Diagnosing and treating pain in the horse
Where are we today?

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Pain recognition and management in small animals and people have advanced considerably in the last decade; however, horses have not fared so well. This may in part result from the fact that the range of surgical procedures carried out in horses is much more limited; for instance, thoracotomies and major postcancer surgical reconstruction are not common equine procedures. Nevertheless, horses suffer their share of trauma and diseases causing pain: orthopedic trauma, infected synovial structures, and colic are three obvious examples. This article sets out to review the current status in horses and to point the way for development in the future. To prevent reinvention of the wheel, lessons learned from small animal and laboratory animal pain management are outlined.

Pain can only be experienced by an individual; it cannot yet be adequately observed or measured. This has led to considerable debate over the use of the term \textit{pain} when it is applied to animals. From an evolutionary point of view, it is essential that an animal has the ability to recognize stimuli that might cause tissue damage and is able to carry out behaviors that might avoid or minimize this damage. Conversely, species that are prey animals must have mechanisms in place capable of minimizing the display of pain...
so that they do not become easy targets for their predators. Do horses experience pain, or should we merely refer to nociceptive responses to noxious stimuli? Most people who have spent any time dealing with horses have come across dramatic evidence that horses experience pain. Examples such as the aversion that horses have for places and things that have caused them pain in the past or behaviors associated with intestinal strangulation support this view. These are highly “emotional” responses and suggest that these animals have a definite affective component to their nociceptive experience.

Yet, there is still considerable reluctance to use analgesics in animals. Recent studies have examined the attitudes and use of analgesics in the perioperative management of pain and have shown there is still some reluctance to treat small animals that have undergone surgery. Attitudes are changing with the entry of more women into the profession and with the recent emphasis on this subject in the veterinary schools and through continuing education materials [11,15,41]. In horses, the main arguments against pain relief are as follows:

1. If you remove the pain of an injured body part, the animal is likely to overuse that part and cause further damage. This is a poor argument on humanitarian grounds as well as on practical grounds; an agitated horse in pain from a fractured limb may actually cause more damage than a calm and relaxed animal given good analgesia and limb support. Horses that do not eat as a result of pain delay their recovery, because the response to injury and stress is to go into a catabolic state. This can only be reversed with adequate intake of high-quality nutrition. In addition, clinical experience suggests that pain may contribute to a poor recovery from anesthesia in horses [86]. There is always the risk that an unstable fracture may become worse, and good limb support is essential in addition to analgesia. This enhances the analgesia as well as protecting the limb. Excellent descriptions of the application of limb-supporting casts have been published [5,91]. Nevertheless, it is important to recognize the difference between providing pain relief and removing all sensation from the affected area. When local anesthetics are used to block sensation from an area, the horse may indeed injure that part of the body by placing undue stress on it or ramming it into something. If the use of a local anesthetic technique is the best method for providing pain control, the horse should be supervised to ensure that it does not hurt itself.

2. The drugs used may have side effects, and this often leads to their underuse in any species [11,17,41,42]. The horse is affected by this point of view as much as any animal, but such anticipated problems are often unfounded and can be more easily managed than traditionally believed.

3. Analgesia may mask a worsening disease condition. This consideration is applicable in certain circumstances such as, for example, the treatment of infected joints and tendon sheaths and some types of colic. This issue has
been examined in people with abdominal pain, where the patients were treated with an opioid or with saline. The opioid-treated patients had better pain relief, and this did not interfere with the diagnosis of their condition [1,67,90,94]. In horses, it is possible to reduce the analgesic cover briefly on, for instance, a daily basis so as to assess the disease progress. This approach, coupled with attempts to decrease the dose or frequency of analgesic cover as the disease improves, as well as careful assessment of the overall condition of the horse should not preclude good pain management. It is likely that opioid analgesia without concurrent nonsteroidal anti-inflammatory drug (NSAID) therapy may allow breakthrough pain in seriously worsening inflammation and infection and hence might be the treatment of choice when there is particular concern that infection may be missed. If this is a major concern for a particular patient, drugs with a short duration of action should be chosen (e.g., fentanyl or meperidine versus methadone or morphine) to allow more frequent assessment.

