Identifying and preventing pain and suffering in dairy cattle

Daniel M. Weary & Marina A.G. von Keyserlingk

Animal Welfare Program, Faculty of Land and Food Systems, University of British Columbia, Vancouver, Canada, dan.weary@ubc.ca and/or marina.vonkeyserlingk@ubc.ca

Introduction

People's concerns about the appropriate treatment of others (animals and humans) often place much importance on the prevention of pain. Causing pain to another individual is typically considered immoral, and failing to prevent pain (that can, reasonably be prevented) is almost as bad. But farmed cattle routinely experience pain, sometimes severe and long lasting, sometimes directly caused by the procedures we apply, and other times by ailments that they experience. Very often the pain experienced is not treated, despite the widespread availability of effective treatments. This chapter reviews research on pain assessment and prevention in cattle, describes a variety of methods to identify pain, discusses ways of treating common sources of pain, and ends with a discussion of how pain can lead to suffering in animals.

Pain assessment and prevention

Pain assessment is not always straightforward. The methods we use to assess pain in people will not necessarily apply to animals. For example, the gold standard in pain research on most humans is the verbal reports, but this is impossible in animals. We thus need to develop innovative ways of 'asking' animals indirectly about the pain they experience. For example, some non-verbal measures first developed for use in humans, like the facial expressions described by Darwin (1872), have shown promise in laboratory mice (Langford et al., 2010) and farm animals (Gleerup et al., 2015). Finding out what measures are useful in cattle requires research, as described below.

Responses to a noxious stimulus

The most obvious method of identifying responses useful in pain assessment is to record how the animal responds to a noxious stimulus that can reasonably assumed to cause pain. The response measures can be physiological or behavioral, but for the purposes of this paper we will concentrate on behavioral measures, in part because we believe that we can draw stronger inferences regarding pain from behavioral responses.

Cattle are often subjected to injuries that are likely to cause pain, meaning that pain responses are also relatively easy to observe. Consider, for example, hot iron dehorning. Dehorning (sometimes referred to as 'disbudding' when calves are young) is typically achieved in calves by cauterizing the tissue around the base of the horn, thereby preventing any further horn development. The resulting burn injury is associated with a number of well-documented acute pain responses, including kicking, struggling, vocalizing, etc.

In addition to these intra-operative responses, calves show a number of responses to the pain that persists in the hours following the procedure. For example, some work has shown that calves show sensitivity to touch around the wounded area for up to 75 h after dehorning (Mintline et al., 2013). In addition to this heightened response to tissue palpation, calves show altered lying behavior, and increased wound directed behaviors including head shakes, ear flicks and head rubs (Faulkner and Weary, 2000).

One way to be more certain that these responses are specific to pain is to examine responses with and without analgesics. Ideally, animals are also tested in a sham procedure (for example, with exposer to a cold iron that causes no burn), again with and without a proven analgesic. The ideal pain response measures are those that change only in response to the painful injury without analgesia. Animals that are injured but also receive analgesia should show a reduced response (ideally similar to the sham baseline), and the analgesic on its own (when provided to the sham treated animals) should have no effect on the response measures. This type of approach to validation is described in more detail in Weary et al. (2006), and an example of the approach as applied to dehorning of dairy calves is provided in Figure 1.

In addition to documenting how cattle respond to pain, this type of research has been useful in identifying how best to mitigate the pain caused by such procedures.

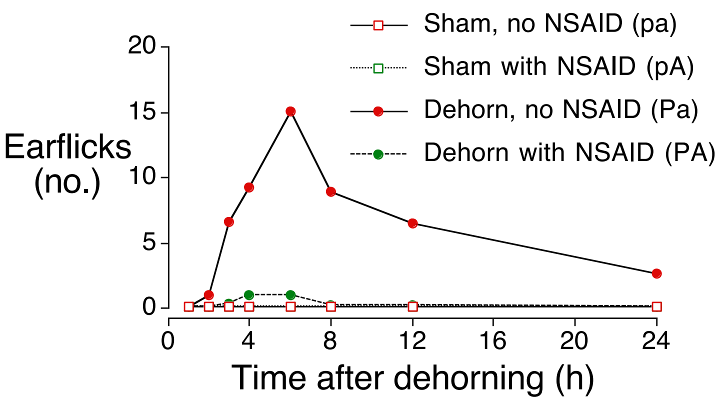

Figure 1.The number of ear flicks, per observational period, for calves assigned to one of four different treatments: dehorning with (PA) without (Pa) the provision of a NSAID, and sham dehorningwith (pA) and without (pa) effective the analgesic. Redrawn from Faulkner and Weary, 2000.

