Recognition and management of pain in cattle

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ATTITUDES towards pain and its control in farm animals have lagged behind those in companion animal species. However, a considerable amount of work over the past 15 years has focused on the perception of pain in cattle based on objective and subjective assessment by clinicians working with this species. A recent large-scale survey of cattle practitioners revealed that over half of the respondents felt their knowledge of pain and analgesia in cattle was inadequate or could be improved, and the majority of these identified a lack of readily available information on the subject as being a contributory factor. This article reviews current knowledge on pain assessment in cattle in a clinical setting, and discusses some protocols for pain management in specific conditions.

**PHYSIOLOGY**

Pain results from chemical, mechanical or thermal stimulation of free nerve endings containing nociceptors. Injury to cells in tissues releases inflammatory mediators, such as prostaglandins, histamine and bradykinin, which stimulate nociceptors in nearby nerve endings. Therefore, a stimulus affecting a relatively small number of nerve endings stimulates many more, effectively amplifying the sensation. The resulting impulses are conducted via the ventrolateral part of the spinal cord to the brainstem and thalamus, where there is further amplification – so-called ‘wind-up’. Conscious perception of pain is a result of activation of certain areas of the cerebral cortex via the thalamus. Theoretically, pain is a central ‘experience’ that is due to nociception in peripheral nerves.

Tissue injury results in acute pain, which stimulates muscular action to avoid the noxious stimulus caused by either reflex limb flexion or conscious mechanisms, thus activating the sympathetic autonomic nervous system and leading to a heightened state of arousal. Increased sympathetic tone can become persistent if the insult is prolonged or severe. In cases of chronic pain (defined as ‘pain which has persisted beyond normal tissue healing time’ by the International Association for the Study of Pain [IASP]), the presence of high levels of inflammatory mediators around the site of injury and persistent activation of pain fibre pathways in the spinal cord lead to a decrease in pain threshold, so that stimuli are perceived as being more painful than would be normal for the individual concerned. This is termed hyperalgesia.

Another phenomenon associated with chronic pain is allodynia, in which similar mechanisms lead to normally non-painful stimuli being perceived as painful. Prevention or modulation of hyperalgesia and allodynia is one of the main objectives of analgesia. For example, it may be useful in a chronically lame cow that, over time, perceives the lesion as being more painful than it was initially (hyperalgesia) and perceives pain in undamaged surrounding tissues on touch (allodynia).

As well as implications for welfare, pain is also significant in terms of disease progression by potentially having a major effect on the physiological state of the animal (Otto and Short 1998), which may interfere with wound healing.

**ASSESSMENT AND RECOGNITION OF PAIN IN CATTLE**

Pain in humans has been described by the IASP as ‘an unpleasant sensory and emotional experience with actual or potential tissue damage’ (Merskey 1979). It is reasonable to suppose that mammals experience pain in a similar way to humans, because experimental work has demonstrated that the neural pathways of pain sensation are similar. Application of the ‘precautionary principle’, in which the clinician should err on the side of treating or preventing pain, would suggest that this is a safe assumption, unless strong experimental evidence proves otherwise.

A number of methodologies have been employed experimentally to assess or quantify the levels of pain

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Multimodal analgesia is often neglected in cattle, but can be used for various procedures, including disbudding.
Barriers to analgesia

A survey by Huxley and Whay (2006), with over 600 responses, examined why UK practitioners tended to underuse analgesia in cattle. Over 90 per cent of respondents considered that cattle benefited from analgesic therapy as part of their treatment and that the animals recovered faster if analgesics were administered; however, two-thirds of respondents believed that the cost of analgesia was a major issue for their clients. While the financial constraints of the industry must always be considered, there are a number of reasons why they need not always preclude effective analgesia:

- Many analgesic protocols, such as local anaesthetic techniques, are relatively inexpensive to perform and the volumes required for treatment are generally small. These techniques can also be performed quite quickly, and the time taken will be reduced further as clinicians become more experienced;
- Financial benefits are often an unexpected outcome of analgesic treatment. Increases in parameters such as growth rate after calf disbudding (Faulkner and Weary 2000) and milk yield following cases of lameness (O’Callaghan-Lowe and others 2004) have been reported after analgesic therapy was combined with standard treatments. While this increased performance may not cover the total cost of analgesic treatment, it will partially offset the cost in many situations;
- Prices of the most commonly used NSAIDs may fall in the future as more generic products become available.