4. The use of analgesia is expensive and is not economically viable in horses. For the most part, this is rarely true, because the most commonly used analgesics in horses are relatively inexpensive (e.g., phenylbutazone, morphine). It has been well tested in small animal practice that most clients are willing to pay for the extra costs incurred if they can be assured that their animal is going to be made more comfortable.

Benefits of analgesia

The obvious benefits as far as the horse’s welfare are concerned need no further mention. The physiologic effects of severe pain are considerable, and there is a range of published reports on improved outcome from disease in people with good pain relief at the time of surgery or trauma [10,81]. Objective outcome data are not available for the horse; however, the effect of pain on a horse’s outlook, and particularly on its willingness to eat, is well recognized in clinical equine practice. Surgery or trauma leads to a substantial increase in energy requirements as a result of the stress response and the need for tissue repair. If this is not covered by an increase in energy intake, marked weight loss with a negative nitrogen balance develops. This is commonly seen in horses with severe injury or infection, even when the disease process seems to be adequately treated. Good pain relief often reverses an injured horse’s despondent inappetence and aids recovery. A positive energy balance is also required for a fully functional immune system.

There may be added benefits of profound analgesia applied during surgery and in the treatment of trauma. Central sensitization and “wind-up,” the process by which the spinal cord becomes more sensitive to nociceptive and innocuous stimuli, leading to increased perception of pain, is a well-understood phenomenon [93]. There is now good evidence from clinical studies in
people and animals that prevention of wind-up by preemptive and aggressive multimodal perioperative pain therapy leads to better postoperative analgesia. In addition, there are now studies emerging where mobility, tested weeks after surgery, is found to be better in human patients who received more profound analgesia perioperatively [10, 81]. It is likely that these studies apply equally well to horses as to other species. The implications for the treatment of sport horses are obvious, particularly where the loss of performance leading to surgery was minor. Studies in people have also shown that the method of analgesia can affect the rate of return of bowel function, and this may be relevant in the management of equine colic patients [46, 89]. The cost of supplying profound analgesia around the time of surgery may be trivial compared with the potential benefits, but this has yet to be documented in horses.

Pain assessment

Objective assessment

Research scientists and practitioners are always looking for ways to simplify and objectify their approach to the diagnosis and management of equine problems. The literature is replete with attempts to provide “objective” methods of assessing pain in many species, but because of the nature of pain, this is currently impossible. Objective methods are usually described in terms of a measurable sign that varies in some direct way with the intensity of the pain. The following is a discussion of some of the “objective” measurements that have been evaluated in horses.

Heart rate

Although heart rate may vary in an animal in pain, pain may not be the only reason for a change in heart rate; hence, it can only be taken as a measure of the intensity of pain in the context of having removed or accounted for other possible reasons for the observed change. The validation of a change in heart rate as a measure of pain may also depend on the use of some other behavioral test or observation that may in itself be subjective. In dogs, heart rate has not proved to be effective as a method of pain assessment. There were no differences in heart rate between dogs after ovariohysterectomy whether the dogs received oxymorphone or not [20]. This lack of change in heart rate may be representative of an insufficient stimulus or a modifying effect of the drug used for treatment (e.g., oxymorphone tends to decrease the heart rate in dogs). In clinical practice, it is evident that dogs in severe pain often have increased heart rates. In horses, there were no differences in heart rate after arthroscopic surgery when the animals were given either phenylbutazone or no analgesic [71]. Even after major surgery, there was little correlation between subjective assessment of pain and heart rate [72]. In colic, an increase in heart rate was one of the signs analyzed to be
of predictive value for surgical intervention [68]; however, other factors such as shock and endotoxemia may have an unknown influence on heart rate under these conditions. In horses treated for colic pain with detomidine, xylazine, flunixin, or butorphanol, there was a decrease in heart rate in the horses receiving alpha-2 agonists but not in those receiving flunixin or butorphanol. These results correlated to some extent with the relief of pain as judged by behavioral signs, but this is not a good criterion, because it is known that heart rate may be decreased by the administration of alpha-2 agonists in the absence of noxious stimulation, whereas butorphanol and flunixin cause little change in heart rate. In exercising horses, it was shown that a higher than expected heart rate had a significant correlation with lameness [13]. In this study, 40 of 43 horses with a difference greater than 15 m/min between their velocity at 4 mmol/L of lactate and their velocity at a heart rate of 200 beats per minute were diagnosed with orthopedic disease [13]. It is expected that an increased heart rate in the horse may be an indicator of pain but that pain may be present in horses without such an elevation. When considering the use of heart rate as an indicator of pain, it is important to consider the drugs that the animal has received and to recognize their effect on this measurement.

