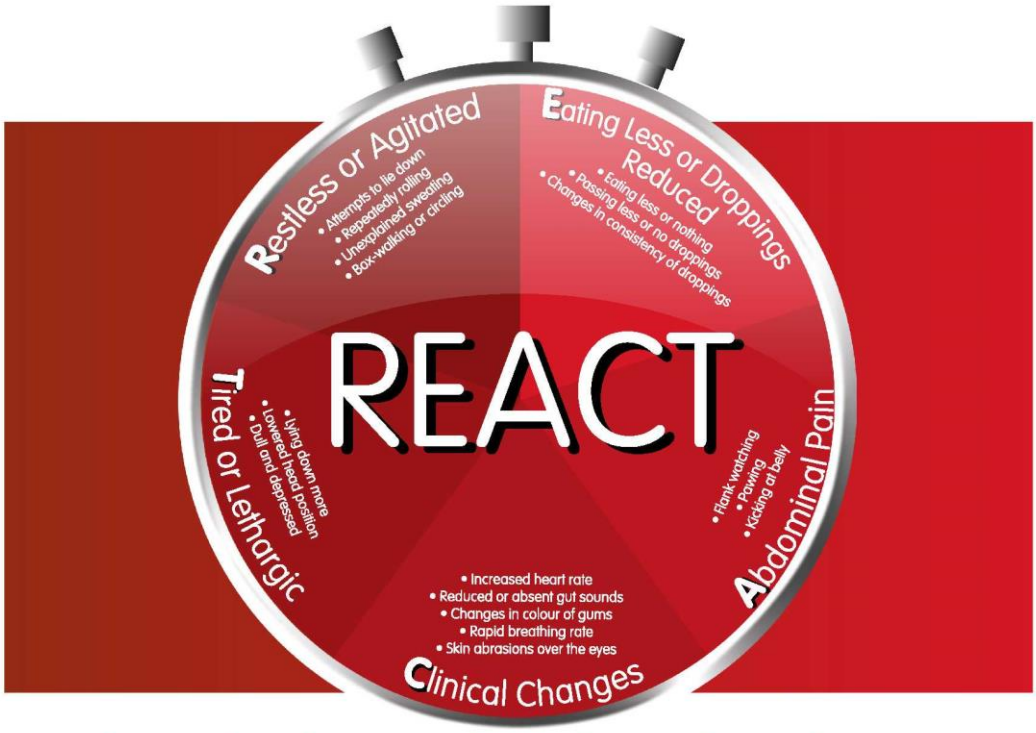
Safety is paramount at all times. Some horses may be resentful of the use of a rectal thermometer. A hard hat should be worn and you must take care to stay out of range of the horse's hind legs. If you do not feel comfortable to take your horse's temperature you should ask someone more experienced or your veterinary surgeon.

Figure 41: REACT "Normal TPR in adult horses" factsheet.

WAITING FOR THE VET TO ARRIVE

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What to do when your horse has colic and you are waiting for the vet or referral to a veterinary hospital

If your horse is in severe pain (i.e. trying to get down and roll) it is advisable to put them in a safe area such as a well bedded stable or in an arena (with a lunge line to be able to keep control of them) to help decrease the risk of injury. Take out any buckets or any other objects the horse may injure themselves on in the stable and leave them quietly until your vet arrives and can give them a sedative / painkiller. Allowing the horse to lie down and/or roll does not make colic worse or cause a twisted gut. Although it can be distressing to witness the horse in significant pain it is strongly advised that the handler does not re-enter the stable without veterinary support to help prevent a potentially serious accident to the handler. If the horse is taken into the arena the handler should not allow the horse to go loose. For safety, the handler should wear a hat and gloves. A horse in significant pain will not be conscious of its surroundings, and therefore you should take all measures to ensure your safety.

For more information please visit: **bhs.org.uk/colic**



If your horse is in significant pain, gentle walking for 15-20 minutes can help and will not harm them. However horses must not be exercised at a trot or canter and should not be walked around for longer periods of time unless under the supervision of your vet. There are specific conditions /circumstances when your vet may recommend other exercise. This should only be done following diagnosis and under supervision from your veterinary surgeon, as any exercise beyond gentle walking is not recommended for most conditions. If in any doubt, ask your veterinary surgeon.

