rccp Revista Colombiana de Ciencias Pecuarias

Lameness and its impact on welfare of cattle

Cojera y su impacto en el bienestar del ganado

Jan K Shearer, DVM, MS, Dipl ACAW

College of Veterinary Medicine, Iowa State University, Ames, Iowa, USA

Abstract

Ulcers, white line disease, and traumatic lesions of the sole are common lameness disorders in dairy cattle. Since they are often associated with abscess formation, many assume that topical antibiotic therapy is required. In fact, topical therapy is unlikely to be of value and violates one of the principal precepts of bioethics in medicine *"first, do no harm"*. The first step in developing a rational treatment strategy is to understand the pathogenesis of lameness conditions and wound healing in animals; otherwise, therapy is likely to interfere with, rather than compliment, the healing process. Finally, while much of our attention is directed at the specific treatment of hoof lesions, it is important to remember that lameness disorders are one of the most painful of health disorders in cattle. Therefore, in addition to early detection of lameness, treatment of lame cows must include considerations for pain management.

Resumen

Las úlceras, la enfermedad de la línea blanca y las lesiones traumáticas de la suela son trastornos comunes de cojeras en el ganado lechero. Puesto que a menudo se asocian con la formación de abscesos, muchos asumen que se requiere terapia con antibióticos tópicos. De hecho, es poco probable que la terapia tópica sea de valor y viola uno de los principales preceptos de la bioética en la medicina «*primero, no hacer daño*". El primer paso en el desarrollo de una estrategia de tratamiento racional es entender la patogénesis de las condiciones de cojera y cicatrización de las heridas en los animales, de lo contrario, es probable que interfiera con la terapia, en lugar de complementar el proceso de curación. Finalmente, aunque gran parte de nuestra atención está dirigida al tratamiento específico de las lesiones de casco, es importante recordar que los trastornos de cojeras son uno de los trastornos de la salud más dolorosos para el ganado vacuno. Por lo tanto, además de la detección temprana de cojera, el tratamiento debe incluir consideraciones para el manejo del dolor.

Treating claw lesions – a rational decision or not?

Irrespective of the antimicrobial/antiseptic compound used in topical therapy, one must question if such treatment makes sense. The causes of claw lesions are metabolic and mechanical or traumatic in nature. Abscess formation, if it occurs, is secondary resulting from the development of a microenvironment that supports the colonization of anaerobic bacteria. Corrective trimming procedures designed to remove all loose and necrotic horn change the microenvironment thereby preventing abscess formation. Normally this, and a foot block applied to the healthy claw to prevent weight bearing on the injured claw, are sufficient to provide significant pain relief and an opportunity for healing.

Some will say the above all makes sense, but, what about post-treatment (post-corrective trimming)

contamination?" Surely topical treatment and a bandage would prevent any problems that might occur once the cow is returned to her home pen. In fact, it is not possible to prevent post-treatment contamination in the housing conditions of most cows. Despite topical treatment and the application of a bandage, lesions become heavily contaminated within a matter of hours in modern dairy cattle housing systems. In addition to direct exposure to manure slurry and moisture, most cattle will pass through a footbath at least once a day. In a very short period what was once a clean protective bandage becomes a slurry covered/footbath solution-soaked wrap. One could argue that this is far worse than no treatment or wrap at all.

Re-epithelialization of the lesion – the key objective in healing

The objective in wound healing is a rapid unimpeded re-epithelialization of the lesion and anything that prolongs the inflammatory or proliferative phases of wound healing is contraindicated. Claw lesions affecting the dermal-epidermal tissues of the bovine claw heal by second intention; that is, by granulation and re-epithelialization. The clinical indication of an interference with wound healing is the presence of exuberant granulation tissue (Auer and Stick, 2012). This is corroborated by the observations of Van Amstel *et al.* (2003), who found that ulcers with excessive granulation tissue healed more slowly compared with lesions free of granulation tissue. Re-epithelialization of mild to moderate lesions requires somewhere around 21-30 d with more severe lesions a minimum of 40 d and potentially as long as 60 d.