Beta-endorphin

This is not a useful measure to the clinician unless a measurement technique can be devised that provides immediate results, because, currently, it is always retrospective. Finding high concentrations of beta-endorphin is also difficult to interpret, because it has analgesic properties; this could mean that the horse is coping with its pain by this mechanism. In a research environment, it has been tested whether plasma concentrations of this substance correlate with clinical signs of pain. In a study by Raekallio et al. [71], plasma beta-endorphin concentrations were higher in the horses receiving placebo treatment 2 hours after arthroscopic surgery but not at other times. The plasma beta-endorphin concentrations were higher at 6 and 12 hours after more invasive surgeries [72], but there was a tremendous amount of variation in the concentrations in each animal. Horses undergoing surgery had higher plasma beta-endorphin than when anesthetized using the same anesthetic protocol without surgery [88]. In horses having a twitch applied, there are significant elevations in plasma beta-endorphin, but it is not certain whether this is a response to the pain or a result of this particular stimulus [38,50]. Plasma beta-endorphin concentrations also increase with stress and shock, especially that associated with endotoxemia [50,84], and may not be increased in chronic conditions [50]. Exercise can also increase plasma beta-endorphin concentrations [27,48]; hence, increased beta-endorphin does not always indicate pain. Even when an immediate assessment of plasma beta-endorphin concentrations becomes possible, these data would suggest that its utility as an objective indicator of pain is limited.
Catecholamines and corticosteroids

Because these are also markers of stress, it is unlikely that they are of much use as objective measures of pain. Research to date has shown poor correlation with signs of pain in horses [72], although cortisol was higher after surgery in a group of horses and ponies after anesthesia and surgery compared with a similar anesthetic protocol without surgery [85]. A recent study examined the fecal concentrations of 11,17-dioxandrostanes (11,17-doa) as a marker of circulating cortisol concentrations [56]. The study showed strong correlations of 11,17-doa with painful episodes, but the authors did not look at stressful nonpainful episodes. The peak fecal concentrations of 11,17-doa tended to occur 24 to 48 hours after the onset of pain, making this a poor tool for clinical practice. It is not clear if cortisol concentrations remain elevated in more chronic pain conditions in horses. The effect of chronic pain on cortisol is variable. Ley et al. [44] reported higher plasma cortisol in sheep with chronic foot rot in a large commercial flock, although the severity of the disease did not correlate. They had previously reported lower plasma cortisol with chronic lameness in sheep from a smaller flock, however [43]. They attributed this apparent contradiction to the additional effects of survival in a large flock causing stress and increasing cortisol, whereas in the small flock, access to food, for instance, was easy, leaving pain alone to affect cortisol, which was decreased. Mills et al. [58] also reported decreased cortisol in adjuvant-induced chronic inflammation in horses, although the degree of pain was not reported. Overall, although it seems that acute pain may increase plasma cortisol, chronic pain may have the opposite effect. In general, cortisol is not a useful marker of pain alone, because so many other stressors may also affect adrenocortical activity.

