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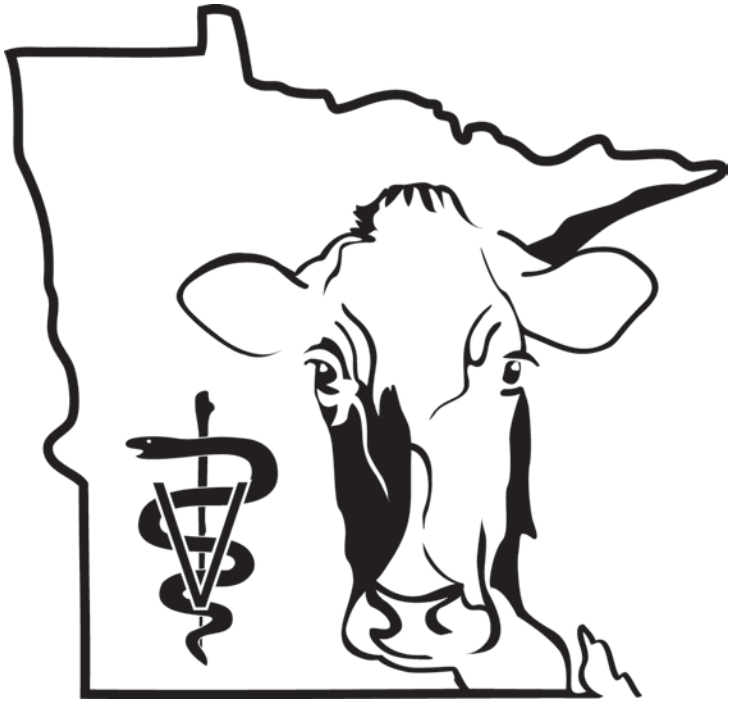

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TREATMENT OF BONE AND JOINT INFECTIONS

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Infections of bone and joint occur as a result of tissue invasion by pathogenic organisms, followed by microbial proliferation and tissue destruction. The tissue destruction occurs as a direct result of microbial toxins and byproducts, and as a result of the host inflammatory response to the invading organisms. Effective treatment must both eliminate inciting organisms and minimize deleterious tissue destruction. An understanding of the pathophysiology of osteomyelitis and infectious arthritis is important if this goal is to be achieved.

Bone and joint infections may be caused by bacteria, spirochetes, chlamydia, fungi and viruses. "Septic" arthritis or osteomyelitis refers to infections by pyogenic bacteria, the most common causative agent in bone and joint infections. Infectious agents gain access to bone and joint by one of 3 main routes; the circulation (hematogenous), extension from an adjacent infection, and direct inoculation. Knowledge of the route of contamination is useful in predicting the types of organisms involved, the likelihood of multiple sites of infection, the amount of structural damage to expect, and the need for ancillary treatment.

Hematogenous spread of bacteria typically occurs in young calves, reflecting a combination of the immature immune system, more permeable mucosal barriers, and a uniquely susceptible vascular anatomy. As the physes and joints develop, hairpin turns with sluggish flow and limited phagocytic ability combine in immature calves to promote localization and growth of any bacteria which have gained access to the circulation. Hematogenous infections are often multifocal, particularly in calves less than 1 month of age. Therefore, identification of one site of infection in neonatal calves should prompt close examination of all joints and bones for additional sites of infection, as well as a thorough evaluation for a source of the septicemia (including lungs, intestine and umbilical remnants). Hematogenous infections are typically monomicrobial in nature, and a limited number of organisms are commonly encountered. *Salmonella spp.* and *Actinomyces pyogenes* are the two most common organisms identified in association with hematogenous bone and joint infections in calves, with *Salmonella spp.* most commonly isolated in calves less than 12 weeks of age and *A. pyogenes* more commonly responsible for infections in older calves. Other organisms commonly recognized in association with hematogenous infections include *Streptococcal species*, *E. coli*, *Klebsiella*, *Proteus*, *Fusobacterium necrophorum*, and *Mycoplasma bovis*. Less commonly implicated organisms include *A. bovis*, *Staphylococcus spp.*, *Erysipelothrix spp.*, *Brucella spp.*, *Haemophilus spp.*, *Bacteroides spp.*, *Chlamydia spp.*, *B. burgdorferi*, and rare viral agents.

Bone and joint infections secondary to spread from a contiguous infection or direct inoculation can occur in any age ruminant. Such infections are commonly solitary in nature and are often associated with loss of structural integrity of bone and or joint. Infections developing by extension from adjacent infection will typically be monomicrobial or involved

synergistic organisms. Treatment must not only deal with the local bone and joint infection, but must deal with the adjacent infection and try to restore the integrity of the joint capsule and or periosteum. With the exception of infections resulting from accidental contamination during arthrocentesis, direct inoculation often involves major tissue damage (fracture, laceration into the joint) and involves multiple organisms and foreign material, with similar treatment considerations.