Wound healing in the context of claw lesions

Wound healing is a complex process generally described in terms of three (some do not include hemostasis) or four overlapping phases including: *Hemostasis, inflammation, proliferation* and *maturation* (Stadelmann *et al.*, 1998; Auer and Stick, 2012). Topical treatment interferes with healing events that occur in the proliferative phase.

Hemostasis. The first response to injury affecting the dermis or corium is hemorrhage. Hemorrhage plays a key role in wound repair as the source of blood platelets essential for blood clot formation. Within minutes, platelets enter the site of injury and begin to clump forming a clot. Coincident with the clotting process is the release of numerous cytokines and vasoactive mediators that cause vasoconstriction to reduce blood loss and also activate inflammatory cells in preparation for the second phase of the healing process (Stadelmann *et al.*, 1998; Auer and Stick, 2012)

Inflammation. The inflammatory phase is characterized by the influx of white blood cells that phagocytize bacteria and cellular debris within the site of injury. The initial phase of vasoconstriction (within 10-15 min post-injury) is followed by a period of vasodilatation and increased vascular permeability whereby white blood cells enter the site and begin engulfing bacteria and debriding devitalized tissues.

Proliferation. The proliferative phase is characterized by angiogenesis, fibroplasia and granulation tissue formation, epithelialization and wound or tissue contraction. Any interference in these events generally results in prolonged wound healing and the potential for the development of a chronic lesion. The timing of topical treatments coincides with key events that occur during this period.

Angiogenesis. It is a key event since wound healing requires a rich blood supply in order to keep pace with the high metabolic demand associated with the synthesis of new tissues. Endothelial cells originate from uninjured blood vessels adjacent to the site of injury. Stimulated by hypoxia, lactate and low pH these cells send cytoplasm-filled projections of cell wall into the extracellular matrix (Stadelmann *et al.*, 1998; Auer and Stick, 2012)

Fibroplasia and the formation of granulation tissue. Normally begins within the first 2-3 d after injury has occurred. Fibroblasts make up the majority of cells and have multiple functions some of which are the production of ground substance and collagen (primarily collagen type III) within the wound site. Neovascularization supports the development of granulation tissue that fills the wound defect. Although less resistant to external factors than intact skin, granulation tissue provides an early, though imperfect, barrier to injurious agents from the environment (Stadelmann *et al.*, 1998; Auer and Stick, 2012).

Re-epithelialization of the lesion. It is the objective in wound healing. The speed of re-epithelialization depends upon the severity and type of injury suffered.

For example, re-epithelialization is rapid when the injury is superficial (i.e. such as an abrasion) and the basement membrane and basal cell layer are intact or minimally damaged. On the other hand, when a full thickness defect of the epithelium occurs the recovery process is prolonged. In this circumstance, residual keratinocytes at the wound site are not immediately available for recruitment to start the healing process. Instead, re-epithelialization must occur from the wound edges requiring centripetal movement of keratinocytes from the wound margins (O'toole, 2001).

Wound contraction. Occurs later in the proliferative stage of wound healing. It usually begins within 1-2 weeks after the initial injury has occurred and may continue for several weeks or months thereafter. By forming connections or adhesions to the extracellular matrix at wound edges, myofibroblasts essentially pull wound edges toward the center of the lesion thereby gradually reducing the size of the wound (Stadelmann *et al.*, 1998; Auer and Stick, 2012).

Maturation (and remodeling). The final phase of wound healing is that which leads to the formation of a scar. Collagen fibers that were once irregularly arranged become realigned and cross-linked in a series of organized fiber bundles. These changes result in an increase of the tensile strength of scar tissue, an important objective in the maturation process (Stadelmann *et al.*, 1998; Auer and Stick, 2012).

As described above, we see that wound healing is a spontaneous and continuous process; therefore, when cattle are presented for examination and treatment claw lesions are encountered in various stages of repair. In every case, our objective should be to avoid using treatment techniques or agents that may interrupt the healing process.