Exercising a horse that is sick will just exhaust them and if they have a serious form of colic that requires surgery, this will not help their recovery from anaesthesia.

- Remove any feed from the stable. Horses that are not in violent pain and are standing calmly in the stable can have water left with them; although a sick horse is unlikely to drink.
- Provide your vet with good directions and a contact phone number.

If it is likely to be difficult for the vet to find your horse, get someone to stand by the roadside near a defined landmark to help direct them to the yard / field.

- If your horse is insured, check whether they are covered for colic (this can cause delays if your vet wishes to send them into a clinic for further assessment and appropriate treatment). You should also check the amount of cover so that you can make informed decisions about treatment if your vet recommends referral.

Check that you have a plan in place for transport in case your vet decides that your horse needs to be assessed at a clinic. If your horse is in a lot of pain or sick, any delay can be crucial so don't leave this until the last minute.

- Check that the trailer / horsebox does not have any flat tyres and that the horsebox will actually start. From a referral centre point of view, difficulties with transport is a frequent cause of delays, which can be really critical in saving the life of a horse with severe colic.

If your vet advises that your horse should be assessed at a clinic:

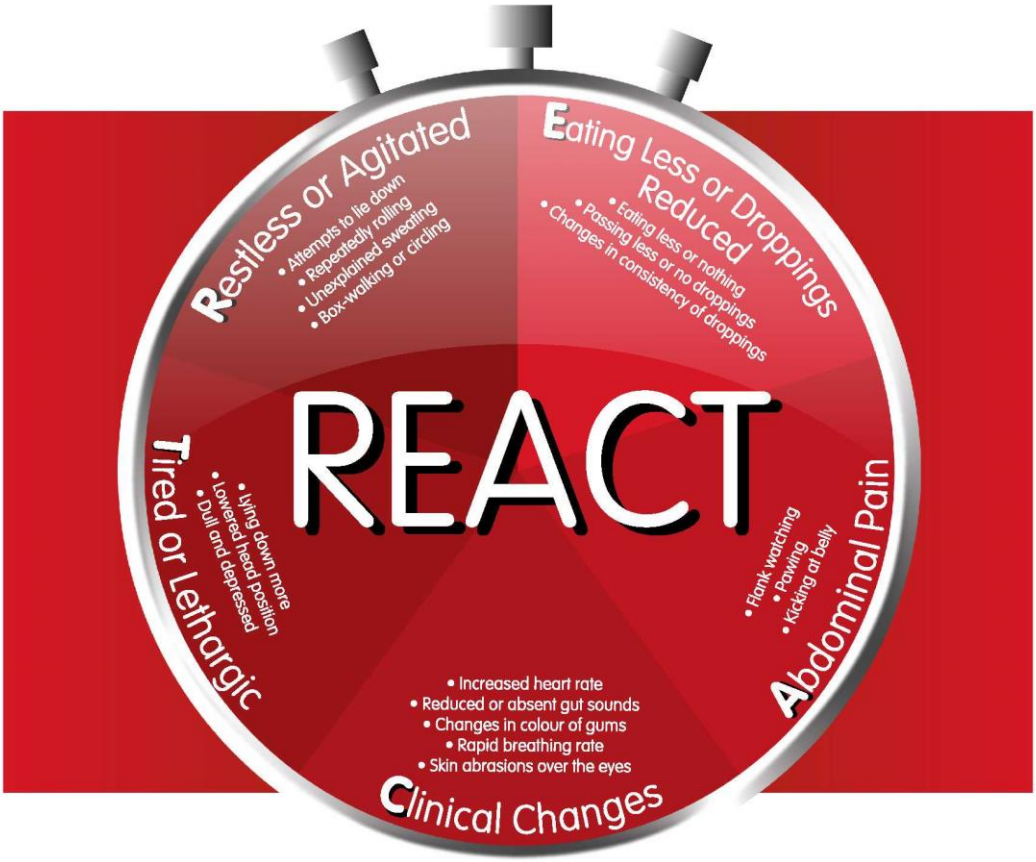
- Discuss the potential costs (at this stage only a rough guide can be provided) and whether a deposit is needed. Costs will vary slightly between clinics, but your vet and the clinic will be able to provide you with more specific estimates and some idea of likely complications and chances of survival.
- Check that you have good directions and the telephone number of the clinic and keep them updated if there are any problems or delays during the journey. It is important to get to the clinic as soon and as safely as possible.

