

Orthopedic Infection: Diagnosis, Treatment, and Recent Literature

Haileigh Avellar, DVM, MS, DACVS-LA
KSU CVM Annual Conference
June 5, 2023

KANSAS STATE
UNIVERSITY

1

Outline

- Review orthopedic infection in foals and adults
- Review modalities of diagnosing orthopedic infection
- Review the rational and effective use of antimicrobials for the treatment of orthopedic infection
- Review adjunctive treatment options and when to apply them in equine patients affected by orthopedic infection
- Review current literature

KANSAS STATE
UNIVERSITY

2

Methods of Joint/Synovial Infection

- Hematogenous
 - Mostly foals, rare in adults
 - synovial infection is secondary
 - Gram negative > gram positive bacteria
- Percutaneous
 - Trauma, arthrocentesis
 - Gram positive > gram negative bacteria
- Adjacent Invasion
 - From physis, other bone infection, cellulitis, subarticular abscess

KANSAS STATE
UNIVERSITY

3

Types of Infections in Foals

- S-Type
 - Only associated with synovial membrane and fluid
 - Usually accompanied by systemic illness or multiple limb lameness
 - <2 weeks old
- E-Type
 - Localized to epiphyseal complex (bone adjacent to the articular cartilage)
 - History of other illness (pneumonia, diarrhea)
 - Older foals
- P-Type
 - Long bone physis, +/- extending to joint capsule
 - Generally healthy foals
 - Older foals
- Take home point: foals may seed infection to different areas in or around joints, history and PE may be different between these types. Adjunct therapy may be different

KANSAS STATE
UNIVERSITY

4

Diagnosing Orthopedic Infection

- History
 - Foals
 - Failure of passive transfer
 - Pneumonia
 - Umbilical abnormalities (infection)
 - Adults
 - Recent wound
 - Open fracture
 - Recent orthopedic procedure
- Physical exam
 - Lameness (grade 4+)
 - Swelling, heat, effusion
 - Wounds or draining tracts
 - Sometimes small wounds are worse
 - Fever not always reliable in adults

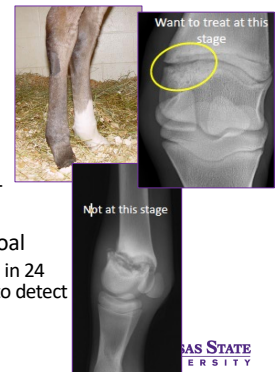


KANSAS STATE
UNIVERSITY

5

Additional Signs in Foals

- Can be subtle changes
- Articular infections
 - Effusion and lameness
- Physeal infections
 - Periarticular edema, +/- lameness
 - Edematous fetlocks in foal
 - Bandage, if not resolved in 24 hours take radiographs to detect any physeal damage



KANSAS STATE
UNIVERSITY

6

Suspect synovial involvement, now what?

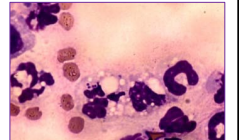
- Determine what structures are involved and severity of involvement
 - Bone surfaces
 - Periosteum, cortex, endosteum, fracture, physis
 - Synovial surfaces
 - Joint, tendon sheath, bursa
 - Soft tissues
 - Skin, SQ, neurovasculature, tendons, ligaments
 - Implant/foreign bodies



7

Diagnosing Orthopedic Infection

- Arthrocentesis + cytology
 - TNCC > 10,000/uL
 - TP > 3.0-3.5 g/dL
 - 90% degenerative neutrophils (PMNs)
 - +/- intracellular bacteria
- Sterile skin preparation and needle placement
- 18 gauge needle
- Sterile EDTA tube (purple)



8

Diagnosing Orthopedic Infection

- Culture (& sensitivity)
 - Synovial Fluid
 - Positive → yes there is an infection
 - Negative → still might be an infection (50/50 for positive culture results)
 - Place in blood culture tube (or red top tube)
 - Blood (foals)
 - Can be helpful but can have multiple bacteria
 - Taken under sterile conditions while placing IVC
 - Best taken prior to antimicrobial treatment
 - Bone or tissue
 - Can be helpful in osteomyelitis cases
 - Decreased positive cultures if antibiotics have been started but should still submit

KANSAS STATE
UNIVERSITY

9

Diagnosing Orthopedic Infection

- Bloodwork
 - CBC not always reliable in adults, should always be done in foals with risk of systemic sepsis
 - Fibrinogen >900 indicative of osteomyelitis

Evaluation of plasma fibrinogen concentration as an indicator of physeal or epiphyseal osteomyelitis in foals: 17 cases (2002-2007)

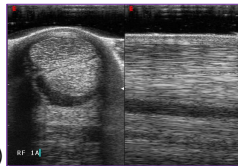
Jennifer M. Newquist, DVM, and Gary M. Baxter, VMD, MS, DACVS