Topical therapy of claw lesions

A survey of Veterinarians and hoof trimmers on treatment practices indicated that topical treatments for claw horn lesions were used by 59% of Veterinarians and 53% of hoof trimmers. The medication used most frequently was the soluble powder form of tetracycline or oxytetracycline (48% by veterinarians and 81% by hoof trimmers) followed by copper sulfate for Veterinarians and ichthammol ointment (a sulphurous, tarry compound with mild antiseptic properties used primarily as a drawing agent) for trimmers (Coetzee *et al.*, 2014).

Tetracyclines are well known for their ability to cause tissue irritation when used parenterally; copper sulfate is corrosive to the skin and eyes and both compounds are readily absorbed through cutaneous tissues and open lesions. As described previously, treatments with low pH and corrosive properties cause cellular toxicity, which interferes with cell migration and proliferation in the early stages of wound healing. The result is granulation tissue formation, inhibited epithelization and wound contraction. On the other hand, since there is no epidermal barrier in the early stages of wound healing, the risk of an infection is significantly higher in these wounds; which is presumably, the logic that most use for justifying treatment of claw lesions.

Research on topical treatment of claw lesions

A topical treatment study. A study to determine the effect of topical treatment with oxytetracycline soluble powder or powdered copper sulfate on the rate of wound healing was conducted on 18 cows with claw lesions. Cows were randomly divided into a treatment group: Treated topically with oxytetracycline soluble powder (n = 7) or copper sulfate powder (n = 3) and a bandage; and a control group (n = 8): No topical treatment and a bandage. Photos of lesions were taken at 24 h post-treatment when the bandages were removed and again at d 21 following the day of treatment. Photos of were presented to two independent observers who scored the lesions for the visual presence of granulation tissue and evidence of re-epithelization. Based upon observer scores at d 21, lesions topically treated with oxytetracycline or copper sulfate were more likely to have granulation tissue ($p>0.0054$) and less likely to have evidence of re-epithelization ($p>0.0553$). Although the number of observations is small, these data suggest that topical treatment with oxytetracycline or copper sulfate may delay wound healing.

Post-treatment pain assessment. Anecdotal observation of animals with claw lesions topically treated with tetracycline or copper sulfate suggests that these compounds cause significant irritation and pain in the immediate post-treatment period. Researchers monitored a subset of cows from both groups for a period of 15 min in the immediate post

treatment period. Results indicated that cows treated topically with either oxytetracycline or copper sulfate exhibited nearly three times as many pain-related behaviors (mean of 4.5/15 min for cows with no topical treatment compared with a mean of 13.6/15 for cows treated with Tet or CS) in the post-treatment period (unpublished data).

Post treatment residues. Finally, it is assumed by most that a drug residue occurring from topical treatment using tetracycline or oxytetracycline is highly unlikely. This was corroborated by a survey of Veterinarians and claw trimmers that found 84% of respondents (81% AABP and 86% HTA) did not recommend withholding milk following topical treatment with tetracycline or oxytetracycline compounds (Coetzee *et al.*, 2014). In order to determine the likelihood of creating a detectable residue, researchers collected blood and milk samples from 11 cows with topically treated claw lesions. Seven cows (farm 1) were treated with oxytetracycline soluble powder (7.3 g) and 4 (farm 2) with one scoop (equivalent to 25.5 g) of tetracycline soluble powder. Blood and milk samples were collected pre and post-treatment (oxytetracycline treated cows sampled 3X/d and the tetracycline treated cows were sampled 2X/d for 3 d post-treatment). Results of the assays for tetracycline in plasma demonstrated a Cmax (maximum concentration) of 4.78 + 2.82 ng/mL; for milk Cmax was 20.64 + 14.51 ng/mL (recorded at the 3rd milking on d 2). Cmax for oxytetracycline in plasma was 2.15 + 1.20 ng/mL (recorded at 48 h post-topical application); for milk Cmax was 20.81 + 19.90 ng/mL (recorded at the 7th milking (milking 3X/d). Regulatory action for oxytetracycline and tetracycline is $\geq$ 300 ppb, which is well above levels observed in this study; but all samples had detectable levels of drug. We also observed that lesions with larger surface areas tended to have higher log-transformed drug concentrations in both plasma ($R2 = 0.51$; $p = 0.03$) and milk ($R2 = 0.44$; $p = 0.03$). We conclude that topical treatment with either tetracycline or oxytetracycline derivatives is likely to result in detectable residues, but concentrations are well below actionable levels (Coetzee *et al.*, 2014)