Ground reaction force

The degree of lameness experienced by a horse is expected to correlate with the degree of pain it is experiencing, although physical limitations to movement may play a role. An objective method to measure the degree of lameness is to measure the forces applied to the ground by each limb at various speeds of movement. An elegant model has been developed to examine the effect of a reversible simulated lameness with adjustable severity, and the measured parameters were able to quantitate subtle lamenesses [55]. Some investigations have used similar force plate technologies to assess clinical lameness, and these approaches have been used to assess the efficacy of treatment [80,92]. Others have used an in-shoe pressure measurement system, which seems to be an accurate and effective method for assessing lameness in the horse and uses more portable and simpler equipment than the force plate [25,32]. Force plate methods may be useful for assessing the progress of chronic lameness, but they are not usually applicable for postoperative pain, because most horses are confined to stall rest immediately after surgery. The in-shoe method might, however, be applicable in a stabled horse.
Response to pressure

Using a quantifiable force on a part of the body is a common method employed for determining pain thresholds. This method has been used in analgesic studies in small animals, where a measurable pressure has been applied close to the surgical site to test for pain and analgesia [40,78]. Owens et al. [65,66] used compression thresholds from calibrated hoof testers in lamin-otic horses as an objective means of measuring foot pain and then applied the results to assess the effects of alpha-2 adrenoceptor agonist analgesia. Although this study used a naturally occurring disease as an experimental model, it is an example of a real objective method of evaluating clinical pain and analgesia in horses.

Gait analysis

High-speed movies of horses allow observers to analyze the component parts of motion and provide objective data on speed, range, and displacement of different parts of the body [19]. These techniques have been further refined by the use of computer analysis software to automate the process [16,26,70]. Quantification of such things as stride length, contact time with the ground, head movements, hip movements, and even changes in segmental spine movement and the center of gravity can be achieved with these techniques [2,7,8,21,26,70]. The main difficulty with this approach is that sophisticated equipment and careful standardized marking of the horse are required when using the automated analysis techniques [9].

Thermographic imaging

The assumption when using thermographic imaging is that pain is going to be associated with an increase in temperature because of an inflammatory response or that there is going to be a decrease in temperature because of chronic changes in autonomic tone or scarring. Thermographic imaging has been useful for the localization of limb pain and has also been useful for analysis of back pain [37,79].

Electroencephalography

This has not been used in awake horses, but some work has been done in anesthetized horses to look at the effect of analgesics on electroencephalographic (EEG) patterns [29,30,63,64]. Only one study has examined the effect of detomidine and ketamine on EEG patterns in the presence and absence of surgery, and it concluded that these analgesics obtunded any EEG arousal caused by the surgery [57]. Further work of this nature could be carried out in horses to test the effect of analgesics in the presence of an arousal response related to a noxious stimulus.
**Behavioral signs**

For a behavior to be considered objective, it must be a something that the horse does for a longer time or more frequently in association with pain. It must also be something that can easily be recognized. Observations of this nature have been carried out in other species. A recent report of a study in rats detailed a limited number of behaviors (e.g., abdominal twitch) that occurred much more frequently in animals that had undergone a laparotomy and were modified by the use of analgesics [76]. Such behavioral observations have been used in scoring pain in horses but without detailed documentation of their specific relevance [71,72].

**Response to analgesics**

This is the most frequently used objective test in the horse in that the diagnosis of lameness is often carried out by using successive local anesthetic blocks until the lameness resolves. This test can be combined with ground reaction force analysis or gait analysis to confirm the effect objectively or can be taken in the context of eliminating a behavior thought to be associated with pain (e.g., lameness). In horses with colic, the administration of systemic analgesics to eliminate associated pain behaviors would be an objective test of their efficacy. This may be complicated by the fact that the drug may eliminate some behaviors as a result of central nervous system depression, however. For example, alpha-2 agonists provide excellent analgesia in horses, but they also cause profound sedation; thus, the elimination of the behaviors described in association with colic may be a reflection of their sedative properties rather than their analgesic effects. Opioids in horses have some analgesic properties, but they also can cause increased locomotor activity, making it difficult to assess the effect on other behaviors.