KANSAS STATE
UNIVERSITY

10

Diagnosing Orthopedic Infection

- Imaging
 - Ultrasound
 - Effusion with flocculent material
 - Swollen synovium
 - Abscess, other soft tissue infection
 - Guide sampling
 - Radiographs (examples next slides)
 - Effusion, osteolysis, osteoarthritis
 - Limitations
 - Several days to detect bony changes
 - Ossification centers in foals are irregular, subtle changes are hard to detect
 - Good to get baseline rads to compare to future rads if treatment doesn't go as planned
 - Progression of OA, lysis, collapse of joint space
 - CT (examples next slides)
 - Great when radiographs aren't clear-cut, upper limb/pelvis
 - More detail

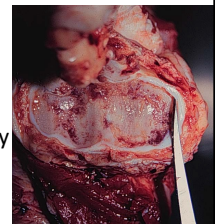


KANSAS STATE
UNIVERSITY

11

Goal of Therapy

- Preserve structures critical to ambulation
 - Cartilage, subchondral bone, tendon, synovium
- Eliminate infection immediately
 - Reduce bacterial load
 - Initiate effective bactericidal therapy
- Reduce inflammation
- Restore tissues to normal health/homeostasis



When articular cartilage is gone and ankylosis is not possible, pain relief is impossible

KANSAS STATE
UNIVERSITY

16

General Guidelines for Treatment

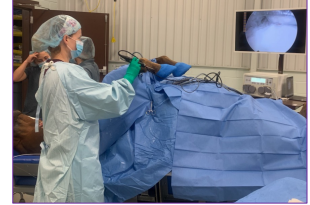
- Lavage
- Debride
- Antimicrobials
- Anti-inflammatories
- Usually need multiple modalities of treatment
- Aggressive early treatment essential
- Kill bacteria at presentation
- Resolve inflammation following resolution of infection

KANSAS STATE
UNIVERSITY

17

Lavage: Arthroscopy

- Pro
 - Higher volume fluids
 - Assess joint surface
 - Visualize debridement
 - Removal of fibrin, foreign bodies
- Con
 - Requires anesthesia
 - Large open wounds → inability to extend joint, decreased visualization
- Not required in every septic joint but good option if suspicious of foreign material



KANSAS STATE
UNIVERSITY

18

Lavage: Needle

- Through and through
- 14-18 gauge needles
- Standing or anesthesia
 - Block need sites if doing standing
- Use at least 1L/joint (adult)
 - Foals at least 500ml

KANSAS STATE
UNIVERSITY

19

Needle Lavage Supply List

- Clippers (if associated with wound)
- Sterile scrub
- 14-18 gauge needles (2-3/joint)
- Syringes
 - 3ml: collect joint fluid for testing
 - 12-20ml: confirm communication
 - 3ml: post lavage antibiotic
- Sterile fluids (isotonic, 1L/joint)
- 10 drop set
- Pressure bag or high volume fluid pump
- Post lavage antibiotic (amikacin most common)

KANSAS STATE
UNIVERSITY

20

Arthrotomy/Thecotomy

- Provides continuous drainage
- Option for synovial structures with high volume fibrin
- Must have sterile bandage
 - Difficult in stifle/upper limb



24

Debridement

- Debridement of dead surfaces is essential
 - Biofilm formation
 - Must be removed for resolution of infection
 - Removal of sequestrum
 - “clean out” involucrum
 - Removal of necrotic tendons, ligaments, skin
 - Must be careful in foals
 - Must preserve growth and articular cartilage
 - Not always necessary

KANSAS STATE
UNIVERSITY

25

Antimicrobials

- Methods of administration
 - Systemic (IV, IM, PO)
 - Local
 - Intra-articular/synovial
 - Regional
 - Bone
 - Artery or vein
 - Repository (beads)

KANSAS STATE
UNIVERSITY

27

Time vs. Concentration Killing

Time Dependent

- $\geq 50\%$ of dosing interval drug concentration is above MIC
- Beta-lactams (penicillin, cephalosporins)
 - Mostly gram +ve and some anaerobes
- Usually safe, used successfully
 - Diarrhea most common side effect

Concentration Dependent

- Concentration $\geq 10\times$ MIC at site of infection
- Best for intermittent administration (IA, RLP)
- Aminoglycosides (gentamicin, amikacin)
 - Mostly gram -ve
- Safe(ish), use with caution
 - Nephrotoxin: check renal values, hydration (especially foals)
 - Acidic can cause skin necrosis and vascular damage, must be diluted for local therapy (RLP)

KANSAS STATE
UNIVERSITY

28

Systemic Antimicrobial Application

- Appropriate application of antimicrobials essential for elimination of infection
 - Use correct drugs
 - Administer correctly
- Initial treatment
 - IV and broad spectrum
- Bactericidal
- Standard protocols
 - Adults: penicillin, gentamicin
 - Foals: penicillin & amikacin
 - Or Penicillin & Gentamicin (12mg/kg, q36h)
 - Current KSU combo due to backordered amikacin



KANSAS STATE
UNIVERSITY

29

Systemic Antimicrobial Application

- Oral antibiotics (only after improvement)
 - Chosen based on culture/sensitivity results
 - Trimethoprim/Sulfa
 - Chloramphenicol (if bone penetration is needed)
 - Tetracyclines: Doxycycline or Minocycline (not in foals)
- Duration of antibiotics?
 - IV: at least 5 days, depends on clinical signs
 - Switch to oral for 14 days after IV
 - Total duration 3+ weeks
- Avoid compounding drugs
 - Unreliable concentrations
 - Now need a medication justification for the use of compounded medications