One of the most noteworthy findings in the survey was that respondents who did not use any analgesics during treatment estimated significantly lower pain scores for the condition or procedure in question (see table on the right). This suggests that one of the key motivators for analgesic usage is the attending clinician’s own perceptions of the patient’s suffering.

Misconceptions

The following misconceptions also emerged from the survey:

- **Age of the animal.** Young animals are often assumed to feel less pain than adults. A good example of this is the lack of analgesia used when calves and lambs are castrated using rubber ring techniques. There is no evidence that young animals perceive pain less than adults. A good example of this is the lack of analgesic treatment. Increases in parameters such as growth rate after calf disbudding (Faulkner and Weary 2000) and milk yield following cases of lameness (O’Callaghan-Lowe and others 2004) have been reported after analgesic therapy was combined with standard treatments. While this increased performance may not cover the total cost of analgesic treatment, it will partially offset the cost in many situations;
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Veterinary surgeons too often assume that farmers are unwilling to the carry costs associated with improvements to the welfare of their animals, but many owners, especially ‘hobby’ farmers or owners of small herds, may be more prepared to pay than the clinician believes. A recent survey of commercial UK cattle farmers (Huxley and Whay 2007), with over 1000 respondents, demonstrated that, for the majority of owners, the cost of analgesic agents remained a significant issue; however, this was not true for all respondents. When asked to state how much they would be prepared to pay for analgesics during and following treatment of a range of conditions and procedures, the answers varied considerably. For all of the 13 conditions considered, a small minority of respondents stated they would pay between £35 and £50 (the highest bracket) as being an acceptable cost for analgesic treatment, but significantly more were prepared to meet a lower cost. For example, 32 per cent of respondents stated they would pay between £5 and £10 for analgesia when surgically castrating calves, and 8 per cent stated they would pay £11 or more. When considering caesarean section surgery, 28 per cent of respondents stated they would pay £11 to £20, 13 per cent stated £21 to £35 and 6 per cent stated £36 to £50. Meanwhile, 21 per cent stated they would pay £5 to £10 for analgesia for disbudding and 4 per cent stated £11 or more.

This survey suggests that cost is not the barrier to analgesia that practitioners may initially believe it to be for some owners. Therefore, it is important to offer a range of costed analgesic treatment protocols for painful procedures and conditions.

| Condition | Median score | Range | Modal score |
|-----------|--------------|-------|-------------|
| Adult cattle procedures | 6 | 1-10 | 7 |
| Claw amputation | 10 | 2-10 | 10 |
| Dystocia | 7 | 2-10 | 8 |
| Dehorning (horns >8 cm) | 8 | 2-10 | 10 |
| Debridng a digital dermatitis lesion | 6 | 1-10 | 5 |
| Left-displaced abomasum surgery | 9 | 2-10 | 10 |
| Uveitis | 6 | 1-10 | 7 |
| Fracture of the tuber coxae | 7 | 2-10 | 8 |
| Left-displaced abomasum | 3 | 1-10 | 3 |
| Digital dermatitis | 6 | 2-10 | 5 |
| Acute metritis | 4 | 1-10 | 3 |
| Swollen hock | 5 | 1-10 | 5 |
| Hock with hair loss | 3 | 1-10 | 2 |
| Acute toxic Escherichia coli mastitis | 7 | 1-10 | 7 |
| Mastitis (clots in milk only) | 3 | 1-10 | 2 |
| Neck calluses | 2 | 1-7 | 2 |
| White line disease with subsole abscess | 7 | 1-10 | 7 |
| Castrations (surgical) | 6 | 2-10 | 5 |
| Castration (rubber ring) | 6 | 1-10 | 5 |
| Castration (Burdizzo) | 7 | 2-10 | 8 |
| Umbilical hernia surgery | 8 | 2-10 | 10 |
| Disbudding | 7 | 2-10 | 8 |
| Distal limb fracture | 8 | 2-10 | 8 |
| Following dystocia | 4 | 1-10 | 3 |
| Umbilical abscess | 5 | 1-10 | 4 |
| Joint-ill | 7 | 1-10 | 8 |
| Pneumonia | 6 | 1-10 | 5 |

* A 10-point scale was used: 1 No pain at all, 10 Worst pain imaginable
† The central score if all the data are arranged in ascending order
‡ Most frequently given answer
§ Fetal–maternal disproportion requiring traction alone
Reproduced from Huxley and Whay (2006)
In Practice  MARCH 2008

Legal considerations

The legal obligations associated with animal welfare have undergone major reorganisation following the introduction of the Animal Welfare Act 2006. Although this Act has effectively replaced most of the previously relevant regulations, and in many cases there is little practical difference, there are variations in the details of the legislation between England, Wales and Scotland.