Figure 42: REACT "Waiting for the vet to arrive" factsheet.

WHAT WILL MY VET DO IF MY HORSE HAS COLIC?

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It can be difficult to find out why a horse has developed colic, and in many cases the exact cause may not be identified. Your vet will go through a series of steps when they examine your horse to help rule out more serious problems and attempt to establish the most likely reasons your horse is showing signs of pain.

It is helpful for your vet to establish the history of the horse and therefore, they will ask a number of questions depending on the particular circumstances of each case. These questions are likely to include if your horse has had any previous health problems, especially colic, current management of the horse and any recent changes[1,2,3]. The best individual to answer these questions is the person who is mainly responsible for the care and management of the horse. If this person is not available, you may need to contact them or ask them to provide this information to the vet at a later stage. Establishing the history of the horse is a very important part of the vet's assessment as it can help indicate likely causes, but the vet will also use this information to give any advice on avoiding problems in the future[2,3].

The next step is the physical examination where the vet will make a full assessment of your horse. Once again, the examination performed will depend on the circumstances of each case, but may include listening to your horse's heart, chest and gut sounds, checking their temperature and gum colour, as well as observing and assessing how much pain the horse is in[4]. The physical examination rarely helps identify the exact cause of colic, but is very important in determining how severe the problem is, and which further tests may be needed.

The vet may request assistance to keep the horse as still and quiet as possible during the physical examination. However, if the horse is very restless, showing signs of significant pain or becomes too difficult to handle, the vet may administer sedatives or painkillers to help them settle and to help keep everyone involved safe. Some situations can be difficult and distressing. If you have any concerns about holding the horse or assisting the vet, you must inform them so they can make alternative arrangements.

The vet may then perform some further tests to assess why the horse has colic but again, the tests used can vary between individuals. The most commonly used diagnostic tests are rectal examination and nasogastric intubation (also called passing a stomach tube)[3].

1. Curtis, L., et al., Systematic Review of Risk Factors for Equine Colic. Equine Veterinary Journal, 2014. 46: p. 21-21.

2. Scantlebury, C.E., et al., Recurrent colic in the horse: Incidence and risk factors for recurrence in the general practice population. Equine Veterinary Journal, 2011. 43: p. 81-88.

3. Jennings, K., et al. Prospective survey of veterinary practitioners' primary assessment of equine colic: clinical features, diagnoses, and treatment of 120 cases of large colon impaction. BMC Vet Res, 2014. 10 DOI: 10.1186/1746-6148-10-S1-S2.

4. Curtis, L., et al., Prospective study of the primary evaluation of 1016 horses with clinical signs of abdominal pain by veterinary practitioners, and the differentiation of critical and non-critical cases. Acta Vet Scand, 2015. 57: p. 69.