**Subjective assessment**

**Behavior**

Assessment of pain in animals depends on interpretation of behavior. Many factors may influence behavior, making interpretation of what is caused by pain alone quite difficult [83]. Horses undergoing diagnosis and treatment of clinical disease are likely to be in a strange environment, and this may alter their normal behavior and mask signs of pain. They are likely to be apprehensive, nervous, or excited. Horses are herd animals and are stressed by isolation from their peers, further altering behavior.

Interpretation of pain in any species depends on understanding its normal behavior. Hence, experience with horses is essential to pain assessment in this species. Extrapolation from other species (worst of all, anthropomorphism) is fraught with problems [14,19]. Horses exhibit a number of behavioral characteristics that are widely accepted as evidence that the horse is experiencing pain. The horse is essentially a flight animal; commonly, its
reaction to any stimulus that frightens or hurts it is to escape from the source. It may then be difficult to distinguish whether the horse is experiencing pain or another unpleasant sensation. A horse may respond violently to a relatively innocuous touch, again making it difficult to distinguish pain.

Taylor [14] has described behavioral effects of pain in horses, building on a description by Silver [80]. Sharp pain of sudden onset usually induces a reflex escape or attack reaction; thus, a horse may gallop off or move away or, alternatively, it may kick or bite at the source of the stimulus. For instance, insect bites usually elicit a kick or bite at the affected area; if this does not dislodge the offending arthropod, a horse may gallop off, or if it is in a restricted area, the horse may become restless and excited. Head pain elicits head shaking, snorting, and restlessness. If associated with mouth or jaw pain, difficulty in eating may be noted, with drooling of saliva and chewing confined to one side of the jaw. Limb pain leads to stamping and constant picking up and replacement of the limb. Alternatively, the limb may be held on the ground, with the weight taken off the heel or occasionally the toe. Abdominal pain causes general restlessness, kicking at the belly, glancing at the flanks, and rolling. Tail swishing in the absence of any other cause such as flies is often a sign of pain and is often seen when pain is severe enough to make the horse restless and distressed. Behavior in response to pain may seem to verge on the neurologic—general restlessness with jerky movement, where the horse moves forward a few strides, stops, swishes its tail, and lowers and may shake its head, followed by a further few strides forward, is often seen in response to sudden-onset intermittent pain.

More severe and unrelenting pain leads to some of the behaviors described previously, which are persistent, distinctly giving the impression that the pain is constant or waxes and wanes in severity but is continuous. Horses with severe pain, whatever the source, are restless, tachypneic, tachycardic, and agitated, and they sweat copiously. Because equine sweat has a high protein content, it may appear as foam on the neck and flanks. The horse’s attitude changes, and it may become difficult to communicate with it; the horse adopts a wild and distracted appearance to the eye and takes little care to avoid knocking into a person or other animal. Some horses may snatch at food, take a mouthful, fail to chew it, but return for another snatched mouthful. Some play with drinking water but do not swallow any.

In addition to the general signs of severe pain, colic causes distracted kicking at the belly; glancing at the flank; and repeatedly lying down, rolling, and getting up again. Sometimes, the horse may stay in lateral or partial dorsal recumbency for a few minutes in an abnormal, hunched, or stretched posture before getting up again. The horse may stretch out as though to urinate but produce little or no urine. Throughout this period of restlessness, the horse sweats, sometimes copiously, until it becomes dehydrated. Horses with colic may repeatedly go to drinking water, sometimes taking a few mouthfuls or standing over the bucket and splashing water around. Some horses with abdominal pain even snatch at food. Lip curling is also seen.
Severe limb pain causes marked lameness and constant lifting of the leg, touching it down, and lifting it again. Restlessness, agitation, and sweating are marked. Occasionally, immediately after an injury such as a fracture, the horse may continue to gallop and even jump or graze for some time. This is similar to the well-known effect sometimes seen on the battlefield or in the emergency room, where no pain is experienced at the time of injury and may not develop until some hours later [54].

