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Review

Systematic pain assessment in horses

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ABSTRACT

Accurate recognition and quantification of pain in horses is imperative for adequate pain management. The past decade has seen a much needed surge in formal development of systematic pain assessment tools for the objective monitoring of pain in equine patients. This narrative review describes parameters that can be used to detect pain in horses, provides an overview of the various pain scales developed (visual analogue scales, simple descriptive scales, numerical rating scales, time budget analysis, composite pain scales and grimace scales), and highlights their strengths and weaknesses for potential clinical implementation. The available literature on the use of each pain assessment tool in specific equine pain states (laminitis, lameness, acute synovitis, post-castration, acute colic and post-abdominal surgery) is discussed, including any problems with sensitivity, reliability or scale validation as well as translation of results to other clinical pain states. The review considers future development and further refinement of currently available equine pain scoring systems.

Introduction

In veterinary practice, adequate diagnosis and treatment of painful conditions is dependent on accurate recognition of pain experienced by non-verbal animals. Pain is defined by the International Association for the Study of Pain (IASP) as an '*unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage*' (Merskey and Bogduk, 1994).[1] As pain is a subjective experience that cannot be verbally communicated by animals it follows that no 'gold standard' method is available its measurement in veterinary patients. Horses pose a particular challenge, as they are a species that has evolved so as not to express pain too openly, presumably in an attempt to avoid predation (Taylor et al., 2002a); also, breed influences and inter-individual variation in pain expression may be considerable (Wagner, 2010). Objective and accurate parameters for the presence and severity of pain in horses are needed for ethical and animal welfare reasons (Zimmermann, 1983).

Clinical studies have tended to focus on differences in physiological, endocrine (hormonal/mediator concentrations) and/or behavioural parameters over time and with analgesic treatment in horses with a range of painful conditions, including laminitis, synovitis and colic. These studies have led to the realisation that one pain assessment tool or system may not perform equally well for different types of pain (e.g. visceral vs. somatic pain, acute vs. chronic pain, nociceptive vs. inflammatory vs. neuropathic pain). Experimental studies on models of induced pain have attempted to validate various (neuro)physiological, endocrine and behavioural parameters hypothesised to reflect the presence and/or severity of pain and hypersensitisation in horses, for example by varying the intensity of the stimulus as in thermal or mechanical nociceptive threshold testing (Spadavecchia et al., 2003; Haussler and Erb, 2006). Although such studies may carry ethical and animal welfare concerns, when used judiciously and with sound methodology they can yield invaluable insights in equine nociceptive and pain responses (Ashley et al., 2005).

This review aims to provide an up-to-date descriptive overview of methods for the systematic assessment of pain in horses, highlighting their strengths and weaknesses, and giving directions for future development and potential use in clinical practice.

Searches

PubMed and Google were searched using the search terms 'horse' or 'equine' in combination with 'pain', 'nociception', 'score', 'scale', 'VAS', 'NRS', 'SDS', 'composite pain scale', 'facial expression' or 'grimace'. Articles were screened and selected based on relevance to topic (key focus on recognition of pain or nociception in horses), and their reference lists were scrutinised for articles that may have been overlooked. Additional key words were used to extend this search for the following specific equine pain states: 'laminitis', 'synovitis', 'castration', 'abdominal', 'colic', and 'celiotomy'.

In total, 57 articles were deemed of primary relevance to pain recognition in horses and were included in the review. Given the qualitative nature of many of the studies and the limited number of studies for each method of pain assessment, no meta-analysis

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[1] See: http://www.iasp-pain.org/Taxonomy (accessed 24 December 2014).

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or statistical analysis was performed, and this article thus constitutes a descriptive rather than a systematic review (see also Appendix: Supplementary Table S1).

Approaches to the study of pain: Putative pain-related parameters

Physiological parameters

Parameters such as heart rate and respiratory rate may be affected by pain and are easily measured and quantified; as a result, heart rate is often quoted by equine veterinarians as an important indicator of pain and the need for analgesia (Price et al., 2003; Dujardin and van Loon, 2011). However, these parameters on their own are non-specific for the presence and severity of pain, since they may be influenced by other factors, including ambient temperature, dehydration, excitement and cardiovascular and/or respiratory disease. Studies have often failed to establish a direct relation between heart rate and presence or severity of pain (Raekallio et al., 1997; Dzikiti et al., 2003). Therefore, these parameters are best incorporated into a composite pain assessment system that also includes behavioural components, such as that of Bussières et al. (2008).