Photos: The University of Nottingham



A vet measuring a horse's heart rate



A sedated pony

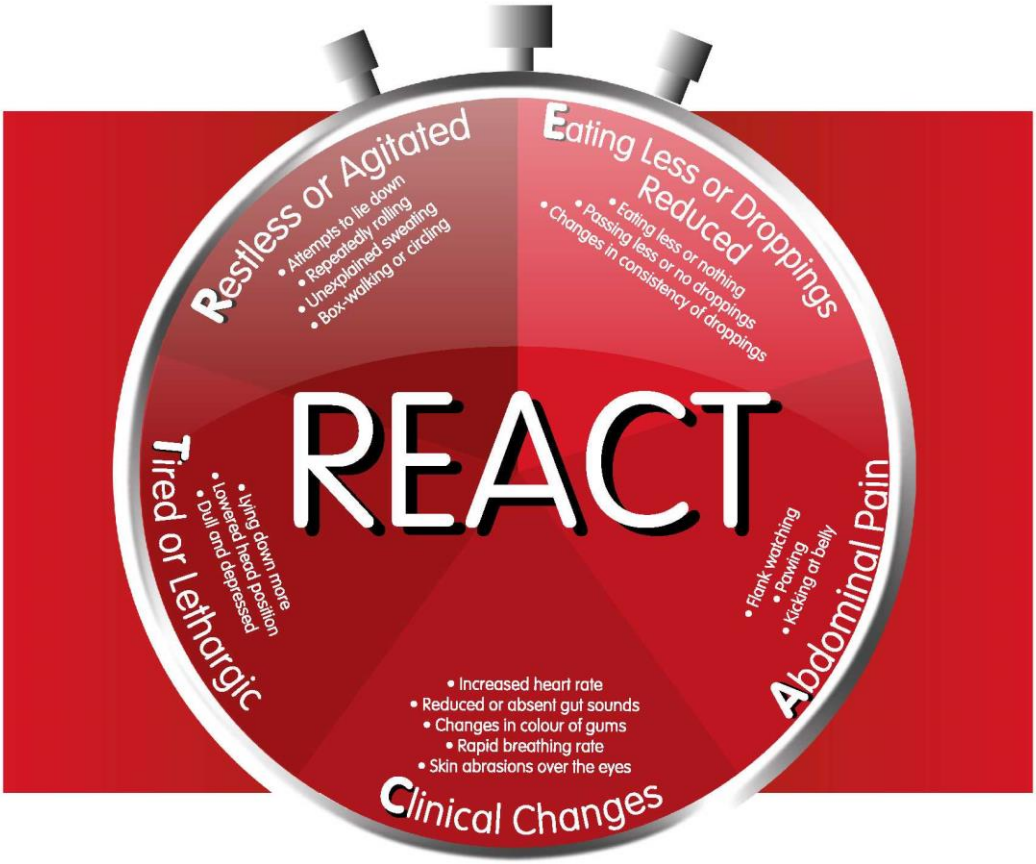
For more information please visit: **bhs.org.uk/colic**

Figure 43: REACT "What will my vet do if my horse has colic?" factsheet.

RECTAL EXAMINATION

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Why is a rectal examination performed in horses with colic?

Rectal examination is the test that vets use most commonly to help them find out the cause of colic[1,2]. Rectal examination involves the vet placing their hand and arm into the horse's rectum so that they can feel inside the abdomen. This enables them to identify anything that feels abnormal or out of place, and in many cases, it is an important part of deciding what next steps and treatments are required. This procedure is not without risk both to the horse and to the vet, but is often the only way to find out what is going on within the horse's abdomen. Rectal examination of a horse is a veterinary procedure, and should only be performed by a veterinary surgeon.



A rectal examination being undertaken by a vet

What happens during a rectal examination?

The horse has to be restrained quietly during this procedure. If you do not feel confident restraining your horse during a rectal examination, you must inform your vet. In veterinary hospitals, the horse may be placed in stocks (open-sided stall that limits the horse's movement) to help restrain it and reduce the risk of the vet being kicked. On the yard or field, the vet will often place the horse against a wall or hay/straw bales to help restrain it. Horses may require sedatives or relaxants for this procedure. The vet will then introduce their hand and arm gradually into the rectum, moving it slowly forwards and then feeling the different organs within the abdomen. Some of the key things that they will be feeling for are whether there is an impaction or feed blockage within the intestine, whether any of the intestine is displaced from its normal position, and whether there is a build-up of gas or fluid within the intestines. The vet can also feel other organs, such as the bladder, uterus, ovaries and spleen, and check for other possible causes of colic. The rectal examination is one of the most important diagnostic tests as it can be the only way of diagnosing some conditions, and specific abnormalities associated with critical or surgical cases.

Limitations and possible complications

There is a risk to the vet of being kicked or injured, and a rare but potentially serious risk to the horse of internal injury during the procedure. In addition, as the horse's abdomen is so large, it is not possible for the vet to feel everything so a potential problem could remain undetected during this procedure. The vet will weigh up the risks against the importance of the test in each case to make a decision on whether or not to proceed. If your horse has a specific condition such as an impaction, or a surgical problem, the rectal examination can give the earliest indication of a problem and the best chance of a successful treatment[3].

If you have any concerns or queries about the procedure, you should discuss these with your vet.