Severe limb pain in more than one leg (e.g., with laminitis) leads to a different picture. Sweating, tachypnea, and dyspnea are present, but the animal develops a fixed board-like posture and is reluctant to move. Severe limb pain may be difficult to distinguish from colic in some instances.

Back pain may elicit a number of behavioral changes, which may be seen as tail swishing, grinding teeth, head shaking, resentment of the saddle or grooming, sinking when the rider mounts, failure to bend or yield to riding aids, stumbling, tripping, bolting, bucking, and rearing. These may be superimposed on more subtle behaviors such as poor performance, loss of appetite, and a sour attitude [49]. Severe head pain may evolve from head shaking to a lowered head and head pressing and eventually to extreme depression.

If it becomes chronic, even severe pain tends eventually to lead to a depressed horse that stands with its head down, avoiding other horses or standing in the corner of the stall. Tension in abdominal muscles may give a tucked up appearance. Back and neck pain may lead to an abnormal head and neck posture, sometimes with the head held to one side or tilted. Mental alertness is decreased, and the eye appears dull, listless, and distant. There is no interest in food or water, and the horse may spend long periods lying down. Severe colic is unlikely to progress to this, because the condition eliciting the pain is likely to be fatal before this stage is reached. Laminitis, peritonitis, or rhabdomyolysis may cause such depression, however.

Behavioral changes associated with pain are also influenced by the individual and the breed. Animals bred for different purposes are likely to demonstrate pain in different ways; animals bred for their hardiness and raised under adverse conditions (e.g., Shetland ponies) are likely to be more stoic (show less overt pain behaviors) than animals bred for speed and raised in a pampered environment (e.g., Thoroughbreds). The effect of genetic factors has been carefully and scientifically documented in mice, where the response to 12 measures of nociception was investigated in 11 inbred strains of mice [59]. The conclusions of this study were that there were heritable characteristics related to the type of nociceptive stimulus and the response of the animals to these stimuli [60]. Although this may apply to a breed as a whole, it is also evident to horse owners and clinicians that each animal is an individual and may have had some experience that alters its behavior under certain conditions. In studies looking at thermal stimuli in horses, we found that some animals would respond with a skin twitch, although others would not (unpublished observations) and that this was not necessarily related to breed.
Pain scoring systems

These are used constantly in people and are the basis for most analgesic studies [45,53,74]. They are the “gold standard” in human adults, because the affected individual is providing the information. In animals, these scoring systems must be carried out by observation and measurement; hence, they must be considered subjective and dependent on the individual observer until they have been validated in some way [23,24]. The scoring systems used can be broken down into three types. A visual analog scale usually consists of a 10-cm line that has statements such as “no pain” at one end of the line and “worst pain possible” at the other end of the line. An observer marks a point on this line appropriate for his or her observation of the animal’s behavior. This approach is highly dependent on the observer and the training he or she has received, and in people judging pain in nonverbal neonates, it tends to underestimate severe pain [4]. A second approach is to use a numeric scale with behavioral descriptions attached to each number. Such simple descriptive scales (SDSs) can be quite effective but, again, are highly dependent on observer training for their consistent application. Such scales also may not be linear (i.e., the difference in pain between a score of 3 and 4 may be quite different from the difference between a score of 5 and 6). The third approach is to use numeric rating scales (NRSs) on many different parameters (including objective data such as heart rate) and to add these numbers together in some form of multidimensional scoring system. Such scores again suffer from the disadvantage of not being linear and need to be tailored to the particular set of conditions being observed (i.e., such a scale would be different for abdominal pain and orthopedic pain). With accurate observation and careful testing, such scales can be made more linear by weighting the different scores. There are also likely to be breed-specific and individual influences on such scoring systems, because the behavioral response to pain is affected by the genetic makeup of the animal.