For hot iron dehorning, work by our group and others, has shown the benefits of a multimodal approach. Specifically, we recommend the use of a preoperative sedative to calm the calf and to facilitate the injections with a local anesthetic that provides intra-operative pain control. And as illustrated in the example above, we also recommend the use of post-operative analgesics to control the long lasting pain responses that result from these burn injuries. The use of caustic chemicals (i.e. 'paste' dehorning) is also possible in young calves, but this method requires different means of pain control (Vickers et al., 2005). Regardless, it is clear that the public expects the dairy industry to provide adequate pain relief for the procedure (Robbins et al., 2015), and dairy industry organization are increasingly requiring that all farmers adopt pain mitigation protocols for dehorning. Dehorning is just one example of a routine surgical procedure causing pain. More work is needed on to develop methods of pain assessment and pain prevention protocols for other sources of surgically induced pain (Walker et al., 2011).

Even better that controlling the pain is to avoid painful procedures if possible. Thus the obvious long-term solution to dealing with the pain due to dehorning is to learn how to manage horned cattle, or to use genetically hornless (i.e. 'polled') sires. The latter has been the preferred option for much of the beef industry, with excellent genetics available in polled lines. The availability of polled sires is more limited for dairy breeds, but the situation is changing rapidly. With greater demand from farmers and veterinarians, the availability of excellent polled dairy sires will continue to grow.

Tail-docking is another example of a procedure for which abstinence is the preferred option. Tail docking became common in the 1990's and early 2000's, in large part due to the mistaken belief that docking cows would help keep animals cleaner, and thus also reduce the risk of intra-mammary infections. Study after study has now shown that tail docking has no such positive effect (e.g. Tucker et al., 2001; see also review by Tucker and Sutherland 2011). Indeed, farms that use this procedure have on average dirtier cows than do farms that do not dock tails (Lombard et al., 2010); this is likely because farms that dock their cows have a problem with cow cleanliness (likely because of poor housing and management on that farm), and they lack the skill or knowledge to adopt more useful approaches.

Responses to injury and disease

In addition to the painful injuries we cause to cattle (like dehorning, branding, etc.), cattle can experience naturally occurring injuries and diseases that cause pain. For naturally occurring ailments we often do not know when precisely the ailment develops or cures, but we can normally identify animals with and without the ailment, providing some basis for identifying measures associated with pain.

Of all the painful ailments experienced by dairy cattle, lameness is likely the most prevalent. Work by our group (von Keyserlingk et al., 2012) and others shows that prevalences often exceed 20% across a diverse range of regions. Lameness cases are often long lasting, likely making the effects of pain more difficult for the animals.

Changes in gait (i.e. the way animal's walk) provide one method of identifying lameness in cattle (Flower and Weary, 2009). Some changes in gait may be due to mechanical or other restrictions; for example, gait differs when cows walk to versus from the milking parlor (Flower et al., 2006), perhaps because the full udder interferes with the cow's ability to walk smoothly. But other changes in gait are likely due to the pain that the cow experiences from placing weight on the injured limb. One way to get a sense for how the pain causes gait changes is to compare animals with and without injury (Flower and Weary, 2006), and to examine changes in gait within lame cows when they are able to walk on a more comfortable walking surface (Flower et al., 2007).