The major legislation relevant to this article states:

- It is an offence on the part of the person responsible for an animal to cause or permit it to suffer.
- It is an offence to carry out, or allow to be carried out, a procedure interfering with the sensitive tissue or bone structure of an animal that is not for medical purposes, unless the procedure is listed in the Mutations (Permitted Procedures) (England) Regulations 2007. In cattle, these include:
  - Calf castration (anaesthetic must be used in calves over two months of age);
  - Disbudding or dehorning cattle of any age (again, anaesthetic must be used, except in the case of chemical caudery, which is only permitted during the first week of life);
  - Removal of supernumerary teats from calves (anaesthetic must be used for calves over three months old).
- It is an offence on the part of the person responsible for an animal not to take reasonable steps to ensure that its needs are met to the extent required by good practice.
- The Welfare of Farmed Animals Regulations 2007 require that those responsible for farmed livestock have access to and are familiar with the specific animal welfare codes for the species they own/care for.

Legal considerations can be broadly categorised as objective and subjective. Objective methods measure physiological stress responses (eg, plasma cortisol levels), changes in levels of biochemical markers (eg, acute phase proteins) or the incidence of clearly defined patterns of behaviour (eg, vocalisation). Subjective methods are value judgements made by a human observer, and involve the evaluation of behaviour, posture and other cues (see below). The degree of pain is then described using a verbal descriptor (eg, mild, moderate or severe) or a visual analogue scale (eg, placement of a mark somewhere on a line between no pain and the worst pain imaginable), or assigned a numerical value (eg, 0 to 10). These judgements become more reliable and consistent with experience and training. It is important to have a consistent approach to pain assessment and to ensure that the same behavioural and physiological signs are assessed in each animal.

In a practical situation, a number of objective and subjective indicators can be employed to assess pain, and should all be evaluated as part of a standard clinical examination. These include:

- Decreased movement/locomotion;
- Decreased interaction with other animals in the group;
- Decreased feed intake (eg, ‘hollow’ left flank caused by an empty rumen);
- Changes relevant to the source of the pain being experienced (eg, altered locomotion, flank watching or kicking, or ear twitching);
- Level of mental activity/responsiveness (animals in severe pain often show reduced responsiveness to stimuli);
- Changes in normal postures associated with pain (eg, lateral recumbency, standing motionless or drooping of the ears);
- Easily measurable indicators of physiological stress (eg, increased heart rate, increased pupil size, altered rate and depth of respiration or trembling);
- Bruxism (tooth grinding);
- Poor coat condition (eg, rough, dusty or unkempt) caused by decreased grooming.

Licensing of veterinary medicines

Licensing issues have a major effect on product choices in farm animal medicine. The Veterinary Medicines Regulations (currently 2007, and updated annually) provide for administration of products outside the terms of a product’s marketing authorisation under the prescribing cascade. However, they state that: ‘any pharmacologically active substances included in a medicinal product administered to a food-producing animal under the cascade must be listed in Annex I, II or III to Council Regulation (EEC) No. 2377/90.’ Annex I lists substances that have a definitive maximum residue limit (MRL), and these are generally products that have an authorisation for use in food-producing animals. Annex II lists substances that have, following initial evaluation by the European Medicines Agency (EMEA), been deemed to pose sufficiently little risk to public health so as not to necessitate the determination of an MRL. Annex III lists substances that are currently undergoing MRL determination and which have been given provisional limits as no outstanding ongoing safety issues are considered to be pending.

Only pharmacologically active substances listed in Annexes I, II and III can be used in veterinary medicinal products for food-producing animals. These are effectively products that are licensed for these particular animals, or products listed in Annex II that do not have a licence for a food-producing species. The only potentially useful compounds listed in Annex II for food-producing animals are therefore ketamine and thiopental; butorphanol, isoflurane and lidocaine are listed, but for Equidae only. Thus, the agents available for use as analgesics are restricted to NSAIDs, xylazine, detomidine and procaine, with ketamine and thiopental being the only options for general anaesthesia.

The use of licensed products outside the terms of their data sheets (eg, for different indications) must be justifiable and for reasons other than economics. It is also important to emphasise that withdrawal periods at least equal to the standard seven days for milk and 28 days for meat should be applied when these products are used in this way. Use of an off-label treatment must be discussed with the owner/keeper of the animal before treatment is given.