Endocrine measures: Hormone and mediator concentrations

Levels of circulating endogenous cortisol, β-endorphins and catecholamines have been evaluated as indirect indicators of pain in horses (McCarthy et al., 1993; Pritchett et al., 2003; Rietmann et al., 2004; Virgin et al., 2010). However, as previously noted, the relation between physiological stress, behavioural distress and pain is complex (Ashley et al., 2005; Wagner, 2010); hence, endocrine measures may reflect stress responses that may not be pain-induced (Virgin et al., 2010; Erber et al., 2012), and the magnitude of change may not be related to the extent or severity of pain (McCarthy et al., 1993). Although there may be a rationale for inclusion of endocrine measures in experimental studies of pain-induced stress (Virgin et al., 2010) and clinical studies of the stress response (Erber et al., 2012), these parameters cannot be relied upon as indicators of pain in horses.

Pro-inflammatory mediators, such as prostaglandin (PG) E_2, substance P and bradykinin, lower the threshold of C-fibre activation and may directly activate such fibres. Measurement of these mediators in inflamed or infected tissues or body fluids is often included in orthopaedic studies when quantifying inflammation (Frisbie et al., 2008; de Grauw et al., 2009a, 2009b; Lindegaard et al., 2010). In one study, synovial fluid substance P level was related to the response to intra-articular (IA) anaesthesia (de Grauw et al., 2006). Reduction of the concentration of synovial PGE_2 with non-steroidal anti-inflammatory drugs (NSAIDs) or IA morphine treatment is consistently associated with attenuation of lameness (de Grauw et al., 2009a, 2014; Frisbie et al., 2009; van Loon et al., 2010). However, it is unlikely that absolute concentrations of inflammatory mediators in local tissue fluids can be used to quantify levels of pain (de Grauw et al., 2006).

Behavioural aspects of pain

Unpleasant sensory and emotional experiences that constitute pain give rise to subtle or overt changes in behaviour that may offer the strongest indication of the presence, localisation and severity of the pain. Several studies have established non-specific indicators of pain in horses, while others have attempted to identify behavioural expressions related to specific types (acute or chronic) or sites (abdominal, distal limb) of pain (Ashley et al., 2005).

Aspects of behaviour that may be altered by pain include elements of demeanour, posture and gait, as well as interactive behaviour. However, a horse's behaviour is influenced by factors other than pain, including breed, temperament, sex, age and (familiarity with) environment (Wagner, 2010; Minghella and Auckburally, 2014). The amount of time needed to carefully observe and assess a horse's behaviour may be a limiting factor in clinical practice (Ashley et al., 2005).

In clinical studies where patients with painful conditions are assessed, two important limitations are encountered. Firstly, no baseline evaluation of the horse's behaviour before the pain occurred is available. Secondly, the horse is seen in distress in a novel environment and this is difficult to correct for. Clinical studies tend to use pre- and post-operative settings or pre- and post-analgesia time points, since these allow each horse to be used as its own control, thus correcting for baseline differences in temperament or demeanour.

Pain assessment systems

Systematic assessment of pain using defined and validated pain scoring systems or scales will help to improve recognition and treatment of painful conditions in horses. In addition to raising awareness of such pain states, they may enhance agreement between different observers or caregivers on the amount of pain a horse is experiencing, thus providing a reliable record of pain severity over time (Dutton et al., 2009; Wagner, 2010).

In order for a pain scoring system to reliably work in practice, it should be easy to use, with relevant well-defined parameters that can be assessed repeatedly and quickly by different observers with consistent results (Wagner, 2010). The pain scale should be sensitive enough to detect mild, moderate or severe pain, ideally have a linear relation with pain severity, and be validated and specific for the type of pain being assessed (Ashley et al., 2005). Methods used for validation of pain scoring tools have been described elsewhere (Brondani et al., 2013; Taffarel et al., 2015) and include assessment of internal consistency, construct validity, responsiveness, and reliability of the scale in clinical cohorts of patients and controls. It should be noted that formal scale construction and thorough clinical validation has not been pursued for most equine pain scales.

Among the tools that have been investigated and employed for objective assessment of pain in horses are the visual analogue scale (VAS), simple descriptive scale (SDS), numerical rating scale (NRS), time budget analysis, composite pain scales (CPS), and scales based on facial expressions of pain (Wagner, 2010).

Visual analogue scale

The VAS consists of a horizontal 10 cm line, representing pain intensity that increases from none at the beginning (left) of the line to the worst imaginable pain at the right. An observer can put a mark anywhere along this line that corresponds to the perceived amount of pain an animal is experiencing. The pain score is then read off as the number of millimetres from the zero end of the scale. A VAS score is a continuous variable and is easy to use. However, the extent to which VAS scores truly reflect a pain continuum rather than discrete classes is questioned by studies in humans who may self-report that they are in the same amount of pain as a few minutes before but provide a VAS score differing by up to 20 mm from their previous entry (DeLoach et al., 1998; Bailey et al., 2012).

Observational VAS scores used in human paediatrics have demonstrated inter-rater reliability ranging from 0.36 to 0.91, meaning only fair to excellent, depending on the study (van Dijk et al., 2002). In equine practice, VAS scores will be influenced by the amount of time taken to observe a horse, and inter-observer agreement tends