As with the responses to the noxious stimulus described above, we are able to make more specific inferences regarding pain if we examine how these responses measures change when the animals are provided an analgesic. For example, Flower et al. (2008) measured changes in the gait score of lame cows when these animals were provided the recommended dose of the drug ketoprofen (3 mg/kg), half the recommended dose (1.5 mg/kg) and a nominal dose (0.1 mg/kg). The gait of the cows improved with treatment, especially at the higher doses (Figure 2). In a parallel study, Rushen et al. (2007) found that gait improved in cows following treatment with a local anesthetic in the injured limb. In addition to changes in gait score, Rushen and colleagues also examined two more objective measures: weight bearing on the injured limb (assessed directly using a load cell) and variability in the weight placed on the injured and contralateral limb; these measures also showed improvement with treatment with a local anesthetic, indicating that at least some of the variation in all three measures was due to pain.

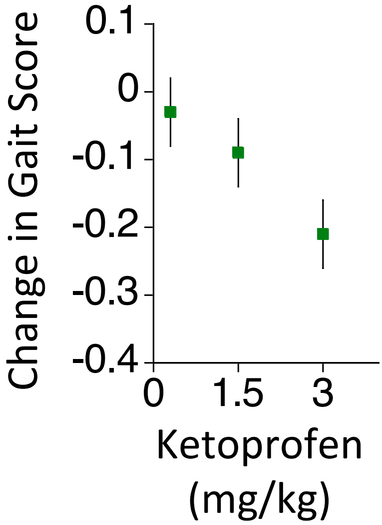

Figure 2.Changes in the gait of lame cows in relation to dose of the non-steroidal anti-inflammatory drug ketoprofen.Redrawn from Flower et al., 2008.

Another common disease that our group at the University of British Columbia (UBC) has worked upon is metritis. Like lameness, many cows experience metritis, especially in the weeks after calving. LeBlanc (2008) estimated that approximately 15% of cows experience clinical endometritis within the first 6 weeks after calving, and an addition 30% experience sub-clinical endometritis. Work on our own UBC herd, where we have carefully follow cows in the weeks after calving, has routinely found clinical metritis in more than 30% of cows (e.g. Huzzey et al., 2007; see also companion conference proceedings von Keyserlingk and Weary)..

We have been interested in using changes in behavior to detect diseases such as metritis that often go undiagnosed. For example, in addition to our work on metritis we have used changes in behavior to better detect animals with ketosis (Goldhawk et al., 2009; Itle et al., 2015) and mastitis (Sepúlveda-Varas et al., 2016). However, it is not clear to what extent these changes in behavior reflect a more general malaise (see Weary et al., 2009) and what, if any, are the result of pain.

In one recent study we have attempted to more directly assess the pain associated with uterine infection by measuring how cows respond to palpation of the affected organ (Stojkov et al., 2015). Back arch is frequently shown in animals experiencing abdominal pain, including in laboratory rats following laparotomy (Roughan and Flecknell, 2001), and is commonly used in the clinical assessment of lameness in dairy cows. In the study by Stojkov and colleagues, we monitored the back arch of dairy cows before and during palpation of the uterus. Cows showed a more pronounced back arch if they were metritic. This effect was clear during the palpation of the uterine wall, but also during the passive rectal exam, suggesting that that palpation of the uterus is not necessary to identify the more pronounced back arch response in sick cows. These results also suggest that metritis is associated with hyperalgesia in cattle, although further work using animals treated with analgesics is now needed to make stronger inferences on the role of pain.

What next – identifying and preventing suffering

As illustrated above, much is known about pain assessment in cattle, and this work has lead to important refinements in how to reduce the pain that cows experience. However, we have little basis for how to prioritize our work in pain detection and treatment. For example, should new work focus especially on painful and potentially painful procedures such as left displaced abomasum (LDA) surgery, teat removal, dehorning, freeze branding, hoof trimming, etc., or on ailments like lameness, metritis and mastitis?