Treatment of infectious osteomyelitis and arthritis should focus on 3 goals: 1) elimination of causative agents; 2) elimination of inflammatory cells and debris; and 3) prevention of further damage. The main tools in treatment are antibiotics, drainage and immobilization/stabilization. While antibiotics are an essential part of treatment for any non-viral bone or joint infection, it is crucial to remember that the infectious agents are responsible for only a limited amount of the damage cause to osseous and articular structures. Therefore, antimicrobial therapy should never be considered sufficient as the sole method of treatment. Attention to drainage and stabilization are equally important in therapy and failure to address these areas effectively can result in a costly and potentially needless treatment failure. In addition, the importance of early treatment can not be overemphasized. Irreversible and irreparable tissue damage occurs within 48-72 hours of joint infection, and any delay in initiation of the components of treatment can drastically decrease the likelihood and quality of recovery.

Effective antimicrobial therapy depends on selection of an antibiotic which is effective against the organisms involved, penetrates effectively into the tissues affected and is active in the environment of the infection, and on maintenance of antimicrobial levels for long enough to allow complete elimination of all involved organisms. Due to the slow clearance of organisms from bone and joint infections, antimicrobial treatment should be continued at high levels for 4-6 weeks, presenting a significant challenge in cost and management for food animals. Very few antibiotics meet all of these criteria in food animals and some compromise may be necessary. As an example of conflicting criteria, aminoglycosides are considered to have excellent *in vitro* efficacy against Gram-negative organisms but have poor activity in the presence of the necrotic debris and acidic environment encountered in the septic environment. Similarly, procaine penicillin has good spectrum against Gram-positive organisms and has a low enough cost to be continued for the required time for effective treatment, but the procaine form achieves less effective levels in bone and joint than do the more expensive sodium and potassium salt forms. Initial broad spectrum activity is indicated pending results of culture and sensitivity. Cephalosporins (eg., ceftiofur) and fluoroquinolones (eg., mycotil) may provide the best combination of efficacy, penetration and cost, although *in vivo* efficacy has not been confirmed in treatment of bone and joint infection in cattle. Alternatively (recognizing some limitations), a combination of a Beta-lactam antibiotic (penicillin or ampicillin) with an aminoglycoside, oxytetracycline, or potentiated sulfas have been used with reported clinical success.

Control of inflammatory damage involves use of effective anti-inflammatory therapy

and drainage. While use of non-steroidal antiinflammatory drugs (NSAIDs) such as aspirin and phenylbutazone are somewhat controversial, they have a number of distinct advantages in treatment of both bone and joint infection. Not only do they improve comfort and decrease inflammation, they specifically decrease prostaglandin mediated bone lysis, potentially decreasing the amount of early bone destruction. Caution should be used in instituting NSAID therapy prior to effective stabilization of unstable fractures. Debridement and/or drainage/lavage are extremely important components in treatment of almost all bone and joint infections to relieve pressure and remove potentially destructive inflammatory debris. One exception would be for treatment of acute diffuse osteomyelitic lesions which have not yet localized. Attempted debridement at this stage is unlikely to completely remove all affected tissue and may disrupt developing host localization. The second exception occurs in periarticular bone infections in which debridement is mechanically impossible without risking entry into the joint.

The final consideration in treatment of bone and joint infection is prevention of further mechanical injury. If the infection is associated with a fracture or ligamentous injury, mechanical stabilization is an essential part of treatment. Immobilization may play an important role in stabilization, although prolonged immobilization can have detrimental effects in treatment of infected joints. While immobilization can decrease the amount of mechanical trauma to joint surfaces, it also impairs venous and lymphatic drainage from the joint and can promote formation of mechanically limiting fibrous adhesions. As a thumb rule, controlled mobilization should be encouraged as soon as possible after definite improvement in local inflammation and pain can be demonstrated. If mobilization results in an increase in pain or swelling, then immobilization should be resumed.

Successful treatment of bone and joint infection in cattle depends on early recognition, accurate identification of the organisms and tissues involved, rapid initiation of aggressive therapy addressing the 3 therapeutic goals described, and continuation of therapy for long enough to completely resolve the lesion. As veterinarians, we do not always see affected animals in time to prevent permanent damage or even, in some cases, to overcome progressive damage. Nonetheless, recognition of the pathophysiology of infection and attention to the therapeutic goals can lead to successful management in many cases.