There are numerous studies in small animals assessing postoperative pain using one or all of the visual analog scale, SDS, and NRS systems [39,62,73,87]. Holton et al. [24] assessed these methods and found that although individual observers were consistent, reproducibility between observers was poor. A number of composite NRSs have been developed, particularly for laboratory animals [61]. Recently, well-validated composite scales for dogs have been developed, although it is too soon to report how well these are likely to fair with widespread use [18,22]. It is also important to recognize that although therapy may produce lower scores on a given scale, this does not necessarily mean that the horse has received clinically relevant pain relief.

There is remarkably little use of these pain scales and few attempts to develop any in horses. Johnson et al. [31] used an SDS to compare three NSAIDs for postoperative analgesia in horses. Raekallio et al. [71] attempted to develop NRS scoring for postoperative pain assessment in horses. A placebo-controlled study in horses undergoing arthroscopic surgery used
sampling of a number of behavioral patterns as well as endocrine and physiologic changes. Considerable difficulties were encountered in identifying objective measurements to make, and few correlated with each other. The overall “impression score” was still considered the most reliable for clinical assessment. Jochle et al. [28] used an NRS based on a range of behavioral and physiologic signs to score pain in horses with colic before and after administration of a number of analgesics, but the scale was not used in the final analysis of the data. Most retrospective and some prospective studies of colic treatment and outcome use behavioral signs of pain as one of the criteria for classifying the severity of the disease [68]. Betley et al. [3] used an NRS to compare ketoprofen with flunixin for colic pain, but there were only five horses per group, so this study does little to help evaluate such methods for use in horses.

In spite of these isolated studies, there is no doubt that clinical pain scoring systems for horses still require much development. Characterization of specific pain behaviors to the point of being able to use them objectively to identify pain has recently been described for rats [76]. Although this offers one of the best ways of allowing inexperienced observers to assess whether an animal is in pain and needs treatment, it is species specific and has not yet been developed for dogs; hence, it is currently an even more distant prospect for horses.

**Chinese meridian imbalance**

The palpation of certain acupoints has been associated with changes along the meridians. Because these meridians are thought to run over the joints of the forelegs and hind legs, it is possible to use reactivity at these points as an aid to the diagnosis of pain in the limbs. This approach is relatively nonspecific, however, because the points may or may not be reactive in lame horses. In one study of point sensitivity related to hind limb lameness, 42% of the lame horses had no acupoint reactivity, although in another study, only 10% of the animals with point sensitivity related to the fetlock became sound after injection of intra-articular mepivacaine [51,52]. Nevertheless, the use of such point sensitivity may be of help in subtle lameness or cases with multiple limb involvement.

**Experimental studies**

Numerous experimental studies in horses have used inflicted pain to assess response to analgesic treatment. Several investigations used heat focused on skin on the leg, withers, or coronary band [33,35,36,69]. It is easy to observe and record the horse’s avoidance reaction of either raising the leg or twitching the skin on the withers. Studies where a balloon is inflated in the cecum or rectum induce transient acute visceral pain leading to a behavioral response, but a simple movement is usually accepted as the end point. This
end point may not add to our ability to interpret visceral pain clinically [34,69]. Implanted periosteal or tooth pulp electrodes have been used to induce transient acute pain for assessment of analgesic drug effects [6,69]; again, the end point was movement of the limb or head, adding little to our knowledge of a specific identifiable behavioral response to pain. Chambers et al. [12] used pressure on a limb and a similar movement response as the end point. These studies were all designed to assess the potency or duration of an analgesic treatment rather than to develop means of assessing pain in horses [12]. They depend primarily on an avoidance reaction to a transient acute stimulus. Although this approach is essential for evaluating analgesic drugs, little additional light is thrown on ways of assessing nonexperimental clinical pain, which tends to be continuous and does not produce a simple acute response. Robertson and Muir [75] used a surgical incision and repair as the nociceptive stimulus for assessing the duration of effect of a xylazine-butorphanol combination. Behavioral responses of kicking, tail swishing, vigorous movement, and turning toward the surgical site were similar to those seen under clinical conditions. More chronic conditions to assess epidural analgesia have been produced by amphotericin-induced synovitis [82], but many would suggest that naturally occurring clinical cases could be used effectively to assess analgesic treatment rather than inflicting such severe pain in experimental animals.