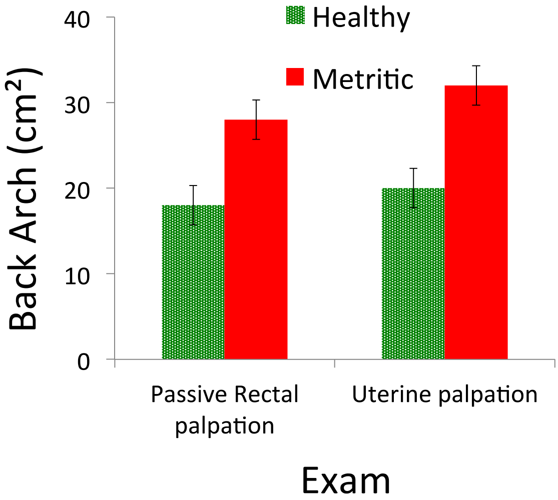

Figure 3.The extent of back arch shown by dairy cows diagnosed as healthy or metritic. Back arch was measured (in cm^2 from calibrated video) during a rectal exam with either a passive hand or during active palpation of the uterine wall. Redrawn from Stojkov et al., 2015.

Laws relating to animal welfare often refer to the concept of ‘suffering’, suggesting that preventing pain associated with suffering may be especially important. Unfortunately, scientific usage of the word suffering has tended to be weak; authors use the term simply as an embellishment (i.e. ‘pain and suffering’), or to indicate that the animal is somehow aware of the pain (an issue rarely contested in cattle), or that the pain is long lasting or severe (duration and severity can be assessed independently, and there is no clear threshold for either factor allowing us to say when suffering might begin). Given that suffering has strong moral and legal implications, we have attempted to develop some criteria by which we might better identify cases of animal suffering (Weary, 2014).

Here we wish to focus on two main attributes often referenced in human reports of suffering related to pain. One is that the pain is associated with depression and the other is that pain is associated with the lack of control. We explain both aspects below and show how these could apply to our thinking of suffering in cattle.

Many of us experience at least some pain. For example, you might experience shoulder pain associated with repetitive strain from too much time using a keyboard and mouse? In many cases such pain will not affect your quality of life. You can still do everything you want to do; in no way does the pain take away from the joy of the good things in life. In other cases, however, pain can seriously diminish mood, and in the most serious cases patients become anhedonic. Thus one way to assess suffering in animals might be to see when pain results in low mood states consistent with depression in humans.

One way to assess mood states in human patients is to examine responses to neutral or ambiguous stimuli. For example, if you read the phrase 'the doctor examined the child's growth', what do you think? An optimistic assessment would be that the doctor was examining how well the child was growing, but a pessimistic assessment would be the doctor was examining the child's cancerous growth. This type of cognitive bias test can also be applied to animals, and some types of pain result in shifts in assessment consistent with low mood in animals.

In one study we trained calves to approach a colored video screen to earn a milk reward (Neave et al., 2013). For some animals, approaches to a red screen resulted in the milk reward, but approaches to a white screen were punished with a 'time out' when the screen would not turn on. In this way calves learned to approach the screen only when it was red. Once calves had learned the task they could then be presented with ambiguous screens (i.e. various shades of pink created by mixing the red and white colors). We found that calves would show intermediate responses to these cues, for example, approaching the mid-way shade of pink about half the time (Figure 4). However, in the hours after hot-iron dehorning (when calves are know to experience post-operative pain, as reviewed above), calves showed a pessimistic response bias, responding less frequently to the ambiguous shades, especially to those colors most similar to the negative screen. We also found evidence of cognitive bias in a second study examining calf responses before and after disbudding, and perhaps more interestingly, found a similar bias in the days after experiencing the emotional 'pain' associated with separation from the cow (Daros et al., 2014).

We argue that pain (both the physical pain from dehorning and the emotional pain associated with cow-calf separation) that results in changes in mood can be considered indicative of suffering, suggesting that treating or avoiding this type of pain may be especially important in our care for animals.

Finally, we would ask you to consider the issue of control and how this may affect the risk of suffering in animals. Not being able to control exposure to pain (e.g. ability to avoid the painful stimulus), not having the ability to control the duration and severity of the pain (e.g. the ability to access effective analgesics) and ultimately the fear that the pain will make you lose control over your sense of self, are often referenced in human descriptions of suffering, but we rarely consider the issue of control in the care and treatment of pain in animals. Compare, for example, two animals. One is restrained without warning and held down while it receives an injection. The second is trained (using a food reward) to voluntarily approach the handler for the same injection. The pain of the injection may be the same, but the animal's experience likely differs greatly.

