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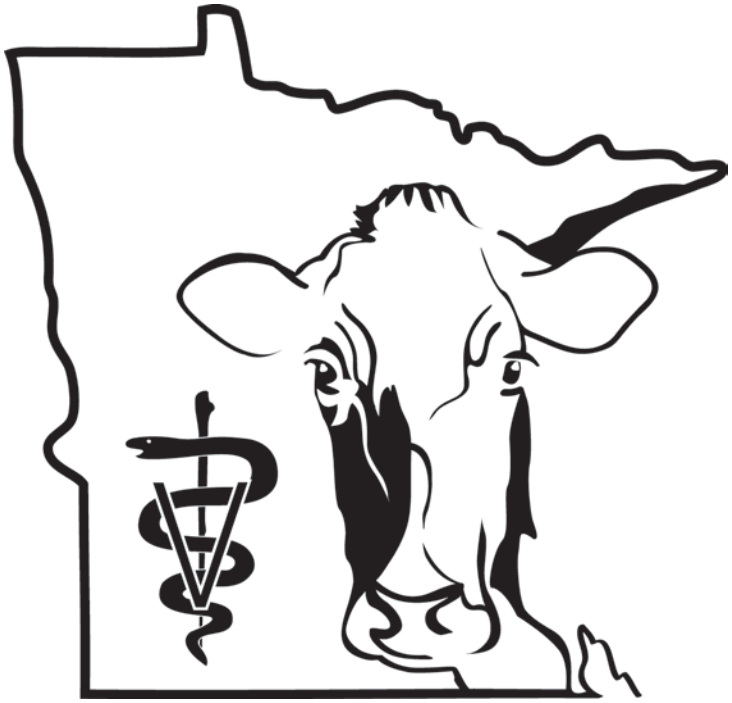

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Treatment of Orthopedic Infections in Cattle

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Cattle seem to be highly prone to developing lower limb infections. In general, an area may become infected via direct penetration, extension from an infected region, or by hematogenous spread of bacteria. Cows rarely develop uninfected seromas or hematomas and often have subcutaneous infections without any history of skin penetration. It may be that the original insult was not detected or that cows may be more prone to hematogenous spread than are other adult animals. Regardless of the inciting cause, they must be treated before they extend into deeper structures and we should be aware of the risk of infection involved after any traumatic event.

We are commonly presented with cattle with infections that have been misdiagnosed or undiagnosed. This is due to a combination of factors that impair easy diagnosis of limb infections:

- the lameness associated may be so severe that fracture is suspected
- the tolerant nature of the animal and the type of housing/exercise prevents early diagnosis due to minimal clinical signs
- minimal swelling associated unless the infection is severe or cellulitis is involved
- trauma is fairly common in many barns
- no obvious penetrating wound
- radiographic or ultrasonagraphic capability may be required for diagnosis

Diagnostic Tests

When presented with a lame cow, we do find both radiographs and ultrasound to be highly effective in helping with a diagnosis. Not only do radiographs help rule-in or rule-out a fracture, we may also see gas lines or gas-fluid interfaces that suggest infection or abscess. Cows also develop severe periosteal reactions where pus had access to the bone. Radiographs are often taken with a portable machine (settings :). Contrast radiographs may also be helpful in determining which structures are involved, particularly if a wound is present.

Ultrasound can help examine the tendon sheaths and joints to determine if they are filled with excess fluids and can help determine the location and extent of any abscesses to allow better drainage.The linear probe used for rectal examinations can also be used on the lower limb; however, a standoff pad may help in visualizing more superficial structures.

With a swollen limb it may be difficult to detect which area is the primary problem. We will also "sweat" the limb overnight to remove edema. This involves placing nitrofurazone ointment on the limb, covering it with plastic (Saran Wrap or rectal sleeve),

and then applying a snug cotton wrap (using brown gauze and vet wrap, etc). The following day we can more easily identify the location of the problem.
We will also try to tap potentially infected structures, such as joints or tendon sheaths, to obtain fluid for cytology (may not be necessary if it is white and smelly) and/or culture (usually A. pyogenes and sensitive to most antibiotics if they can reach the area). We try to avoid tapping through cellulitis or areas of infection to prevent the spread of infection into potentially uninfected structures. Finding pus usually requires a large needle (14ga or 16ga) due to the consistency of the pus, and may therefore be dangerous in standing animals. We will often wait and combine these diagnostic tests with any planned treatment, particularly if we plan to cast the cow or to restrain her in a chute.