Further information, which is updated regularly, is available on the Veterinary Medicines Directorate’s website (www.vmd.gov.uk).
Long-term analgesia in farm animals

The long-term management of pain in farm animals with chronically painful conditions is currently difficult, largely due to licensing restrictions and cost. Oral phenylbutazone was available for this purpose, but its use in food-producing animals is now illegal.

An alternative approach is the use of repeated doses of injectable NSAIDs. This use is off-licence beyond five days, although it could be justified under the cascade system. As authorised NSAIDs all have established MRLs, the standard withdrawal periods of seven days for milk and 28 days for meat would apply. Although the safety of long-term NSAID treatment in farm animals has not been extensively researched, there have been anecdotal reports of phenylbutazone being well tolerated over time.

The major barrier to the long-term use of parenteral NSAIDs is cost: ketoprofen given daily would currently cost around £1.20 to £1.70/100 kg/day, while meloxicam given every three days would cost £0.57/100 kg/day (both at list price). This level of expenditure may only be justified in a limited number of cases, so the use of NSAIDs is usually restricted to episodes of acute pain.

Euthanasia should always be seriously considered in cases where an animal is likely to experience long-term pain.

Cattle are stoical animals by nature because, as a species, they have been subject to a strong evolutionary pressure to mask pain, which may be perceived as weakness by predators. As a result, they frequently do not demonstrate appreciable definite signs of pain until the stimulus is severe. Unwillingness to move may be the predominant indicator, particularly in adult cattle, so the precautionary principle should be applied, as the cost of unnecessary treatment is relatively less than the cost of failing to manage animals that are suffering.

TECHNIQUES FOR ALLEVIATING PAIN

Pain in cattle may be alleviated by pre-emptive, reactive or multimodal analgesia. Where pain is predictable (eg, when conducting surgical procedures), it is preferable to provide pre-emptive analgesia. By ensuring that effective analgesia is in place before the onset of pain, phenomena such as wind-up, hyperalgesia and allodynia can be reduced or prevented. This is obviously not always feasible, but the provision of analgesia as soon as possible after the onset of pain will minimise these effects. Pre-emptive analgesia is likely to be more effective than reactive analgesia.

In human and companion animal medicine, it is well recognised that the most effective analgesia is provided using a combination of agents that act on different pathways. However, this strategy is often neglected in cattle, even though it could be beneficial in some cases. For example, the use of an epidural containing local anaesthetic and xylazine, combined with a systemic non-steroidal anti-inflammatory drug (NSAID), provides appropriate analgesia in cases of dystocia.

There are several routes of administration that can be used to provide analgesia to cattle. Systemic treatment involves parenteral provision of systemically active analgesic agents, while local techniques, such as epidural anaesthesia, intravenous regional anaesthesia (IVRA) and the use of local nerve blocks, provide analgesia to specific areas.

SYSTEMIC ANALGESIA

Analgesic drugs available for systemic use in animals include NSAIDs, α₂-agonists and opioids. Licensing is a major consideration when prescribing drugs for food-producing animals (see box on page 129), and this places many restrictions on the agents that can be used in cattle. However, a number of NSAIDs, as well as the α₂-agonists xylazine and detomidine, are licensed for use.

General anaesthesia in farm animals

In many respects, general anaesthesia can be thought of as the ‘gold standard’ in terms of pain management. However, induction of, and recovery from, general anaesthesia are stressful processes, and pain relief is only provided for the duration of the anaesthetic. Some agents have very poor analgesic properties, in which case multimodal pain relief should be employed.

General anaesthesia, either in the field or in a hospital setting, is a useful procedure, particularly in young animals (the weight of the gastrointestinal tract makes it more dangerous in adults). Licensing restrictions affect which products may be used, but anaesthesia may be induced using a xylazine and ketamine combination, and maintained with incremental doses of ketamine. An additional benefit of the use of ketamine is that, as an N-methyl D-aspartate (NMDA) antagonist, it is thought to interrupt central pain amplification processes (wind-up).