1. Curtis, L., et al., Prospective study of the primary evaluation of 1016 horses with clinical signs of abdominal pain by veterinary practitioners, and the differentiation of critical and non-critical cases. Acta Vet Scand, 2015. 57: p. 69.
2. Curtis, L., et al., Veterinary practitioners' selection of diagnostic tests for the primary evaluation of colic in the horse. Vet Rec Open, 2015. 2(2): p. e000145.
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Photo: The University of Nottingham

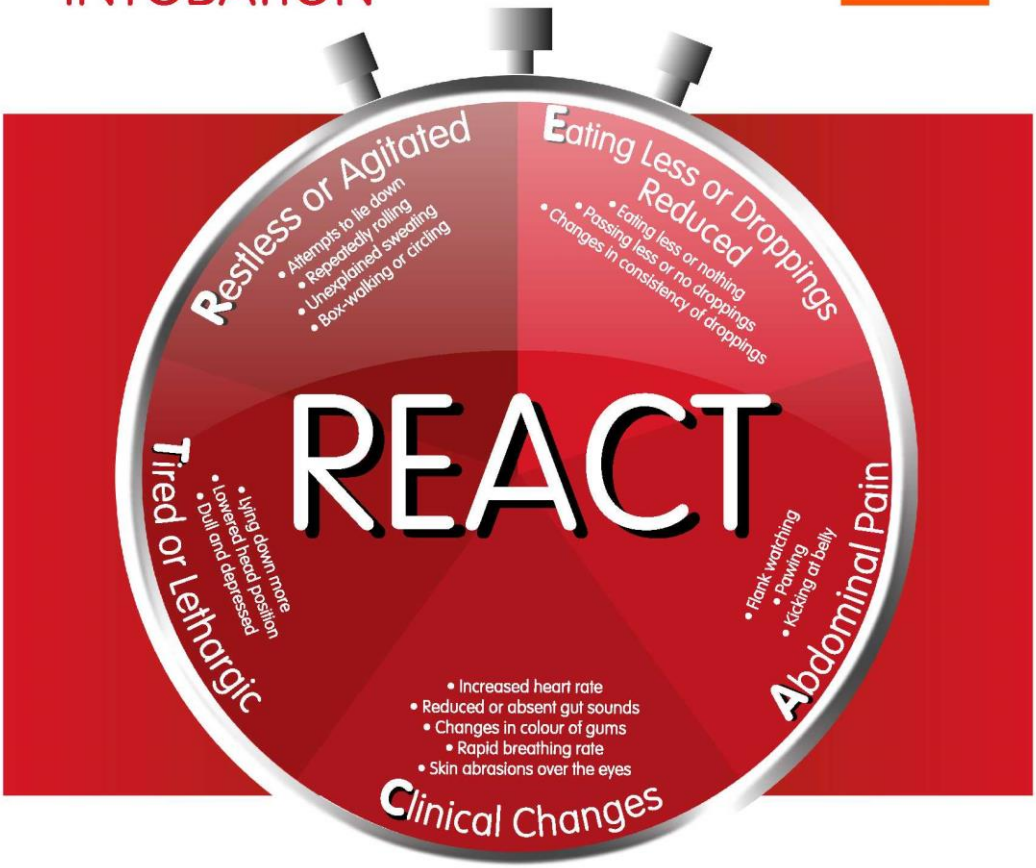
For more information please visit: **bhs.org.uk/colic**

Figure 44: REACT "Rectal examination" factsheet.

NASOGASTRIC INTUBATION

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WHAT IS NASOGASTRIC INTUBATION?

Nasogastric intubation, more commonly known as stomach tubing, involves passing a hollow tube up the horse's nose, down the oesophagus (gullet) into the horse's stomach. It is used by a vet to identify if there are any abnormal contents in the horse's stomach, and to administer fluids and some treatments directly into the stomach. It is the second most commonly used test to help diagnose horses with colic (rectal examination being the most common). Horses may resent this action being undertaken, but it can be an essential procedure to perform in some cases.

Why is it performed?

The anatomy of the horse's gastrointestinal tract means that in theory, horses are unable to vomit[2]. Therefore, any blockages resulting in a build-up of food and fluid within the stomach or small intestine can't be relieved. Instead the stomach becomes more and more distended (swollen), causing severe pain. If this distension is not relieved, the stomach can rupture with fatal consequences. This is rare and only occurs with certain types of colic, but it is an important reason why a vet may want to use a stomach tube.

Nasogastric intubation is also the only method of giving fluids directly into the intestinal tract. Fluids are used to relieve conditions such as impactions, to provide electrolytes and administer other treatments as required[3]. This can be an important part of treatment as horses with colic are often reluctant to eat or drink.