Hoof trimming in cattle is thought to reduce the risk of hoof lesions associated with lameness, and to help lame animals recover. However, the trimming can cause pain, and the restraint and handling associated with trimming is fear provoking and provides the animals with no control. According to the logic of our argument above, we suggest that routine trimming would be much less likely to result in suffering if animals were trained to voluntarily approach the trimmer. We encourage new research that examines pain in the context in which the pain occurs, with special focus on fear and control caused by the handling procedures.

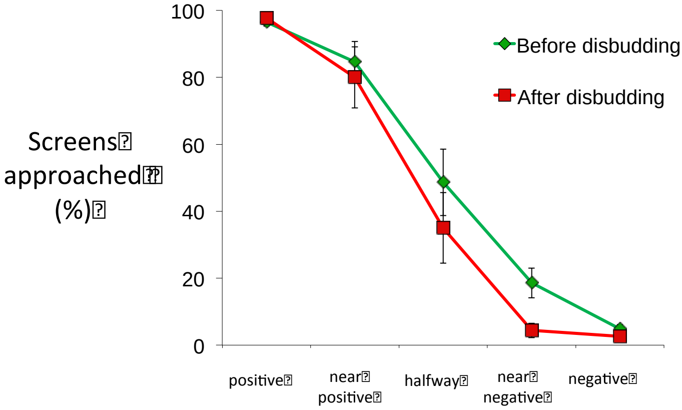

Figure 4.The % approach responses to positive and negative training screens and to three ambiguous colours intermediate to the training colors. Responses are shown separately before and during the 24 h after hot-iron dehorning. Redrawn from Neave et al., 2013

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References

1. Daros, R.R., J.H.C. Costa, M.A.G. von Keyserlingk, M.J. Hötzel and D.M. Weary. 2014. Separation from the dam causes negative judgment bias in dairy calves. PLOS ONE 9:e98429.
2. Darwin, C. 1872. The Expression of the Emotions in Man and Animals. John Murray, London.
3. Faulkner, P. and D.M. Weary. 2000. Reducing pain after dehorning in dairy calves. J. Dairy Sci. 83:2037-2041.
4. Flower, F.C., A.M. de Passillé, D.M. Weary, D.J. Sanderson and J. Rushen. 2007. Softer, higher-friction flooring improves gait of cows with and without sole ulcers. J. Dairy Sci. 90: 1235-1242.
5. Flower, F.C., D.J. Sanderson and D.M. Weary. 2006. Effects of milking on dairy cow gait. J. Dairy Sci. 89:2084-2089.
6. Flower, F.C., M. Sedlbauer, E. Carter, M.A.G. von Keyserlingk, D.J. Sanderson and D.M. Weary. 2008. Analgesics improve the gait of lame dairy cattle. J. Dairy Sci. 91: 3010–3014.
7. Flower, F.C. and D.M. Weary. 2006. Effect of hoof pathologies on subjective assessments of dairy cow gait. J. Dairy Sci. 89: 139-146.
8. Flower, F.C. and D.M. Weary. 2009. Gait assessment in dairy cattle. Animal 3: 87-95.
9. Gleerup K.B., B. Forkman, C. Lindegaard and P.H. Andersen. 2015. An equine pain face. Vet. Anaesth. Analg. 42:103-114.
10. Goldhawk, C., N. Chapinal, D.M. Veira, D.M. Weary and M.A.G. von Keyserlingk. 2009. Prepartum feeding behavior is an early indicator of subclinical ketosis. J. Dairy Sci. 92: 4971-4977.
11. Huzzey, J.M., D.M. Veira, D.M. Weary and M.A.G. von Keyserlingk. 2007. Prepartum behavior and dry matter intake identify dairy cows at risk for metritis. J. Dairy Sci. 90:3220-3233
12. Itle, A.J., J.M. Huzzey, D.M. Weary and M.A.G. von Keyserlingk. 2015. Clinical ketosis and standing behavior in transition cows. J. Dairy Sci. 98:128-134
13. Langford, D.K., A.L. Bailey, M.L. Chanda, S.E. Clarke, T.E. Drummond, S. Echols, S. Glick, J. Ingrao, T. Klassen-Ross, M.L. LaCroix-Fralish, L. Matsumiya, R.E. Sorge, S.G. Sotocinal, J.M. Tabaka, D. Wong, A.M.J.M. van den Maagdenberg, M.D. Ferrari, K.D. Craig and J.S. Mogil. 2010. Coding of facial expressions of pain in the laboratory mouse. Nat. Methods 7:447-452.
14. LeBlanc, S. 2008. Postpartum uterine disease and dairy herd reproductive performance: A review. Vet. J. 176:102-114.
15. Lombard, J.E., C.B. Tucker, M.A.G. von Keyserlingk, C.A. Kopral and D.M. Weary. 2010. Associations between cow hygiene, hock injuries, and free stall usage on US dairy farms. J. Dairy Sci. 93: 4668–4676.
16. Mintline, E.M., M. Stewart, A.R. Rogers, N.R. Cox, G.A. Verkerk, J.M. Stookey, J.R. Webster and C.B. Tucker. 2013. Play behavior as an indicator of animal welfare: Disbudding in dairy calves. Appl. Anim. Behav. Sci. 144:22-30.