Clinical studies

Management of clinical pain in horses has been largely empiric, and it is only relatively recently that interest in new and potentially more effective methods has developed. As a consequence, there are still remarkably few published reports of studies attempting to use pain assessment in horses to evaluate and develop methods of pain management. Johnson et al. compared the effects of three NSAIDs after elective orthopedic surgery using a score awarded by one of two assessors based on overall impression of behavior [31]. They did not include a control group, and although pain relief appeared generally adequate, they did not detect any difference between the three drugs used. Raekallio et al. performed a placebo-controlled study investigating some effects of phenylbutazone administration in horses undergoing arthroscopic surgery [71]. The study was also used to develop methods of pain assessment but did show some benefits of analgesic therapy despite the relatively mildly invasive surgery of the horses studied. Colic pain has been used to evaluate the effect of a range of analgesics. Jochle et al. collected data from a number of clinics treating horses with pain [28]. They reported that detomidine was superior to both flunixin and butorphanol and that flunixin provided better pain relief than butorphanol, but the drugs were compared in different groups and the pain assessment used an NRS with multiple observers. Owens et al. reported that detomidine provided
good pain relief in horses with laminitis and that ketoprofen was more effective than phenylbutazone [65,66].

**Future directions**

It is evident that the limited number of studies barely scratches the surface and that many questions still need to be answered. How often should we repeat a drug treatment? Our knowledge of the pharmacokinetics and pharmacodynamics of many analgesics is limited in healthy horses—how do these change when you are treating a sick animal or an animal in pain? What kind of variability is there in the required drug doses to provide adequate pain relief? In people, the dose of drug self-administered by patients varies considerably even after the same type of surgery—is this the case in horses? Do we get better pain relief if we provide a continuous administration technique rather than intermittent boluses? Evidence in people and dogs would suggest that a continuous background concentration of analgesic provides better pain relief and uses less drug than intermittent techniques [47]. Can we get better postoperative results with the use of adequate analgesia and joint mobilization as suggested in human beings [10,81]? Are fewer horses likely to get ileus after colic surgery if we can provide better analgesia before and during the procedure as in people [46,89]? What is the role of multimodal therapies involving different drugs or physical methods? The possible permutations of such therapies are endless, but some of these approaches need to be studied in a clinical environment using careful assessment by observers masked to the treatments in a sufficient number of horses so as to make the results meaningful.

In spite of the limited number of studies designed to evaluate methods of pain management, a considerable range of treatments are now used in horses to provide pain relief rather than just treatment of the disease process. Many of these methods are as yet empiric, but clinical and objective experience with all of them is growing as indicated in other articles in this issue.

**Conclusions**

Although people have had an interest in the management of equine pain since the taming of the first horse, it has not been studied scientifically until recently. Although we have learned much about analgesia and methods of studying it from other species, we still need to carry out research in horses, because they clearly have different behavioral and pharmacologic responses in comparison with other species. It is essential to remember that once a course of analgesic management has been started, it must be assessed continuously alongside other treatment. Our ability to assess this response is still crude from a scientific standpoint, but within a particular clinic, the use of a
scoring system may help to define the therapeutic end point. It is also vital that analgesic therapies should not be undertaken in isolation. Multimodal or balanced analgesia has found considerable application in medical practice [77] and can enhance the effect while using lower and less toxic doses of each agent. We should now embark on proper assessment of the various options for pain management discussed previously in this review in well-managed prospective clinical studies involving adequate numbers of animals.

References