Endotracheal intubation, with or without oxygen supplementation, is recommended in all cases, even though volatile agents cannot be used for maintenance. Isoflurane could be used for maintenance to make longer procedures practicable, but current licensing rules do not permit this.
Suggested standard operating procedures for managing pain

Standing flank laparotomy in adult cattle
- Systemic NSAID before surgery
- Systemic xylazine or detomidine can be used, but extreme care is needed with the dose to ensure that the animal does not become recumbent. The analgesic effects of xylazine are limited at dose rates that allow the patient to remain standing. May be necessary in very fractious patients
- Paravertebral nerve block (procaine) provides effective anaesthesia of the flank area
- Epidural anaesthesia may be used for a caesarean section to eliminate tenesmus that may hinder surgery

Castration and disbudding of calves
- Cornual nerve block using local anaesthetic
- Local infiltration of local anaesthetic in the skin of the distal scrotum (surgical castration) and over the neck of the scrotum to provide analgesia to the spermatic cord (surgical and Burdizzo castrations). Injection of local anaesthetic into the testes themselves may or may not be used. This constitutes an off-licence use of procaine
- Additional pre-emptive use of NSAIDs is desirable where economically acceptable. Several researchers have found that this results in welfare benefits (Earley and Crowe 2002, Ting and others 2003). Clinicians too often fail to offer this option to clients, who may well be happy to pay the relatively small cost of extended analgesia

Foot surgery/treatment of severe claw horn lesions (e.g., severe sole ulcers)
- Systemic NSAID before treatment
- Intravenous regional anaesthesia for short-term anaesthesia of the foot

Other potentially painful conditions
- JOINT-ILL AND NAVEL ILL IN CALVES. NSAIDs should be considered, as septic arthritis in particular is thought to be an extremely painful condition in humans and companion animals, but analgesia is too often neglected in cattle
- MASTITIS. NSAIDs should be considered in all cases of mastitis involving the udder or systemic signs, as opposed to mastitis in which signs are restricted to milk changes (Milne and others 2003)

Castration and disbudding of calves
- NSAIDs should be considered in addition to local anaesthesia for both surgical (left) and Burdizzo (above) castration of bull calves

Castration and disbudding of calves
- NSAIDs have anti-inflammatory and analgesic properties and should be considered for use in all cases of mastitis involving the udder or systemic signs

Castration and disbudding of calves
- LAMENESS. In addition to foot surgery and the treatment of severe claw horn lesions, the use of NSAIDs in cases of less severe lameness is beneficial (O’Callaghan-Lowe and others 2004)
- DYSTOCIA. The use of NSAIDs is relatively common following dystocia; analgesia should be considered for both the calf and the dam
- UVEITIS AND KERATOCONJUNCTIVITIS. These are both relatively common ocula conditions in cattle (‘silage eye’ and ‘New Forest eye’, respectively), and the underlying pathology (uveitis and corneal ulceration, respectively) is considered to produce severe pain in humans and companion animals. As well as providing analgesia, NSAIDs may increase the speed of response to treatment by reducing inflammation in cases of uveitis

Castration and disbudding of calves
- New Forest eye in a cow, caused by infectious bovine keratoconjunctivitis. Corneal ulceration causes severe pain in humans
**NSAIDs**

NSAIDs work by inhibiting inflammatory mediators (see box below). They provide effective analgesia for mild to moderate pain, and can be administered via a variety of routes (see table on page 133). They also have anti-endotoxic effects, which provide major benefits in terms of morbidity and mortality in some disease states.

The duration of activity is generally between 24 and 72 hours per dose. Some products are licensed for repeated administration, up to a maximum of five days of treatment, but have also been used for longer periods with few reports of side effects.

**α₂-agonists**

α₂-agonists work by activating α₂-adrenoreceptors in the central and peripheral autonomic nervous system. These agents have a negative effect on sympathetic activity and the release of noradrenaline, leading to sedation and analgesia. They can provide deep sedation and effective analgesia for moderate pain in cattle. Due to the sedative and analgesic effects of this class of drugs, α₂-agonists are more useful during some types of surgery and should not be used for the provision of longer-term analgesia. Xylazine and, recently, detomidine are the only licensed drugs in this class of agents.

**Opioids**

Opioids are very potent analgesics and are an important component of multimodal analgesia protocols in other species. However, under current legislation, no opioids are licensed for use in cattle.

**REGIONAL AND LOCAL ANALGESIA**

Local analgesia can be provided using epidural analgesia, IVRA and local nerve blocks.

**Epidural analgesia**

Epidural analgesia is quick and straightforward to perform in cattle, and the technique is described in full by Holden (1998). Analgesic agents are injected into the epidural space to desensitise the nerves leaving the spinal cord. Low-volume epidural anaesthesia (4 to 6 ml of injectable solution for an adult cow) is most commonly performed, providing analgesia of the genital tract, rectum and perineal area, and abolition of tenesmus. High-volume techniques (up to 100 ml per adult cow) are also described and may be used to anaesthetise the entire abdomen, but motor control to the hindlimbs is lost, so the patient will become recumbent.