Providing drainage

Many early infections can be readily treated in the standing cow and involve primarily providing drainage to any abscess or infection. An area of subcutaneous infection (abscess) can be identified by palpation and aspiration. The abscess is then opened to drain. The drainage hole will preferably be large enough to insert a finger or hose at the very least. These holes close very quickly so we try to err on the side of making them as big as possible without hitting other structures such as joints, large vessels, etc. This is easiest to do if two needles are used to identify two sites of the same abscess at least finger width apart. After local anesthesia with lidocaine, an incision is then made between the needles. A finger can then be inserted to determine the depth of the pocket and the incision opened so that that it extends to the bottom of the pocket if possible. This also ensures easy ventral drainage. If needed, the incision can also be extended proximally. As tap water will be an ideal medium for flushing these out, it is often nice to make the hole big enough to allow insertion of a hose. If the hole cannot be made that big it may need to be reopened daily (by digital pressure or a hemostat) or some type of drain, roll gauze or tube placed to prevent closure prematurely.
The drainage areas should be flushed as long as possible to prevent skin closure before the interior pocket has been cleared of infection and has filled in with granulation tissue. These cows may be put on antibiotics but it should not be necessary unless they are febrile. An exception would be a cow with cellulitis (the area is warm, firm, and swollen and does not decrease with sweating). Antibiotics are recommended until 2-3 days after the cellulitis resolves.

Joint lavage/ tendon sheath lavage

The importance of drainage applies to joints and tendon sheaths as well as to subcutaneous infections; however, it is more difficult to achieve. For infections in the joint, through and through lavage or arthrotomy (tenotomy) + lavage are required to have any hope of salvaging the joint and potentially the cow. For through and through lavage, 14 ga needles are placed in at least two areas of the joint. Lactated ringers solution is flushed into one needle and forces fluid out the second site.

Finding the joint is not always easy. A cow with a chronic infection may have a thickened synovium, preventing aspiration of fluid. Try using a syringe of fluid to check for easy

flow if no pus can be removed. Once one needle is placed correctly, injecting more fluid will distend the joint and make it easier to find a site for the second needle. More needles can be placed but too many will slow down the fluid pressure and may impair the efficacy of the lavage. If the needles are correctly placed but minimal fluid flow is obtained, this usually indicates a chronically infected joint with secondary synovial changes and the prognosis is very poor.

Several different kinds of fluids have been used to flush joints. In general, large volumes (at least 1-2 liters) isotonic fluids with a normal ph are optimum. Additives may cause problems, particularly if left in a closed space such as a joint. Iodine and chlorhexidine should not be used. Pressure bags or syringes attached to 3 way valves help increase the lavage presssure. The joint may need repeated flushing. This should be done daily if possible due to the rapid development of fibrous tracts within the joint that prevent good lavage after several days.

The same techniques are used for the tendon sheath. Early control of the infection is essential to prevent the formation of restrictive adhesions that can cause chronic pain. Lavage may also be useful following digit amputation for those infections that have already ascended.

In many cases, the pus is too thick to be easily removed with through and through lavage. We have often used small arthotomy/tenotomy incisions in more chronic cases. Due to the rapid closure of these holes in cattle, these seem to be minimally risky; however, they are often used when nothing else works (and may not work either) so the ability to judge their effectiveness compared to through and through lavage is hard. The larger incisions make it easier to to flush the joint initially and should allow drainage between flushes. However, they wound should be kept covered with a sterile bandage until they close. Septic tendon sheaths may also benefit from the placement of a fenestrated drain through two tenotomy incisions to allow more frequent lavage without having to cast the cow. Antibiotics may also be infused through the drain following lavage.

Antiinflammatories

Due to milk and meat withholding, antiinflammatories are not routinely used in dairy cattle but are not contraindicated and may help with healing along with providing analgesia. Options include phenylbutazone (9.9mg/kg po initially and then 4.4 mg/kg po every 36-48h), banamine (1.1 mg/kg iv every 12-24 hours), and ketofen (2.2 mg/kg iv every 12-24 hours). Intramuscular banamine has been associated with the development of clostridiosis and should be avoided if possible.

Bandaging

Whether or not a limb is bandaged depends upon the environment and treatment plan. It is much more labor intensive to remove and replace a bandage for each lavage treatment and this may decrease the amount of flushing a cow receives. If the environment can be kept relatively clean, we will often forgo a bandage and ask for more frequent flushing.

Antibiotics

As mentioned, infections in cattle are often by *A. pyogenes* and will theoretically be sensitive to most antibiotics, including penicillin. Other common bacteria are *E coli* and anaerobes. However, antibiotics will often not penetrate an abscess due to the thick capsule. Therefore, drainage and/or flushing are of optimum importance. However, we do have a few methods of increasing local concentration of antibiotics for areas with poor or no drainage available.

Local injection **:** Antibiotics may be added to the lavage fluid, or more often, injected into the pocket, joint or tendon sheath after the flush (see table below -same amounts as regional perfusion). Withdrawal recommendations need to be followed and may be more difficult to calculate due to the changes in metabolism.