17. Neave, H.W., R.R. Daros, J.H.C. Costa, M.A.G. von Keyserlingk and D.M. Weary. 2013. Pain and pessimism: dairy calves exhibit negative judgment bias following hot-iron disbudding. PLOS ONE 8: e80556.
18. Roughan, J.V. and P.A. Flecknell. 2001. Behavioural effects of laparotomy and analgesic effects of ketoprofen and carprofen in rats. Pain 90:65–74.
19. Sepúlveda-Varas, P., K.L. Proudfoot, D.M. Weary and M.A.G. von Keyserlingk. 2016. Changes in behaviour of dairy cows with clinical mastitis. Appl. Anim. Behav. Sci. 175:8-13.
20. Tucker, C.B., D. Fraser and D.M. Weary. 2001. Tail docking dairy cattle: effects on cow cleanliness and udder health. J. Dairy Sci. 84: 84-87.
21. Robbins, J.A., Weary, D.M., Schuppli, C.A. and von Keyserlingk, M.A.G. 2015. Stakeholder views on treating pain due to dehorning dairy calves. Anim. Welfare 24:399-406.
22. Rushen, J., E. Pombourcq and A.M. de Passillé. 2007. Validation of two measures of lameness in dairy cows. Appl. Anim. Behav. Sci. 106:173-177.
23. Stojkov, J., M.A.G. von Keyserlingk, J.N. Marchant-Forde and D.M. Weary. 2015. Assessment of visceral pain associated with metritis in dairy cows. J. Dairy Sci. 98:5352-5361.
24. Sutherland, M.A. and C.B. Tucker. 2011. The long and short of it: a review of tail docking in farm animals. Appl. Anim. Behav. Sci. 135: 179-191.
25. Vickers, K.J., L. Niel, L.M. Kiehlbauch and D.M. Weary. 2005. Calf response to caustic paste and hot-iron dehorning using sedation with and without local anesthetic. J. Dairy Sci. 88:1454-1459.
26. von Keyserlingk, M.A.G., J. Rushen, A.M. de Passillé and D.M. Weary. 2009. Invited Review: The welfare of dairy cattle – key concepts and the role of science. J. Dairy Sci. 92:4101-4112.
27. Walker, K.A., T. Duffield and D.M. Weary. 2011. Identifying and preventing pain during and after surgery in farm animals. Appl. Anim. Behav. Sci. 135: 259-265.
28. Weary, D.M. 2014. What is suffering in animals? In: Dilemmas in Animal Welfare. (Edited by Appleby, M.C., Weary, D.M. and Sandøe, P.). CAB International, Wallingford, UK, pp. 188-202.
29. Weary, D.M., J.M. Huzzey and M.A.G. von Keyserlingk. 2009. Board Invited Review: Using behavior to predict and identify ill health in animals. J. Anim. Sci. 87:770-777
30. Weary, D.M., L. Niel, F.C. Flower and D. Fraser. 2006. Identifying and preventing pain in animals. Appl. Anim. Behav. Sci. 100:64-76.