Non-irritating topical treatment options

Options that one might consider for topical treatment of claw lesions that are less irritating and residue-free might include petrolatum-based ointments. These ointments limit surface bacterial growth and prevent dressings from sticking to wounds (Morales-Burgos *et al.*, 2013). A product more commonly used on farms for minor skin wounds and irritation is Bag Balm (Dairy Association Co, Lyndonville, Vermont, USA, and Rock Island, Quebec, Canada). It consists of 8-hydroxyquinoline sulfate 0.3% in a petroleum jelly and lanolin base (http://en.wikipedia.org/wiki/Bag_Balm). Udder Balm contains petrolatum, propylene glycol, aloe vera, lanolin, and vitamins A, D, E, and multiple other ingredients (http://www.drugs.com/vet/udder-balm.html). Udder balm rarely causes irritation to sensitive tissues and helps to prevent the loss of moisture from the skin, which is helpful in wound healing.

Granular sugar and honey are also used as topical wound dressings on claw lesions. The theory of sugar's effectiveness in wound healing is based upon its high osmolarity which draws moisture from the wound, thus inhibiting the growth of bacteria. Sugar has also been used in infected lesions for the debridement of necrotic tissue. Honey's antibacterial benefits are likely related to its low pH, high osmolarity and peroxide activity (Winkler, 2012).

Sensible treatment of claw lesions

Beyond early identification of lame cows, dairies must have a plan for how they will assure prompt examination and treatment of these animals. When lameness is severe, there are essentially 3 options: Treatment, euthanasia, or in rare cases slaughter. The choice of one over the other must consider what is best for the welfare of the animal. If treatment is chosen, the dairy, the trimmer and Veterinarian must commit to doing whatever may be required to achieve a successful outcome. At a minimum, a treatment strategy would include corrective trimming and the use of a foot block to relieve weight bearing on injured claws. Far better is a multimodal approach that also includes pain management and appropriate housing during the recovery period. One example of multimodal treatment regimen might include the following (Shearer *et al.*, 2013; Whay and Shearer, 2017):

1. Use of intravenous regional or ring block anesthesia for corrective trimming of painful conditions,
2. Sedative-analgesics (xylazine, for example) to reduce the pain and anxiety associated with restraint and treatment,
3. Careful and thorough corrective trimming that avoids damage to adjacent healthy corium tissues,

4. Use of an orthopedic foot block applied to the healthy claw to relieve weight bearing on the injured claw,
5. Avoidance of topical therapies that increase discomfort and prolong recovery,
6. Administration of analgesics, nonsteroidal anti-inflammatories (NSAIDs), to manage pain in the post-treatment period, and critically,
7. Comfortable housing and attentive management of lame cows during the post-treatment period.

If the welfare of an animal with lameness cannot be assured by treatment or if treatment fails, the animal must be euthanized. In rare situations, slaughter may be a consideration; for example, on-farm slaughter for personal use. Veterinarians can assist by taking time to observe these cows, reviewing treatment records and offering advice on lame animals during their regular visits. Too often cows with irreversible lameness conditions are left to languish and die. This is unacceptable.