Regional perfusion : This involves injecting antibiotics into a vessel below a tourniquet. The antibiotic is given in sufficient volume and allowed sufficient time that the antibiotic flows out of the vessel and into the surrounding tissues. This provides a high concentration of antibiotic to the area involved. This technique has been well documented in horses and has had excellent preliminary results in cattle. This can be done standing but is somewhat painful, not to mention difficult, and is usually done with the cow down.

The techniqe is the same as that used to provide intravenous regional anesthesia (IVRA) to the lower limb of cattle and may be combined with IVRA. A tourniquet is placed on the midcannon bone or above the infected area. A butterfly needle or small catheter is used to catheterize the dorsal vein as it passes down the middle of the cannon bone. This vessel may not be easy to see and is often punctured blindly. Once blood flow is obtained, 20-30cc of lidocaine is injected to provide anesthesia to the area below the tourniquet, followed by the antibiotic (separate syringe). The antibiotic should be diluted with a balanced electrolyte solution so that a total volume of approximately 60 ml is obtained (adult cow; lidocaine volume + antibiotic). Once one or both drugs are injected, the catheter is removed. The tourniquet should be left on for 30 minutes, if possible, to allow diffusion of the drugs into the tissues. We often perform the perfusion at the start of a procedure both to allow anesthesia of the area and to minimize any time delays.

Any drug that can be administered to dairy cattle by either the im or the iv route should be able to be given by regional perfusion. We routinely use 1 gram of ceftiofur or another cephalosporin (see table below). Doses are empiric and usually reflect the systemic dose (higher doses may cause skin sloughing and cellulitis). Crystalline penicillins, ampicillin, and tetracycline have also been used. Aminoglycosides (250-500 mg amikacin or 100-300mg gentocin) are probably ideal in horses but are not used frequently in cattle due to prolonged withdrawal requirements.

We have also used the protocol in neonates with septic physitis/ joints, etc but decrease the dose of the drug and the volume accordingly. A version of the procedure is to inject the antibiotic into the medullary cavity through a hole drilled into the bone. An injection

portal is glued into the hole to prevent leakage. This can also be done more proximally on the limb; however, tourniquets should be placed both proximal and distal to the site to minimize the vascular space.

Human patients are treated with systemic antibiotics prior to regional perfusion to prevent occasional signs of septicemia. This has not been observed in adults animals but may be a problem in young animals. We often give a second antibiotic systemically (eg penicillin im + ceftiofur via perfusion).

Doses for 500kg animal (intraarticular or iv regional perfusion) :

Penicillin G	1 million units
Cefazolin	250 mg
Ceftiofur	250-1000 mg
Ampicillin	250-500 mg

Antibiotic beads : Antibiotic-impregnated beads are another technique of increasing local antibiotic concentrations but for a prolonged period of time (at least up to 28 days) rather than for a high level temporarily. The most common beads are made out of medical grade polymethyl-methacrylate (PMMA, bone cement) or plaster of paris. The former is not absorbable while the latter is. Antibiotics are incorporated into the beads as they are made. Liquid antibiotics can be used with Plaster of paris; powdered formulations are preferred for PMMA beads. The most common antibiotics for use *in horses* are aminoglycosides (gentocin, amikacin, tobramycin) and penicillin. Others include sodium ceftiofur, cefazolin and ampicillin. Methicillin and cloxacillin have been effective in human studies. Antibiotics that are heat stable and sterilizable (if made ahead of time) are required. Bacteriocidal drugs are preferred. Gentocin, if used, should be kept at a dose of $\leq$ 1.1 mg/kg to prevent nephrotoxicity. Polymyxin B, tetracycline, and chloramphenical do not elute from PMMA. Most protocols recommend the use of a ratio of 1:5 for antibiotic powder to PMMA; eg, if 10 ml of PMMA is used, add 2 ml of antibiotic powder. If you use more than this, the mixture will not harden properly. Plaster of paris beads containing gentocin have been made using 20g of dried calcium sulfate combined with 3 ml phosphate buffered saline and 500 mg gentamicin sulfate. The beads were allowed to harden for one hour and then gas sterilized using ethylene oxide.

The beads are placed into a deep pocket, area of bone infection or near a fracture repair and elute the antibiotic over time. The amount of antibiotic released depends upon surface area, so generally small beads are preferred. Beads are often placed on stainless steel wire (if they are to be removed) or on Vicryl (if absorbable). Beads can be made by hand but are much easier to make (and are smaller) if a mold is used. Plaster of paris beads will dissolve in areas of infection; this decreases their longevity but minimizes the risk of beads acting as a foreign body and maintaining the infection. Elution is less predictable than with PMMA beads and is likely faster (may be better for concentration-dependent antibiotics such as gentocin). Proper withdrawal testing is essential for all beads.

The future : biodegradable antibiotic-impregnated implants that can be used in joints - collagen, etc.

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