Local anaesthetic is the most commonly used agent, but xylazine has also been employed extensive-
local anaesthesia was conducted under heavy sedation using xylazine and This bull was treated with NSAIDs before surgery, which was conducted under heavy sedation using xylazine and local anaesthesia. Multimodal anaesthesia is preferable for entropian surgery. The administration of xylazine by this route is off-licence. Intravenous regional anaesthesia IVRA is another quick and easy standard operating procedure (see box on page 134). It desensitises the limb distal to the tourniquet and is useful for painful procedures in the foot (eg, foot surgery and treatment of severe claw horn lesions), but is underused in the treatment of lame cows. As the effects of IVRA wear off once the tourniquet is released and no ongoing analgesia is provided, it is usually advisable to administer NSAIDs as well, to provide longer-term effective pain relief. The administration of local anaesthetic by this route is off-licence.

Local nerve blocks A number of nerve block techniques have been described in cattle (see Edwards [2001] for further information) and are summarised in the table on page 134. Local anaesthetics are the most commonly used agents for nerve blocks, providing 30 to 90 minutes of effective anaesthesia; procaine is the only licensed product in food-producing animals. Local anaesthetic/xylazine combinations have also been used and are thought to extend the duration of analgesia. Again, this use is off-
Intravenous regional anaesthesia of the hindlimb in cattle

**Equipment**
- Appropriate handling facilities (ie, foot-trimming crush)
- Clippers/scissors
- Chlorhexidine surgical scrub
- Surgical spirit
- Tourniquet (eg, inner tube of a bicycle tyre)
- 20 to 30 ml of local anaesthetic in a syringe (procaine is now the only legal option), depending on the size of the animal
- 18 gauge, 3·81 cm needle

**Procedure**
- Restrain the animal in the crush, with the affected limb raised. This is easier to perform if the limb is not tied to the upright of the crush, as this will get in the way of the injection site
- Clip and surgically prepare the dorso-lateral aspect of the metatarsus
- Apply the tourniquet to the limb, either below or above the hock. If applied above the hock, rolls of bandage or similar may be required to fill the spaces either side of the gastrocnemius tendon. For this reason, the authors prefer to apply the tourniquet below the hock. It must be applied sufficiently tightly and secured
- Palpate the lateral saphenous vein running directly up the dorso-lateral aspect of the metatarsus. Place the needle in the vein (directed distally), with its entire length in the lumen of the vessel. Good needle placement increases the stability of vascular access while the local anaesthetic is injected
- Allow blood to drain through the needle until the pressure drops so that blood is dripping rather than running out of the hub
- Connect the syringe and slowly inject the local anaesthetic
- After five to 10 minutes, check the desensitisation of the foot by pricking the skin of the interdigital space with a sterile needle
- At the end of the procedure, remove the tourniquet gradually, to prevent the theoretical possibility of a bolus of local anaesthetic entering the circulation. This is more important if anaesthesia is only required for a short period of time
- This technique is easily adapted for the forelimb, although it is worth casting the animal as restraint can be more difficult.

| NERVE BLOCKS COMMONLY USED IN CATTLE | Area of analgesia | Comments |
|--------------------------------------|-------------------|----------|
| Paravertebral                        | Flank             | Quick and simple way to provide anaesthesia for flank surgery |
| Cornual                              | Horn and surrounding skin in calves | Less effective in adults |
| Retrobulbar                          | Eye and adnexa    | May result in damage to adnexal structures, usually reserved for enucleation |
| Peterson                             | Eye and adnexa, except eyelids | Less destructive than retrobulbar block, need to anaesthetise eyelids separately for enucleation |
| Auriculopalpebral                    | Eyelids (motor function only) | Provides paralysis but not desensitisation of the eyelids |
| Common peroneal and tibial           | Hindlimb distal to tarsus | Good alternative to intravenous regional anaesthesia, although technically more difficult |

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**SUMMARY**

Despite an increase in research into, and awareness of, pain in cattle over the past 15 years, the management of painful conditions in this species is still too rarely considered in practice. Well-understood concepts such as pre-emptive and multimodal analgesia are significantly underused in practice, and the duration of effect with analgesic drugs is frequently shorter than would be ideal.