A parting thought …

Treating lame cows was my least favorite task as a practitioner. Like many in our profession, I focused on assuring optimal reproductive performance on the dairies I served. I much preferred this to treating foot problems. However, rectal palpation for the determination of a cow's reproductive status are not the sole domain of Veterinarians anymore. Pregnancy diagnosis does not require the skills of a Veterinarian. Things have changed since my days as a practitioner 40 years ago. Lameness, whether we choose to accept it or not, is the most serious health problem on dairy farms and there are few things can affect the dairy's profitability or the welfare of its animals more. Veterinarians must become involved in managing herd lameness and in particular, decision-making on cows with severe lameness conditions. Our clients, and most certainly their cows, need us to do so.

References

Auer JA, Stick JA. *Equine Surgery.* 4th ed. St. Louis: Saunders Elsevier; 2012.

Coetzee J, Kleinhenz K, Pingsterhaus B, Schleining J, Wulf P, Shearer J. Effect of topical treatment of claw horn lesions with tetracycline-derivatives on plasma and milk concentrations. In: Proceedings of the 47th Annual Conference of the American Association of Bovine Practitioners, Albuquerque, New Mexico, September 2014.

Lischer CJ, Koller U, Geyer H, Mulling C, Schulze J, Ossent P. Effect of therapeutic dietary biotin on the healing of uncomplicated sole ulcers in dairy cattle – a double blinded controlled study. Vet J 2002b; 163:51-60.

Morales-Burgos A, Loosemore MP, Goldberg LH. Postoperative wound care after dermatologic procedures: A comparison of 2 commonly used petrolatum-based ointments. J Drugs Dermatol 2013; 12(2):163-164.

O'Toole EA. Extracellular matrix and keratinocyte migration. Clin Experiment Dermatol 2001; 26(6):525-530.

Pyman MFS. Comparison of bandaging and elevation of the claw for the treatment of foot lameness in dairy cows. Aust Vet J 1997; 75(2):132-135.

Raven T. Cattle footcare and claw trimming. 1989. Farming Press Ltd.

Shearer JK, van Amstel SR. Functional and corrective claw trimming. Vet Clin North Am Food Anim Pract 2001; 17(1)53-72.

Shearer JK, Stock ML, Van Amstel SR, Coetzee JF. Assessment and management of pain associated with lameness in cattle, Vet Clin North Am Food Anim Pract 2013; 29:135-156.

Shearer JK, Plummer PJ, Schleining JA, Ju Ji. Effect of topical treatment with oxytetracycline soluble powder or copper sulfate powder on healing of claw lesions. In: The 18th International Symposium and 10th International Conference on Lameness in Ruminants, Valdivia, Chile, November. 22-25, 2015, p. 154.

Shearer JK, Plummer PJ, Schleining JA. Perspectives on the treatment of claw lesions in cattle. Commissioned article for Veterinary Medicine: Research and Reports 2015; 6:273-292.

Stadelmann WK, Digenis AG, Tobin GR. Physiology and healing dynamics of chronic cutaneous wounds. Am J Surg 1998; 176(Sup 2A):26S-278.

Van Amstel SR, Shearer JK, Palin FL. Case report–clinical response to treatment of pododermatitis circumscripta (ulceration of the sole) in dairy cows. Bov Pract 2003; 37:143-150.

Whay HR, Shearer JK. Effect of lameness on welfare of cattle. Vet Clin North Am Food Anim Pract, Bovine Lameness Issue 2017; 33:153-164.

White ME, Glickman LT, Embree C, Powers PM, Pearson EG. A randomized trial for evaluation of bandaging sole abscesses in cattle. J Am Vet Med Assoc 1981; 178(4):375-377.

Wilmink JM, Van Weeren PR. Treatment of exuberant granulation tissue. ClinTechniques Eq Practice 2004; 3(2)141-147.

Winkler KP. Topics in Wound Management. The Merck Veterinary Manual, Merck Sharp & Dohme Corp., a subsidiary of Merck & Co., Inc., Whitehouse Station, N.J., U.S.A. 2012. URL: http://www.merckmanuals.com/vet/emergency_medicine_and_critical_care/wound_management/initial_wound_management.html