Limitations and possible complications

There are some potential complications of nasogastric intubation; the most common resulting in the horse having a nose bleed. There is a highly vascular (lots of blood vessels) structure called the ethmoturbinates at the back of the horse's nasal cavity which the stomach tube passes next to. As a result it is not uncommon for this to bleed during or after intubation.

Nose bleeds in a horse can look quite dramatic; it can look like a large amount of blood, even though it is a small proportion of their total blood volume (for example, an average 500kg horse has over 50 litres of blood in its body). The sensation of a nosebleed will also make the horse blow out through their nose, spreading the blood over their surrounding area. Although nose bleeds in the horse can look dramatic, they are not painful to the horse, and should stop without any problems given enough time.

In some horses it can be difficult to pass the tube into the oesophagus and repeated attempts may be required. Horses that are sedated or are very sick may have a reduced swallow response making it harder to pass the tube. It is very important that the tube is passed into the oesophagus and not the airway and therefore your vet make take extra time to check the position of the tube.

Nasogastric intubation of a horse with colic is a veterinary procedure, and should only be performed by a veterinary surgeon.

Nasogastric intubation is an important part of assessing a horse with colic, and in a horse with severe distension of the stomach it may be a life-saving intervention. If you have any concerns or queries about the procedure, you should discuss these with your vet.

1. Curtis, L., et al., Veterinary practitioners' selection of diagnostic tests for the primary evaluation of colic in the horse. Vet Rec Open, 2015. 2(2): p. e000145.

2. Dyce, K.M., W.O. Sack, and C.J.G. Wensing, Textbook of Veterinary Anatomy. 2002: Saunders.

3. Hallowell, G.D., Retrospective study assessing efficacy of treatment of large colonic impactions. Equine Veterinary Journal, 2008. 40(4): p. 411-3.

Photo: Redwings Horse Sanctuary

What happens during nasogastric intubation?

The tubes that are used are made of hollow plastic with a large hole in the end to allow the fluids to pass through. The sensation of having this passed through their nasal passage is unpleasant and most horses will resent it. They often require firm restraint for this procedure, which may include the use of a twitch and/or sedation. Once the tube has been passed up the nose, most horses will become more settled. The vet will check the placement of the tube as it is passed, as the openings to the airway and oesophagus are next to each other. Correct placement requires the horse to swallow to help the tube pass into the oesophagus. The procedure can be more difficult in some horses, and may require repeated attempts. Once the tube has passed down the oesophagus into the stomach, the vet will check for the presence of gas and fluid before administering any treatment, if needed.



Nasogastric Intubation

For more information please visit: **bhs.org.uk/colic**

Figure 45: REACT "Nasogastric intubation" factsheet.

WHAT HAPPENS AT REFERRAL?

The University of Nottingham
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The British Horse Society

Reasons for referral to an equine hospital

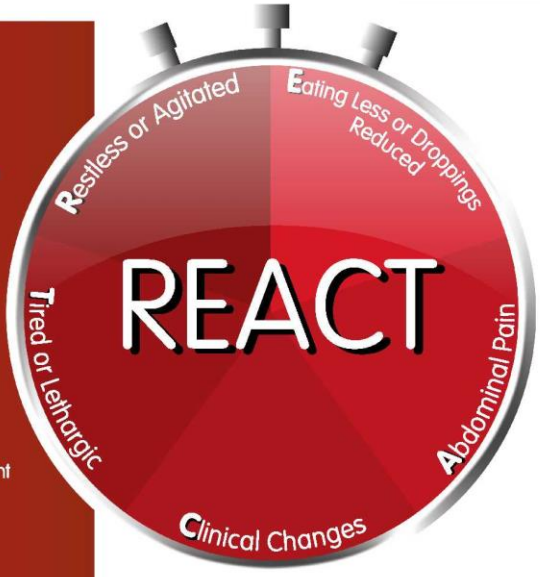
The referral of a horse or pony suffering from colic may be considered for a number of different reasons, including:

- The need to undertake more detailed clinical evaluation that may not be possible at home
- Provide constant observation
- Referral for possible surgery
- Be able to provide intensive medical treatment e.g. intravenous fluid therapy or repeated administration of fluids by nasogastric tube

The decision to refer a horse to an equine hospital should be made jointly by you (the owner), the primary veterinary surgeon and veterinary surgeons at the referral hospital. The choice of which equine hospital to refer to is often dictated by geography – the nearest facility will often be chosen because time is of the essence in many surgical and serious colic cases, and any delay in getting the horse to surgery can negatively impact the chances of recovery. However, the expertise and reputation of the referral hospital are also important factors to consider. Colic surgery is major surgery, and it is important that the hospital has appropriately trained surgeons with the back-up of an experienced team of vets and nurses who can provide the required level of care for anaesthesia and intensive therapy. Choosing a facility that is accredited by the Royal College of Veterinary Surgeons Practice Standards Scheme as an Equine Veterinary Hospital may be a good starting point in helping decide where to refer the horse, but your own veterinary surgeon is also likely to know what facilities and expertise are available in your area.



Surgery for a small intestinal strangulation



Prior to referral

Prior to referral, it is important to establish contact with the hospital to discuss the case. Additionally you should consider:

- Directions to the hospital
- Telephone contact numbers (including mobile phone number during travel)
- Estimated time of arrival
- Any deposit required by the hospital prior to examination/treatment of the horse
- Rough estimates of cost for examination and treatment
- Insurance policy (including any exclusions on the policy)
- Passport
- Brief medical history of the case and drugs administered by the primary veterinary surgeon
- Any previous relevant medical history (e.g. previous colic surgery)
- Advice from the referral hospital about treatments to be administered prior to or during travel to the hospital

What happens when you arrive at the referral hospital?

When you arrive at the hospital, you can expect an examination of the horse to be undertaken straight away. At many larger referral hospitals, this initial assessment will be undertaken by a junior vet (an intern or resident). Depending on the nature of the case, this may include a physical examination, blood tests, rectal examination, ultrasound examination, passage of a stomach tube and belly tap. Some of these examinations may repeat things that your own vet has already done, but it is important that they are repeated in order to give a full picture of the case to the hospital team. The vet will report the findings to the senior veterinary surgeon on duty, who will may also want to examine the horse, and then discuss the case with you and make recommendations about the most appropriate treatment. Any decisions about how to proceed will be made jointly by yourself, your own veterinary surgeon and the senior veterinary surgeons at the hospital.

When your horse is admitted to the hospital for treatment you should be informed about the hospital's policies regarding:

- Visiting times
- How and when you will receive updates about progress of the case
- How and when you will receive updates about costs

Legal issues, consent form and passport

On admission of the horse to the hospital, you will be expected to sign a consent form, which describes the terms and conditions of the service that the hospital is providing. This document should be explained to you prior to you signing it, and you should be given a copy to keep for your future reference.

The hospital will also need to see your horse's passport, in particular to determine whether or not your horse is signed out of the human food chain. There are legal requirements that need to be adhered to when administering medicines to horses that are declared as intended for human consumption as some drugs are not able to be used. If you do not wish your horse to ever enter the human food chain, then you should sign the appropriate part of Section IX (passports produced before January 1st 2016) or Section II Part II (on passports produced after January 1st 2016) on the passport. When your horse is signed out of the human food chain, then all available drugs can be used as needed.

Photo: The University of Nottingham



Ultrasound scan preparation

What happens after your horse is admitted to hospital?

You and your own veterinary surgeon should expect daily updates from the hospital about how your horse is doing and how well he/she is responding to treatment. If your horse requires surgery, the risks associated with the surgery as well as the expected outcomes and costs should be discussed with you.



Horse receiving medication but still showing signs of colic

Unfortunately, colic surgery is never without risk, and a successful outcome can never be guaranteed. Likewise, the medical treatments of horses with other serious abdominal diseases are not always successful. You should expect to have a full and frank discussion with the senior veterinary surgeon about these issues prior to making a decision about whether to proceed with surgical or other treatments and what happens during the course of your horse's stay at the hospital. In some cases, the difficult decision to euthanase your horse may need to be made.

What happens when your horse comes home?

If all goes well, and your horse is ready to be discharged home following treatment, you and your own veterinary surgeon should receive thorough discharge instructions (given both verbally and in writing) that will describe what treatments have been undertaken and how the horse should be managed when he/she gets home.

For more information please visit: bhs.org.uk/colic

Figure 46: REACT "What happens at referral?" factsheet.