KANSAS STATE
UNIVERSITY

30

Local Injection Intra-articular/Intra-synovial

- Directly into joint or tendon sheath
- Repeat daily or every other day
- Concentration dependent
- Bactericidal
- Amikacin most common
 - Dose?
 - 125-500mg
 - New study 30mg
 - Pezzanite (CSU), ACVS Abstract



31

Regional Perfusion- IO

- Achieves higher drug concentrations in tissues than possible with systemic administration
- Intra-osseous (IO)
 - Hole drilled distal to site of sepsis
 - Drill or 14G needle (works well in foals)
 - 1:9 antibiotic dilution



32

Regional Perfusion

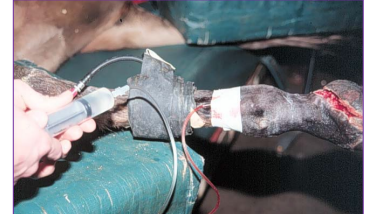
- Intra-venous
 - Achieved high concentrations of drug in synovial structures and surrounding tissue
 - Reduced drug expense and toxicity
 - Good when there is significant soft tissue trauma
 - Tourniquet placed proximal to site of infection
 - Small butterfly catheter (23G)
 - 500 mg-1 gram amikacin QS to 35-60ml (depending on location and foal vs. adult)
 - 20-30 minutes for diffusion
 - Every other day or until satisfied infection is eliminated
 - Standing or under anesthesia during surgical procedure
 - Avoid arteries due to risk of thrombosis or phlebitis

KANSAS STATE UNIVERSITY

33

Regional Perfusion Antimicrobial Properties

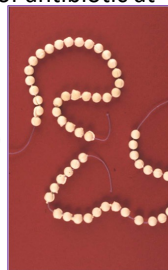
- Concentration Dependent
- Bactericidal
- Amikacin (aminoglycoside) is the most common!!



34

Antibiotic Beads

- Temporary high concentrations of antibiotic at local site
- Fill dead space
- Materials
 - Polymethyl methacrylate (PMMA)
 - Plaster of Paris (POP)
 - Biodegradable matrix or collagen
 - Expensive \$\$\$\$



KANSAS STATE UNIVERSITY

35

Antibiotic Beads

- Do NOT use >1 antibiotic
 - Decreased elution of both drugs
- Time dependent theoretically are best
 - Usually heat sensitive, PMMA creates exothermic reaction possibly inactivating beta-lactams
- Used prophylactically or therapeutically
 - Place along implant on in debrided area
 - Best if tissue can be closed
- PMMA can be made table side
- Pre-made with gas sterilization (POP or PMMA)



KANSAS STATE UNIVERSITY

36

Antibiotic Beads

- Plaster of Paris
 - Cheap, biocompatible, bioabsorbable, long set up time
 - Drug elution: 80% in first 48 hours, then last 20% over 14 days
- PMMA
 - More expensive but relatively cheap, biocompatible, not absorbable (must be removed)
 - Drug elution: quick release in 24 hours then slow over weeks to months

KANSAS STATE UNIVERSITY

37

Other Options

- Intra-articular/Intra-synovial catheters
 - CRI dosing of medication
 - Repeat dosing of IA drugs without sticking a needle each time
 - Can use for antibiotics or local anesthetics
 - Maintain under sterile bandage



KANSAS STATE UNIVERSITY

38

Anti-inflammatories

- Limit inflammation → limit destruction
- Medications
 - NSAIDs
 - Systemic
 - Phenylbutazone
 - Flunixin Meglumine
 - Firocoxib (usually not enough)
 - Local/Topical
 - Diclofenac
 - Coaptation
 - Compression bandage
 - Sweat bandage

KANSAS STATE
UNIVERSITY

39

Outcomes/Prognosis

KANSAS STATE
UNIVERSITY

40

Foals Success Rates

- 56-80% short term survival
- 67-76% long term survival
- 33-67% survival + racing/athletic use
- Negative prognostic indicators
 - ≥ 2 joints involved
 - < 26 days old
 - Multisystemic disease
 - Salmonella
 - Arthritis present

KANSAS STATE
UNIVERSITY

41

	Whisenant, EVJ, 2022	O'Brien, EVJ, 2021	Wright, EVE, 2017	Hepworth, JAVMA, 2015
# of cases	95 (TB, single joint, no other sys dz)	115 (TB, ≤ 180 days)	60 (≤ 60 days old)	83 (≤ 180 days old)
Short-term survival	93%	78%	80%	57%
Long-term survival			67%	
Athletic performance	65%	67%	62%	
Negative Prognostic indicators	Higher last TNCC of synovial fluid Lower earning from septic jt. Foals (KY)	< 26 days old, multisystemic disease, osseomyelitis No difference in racing potential (Australia)	None found Trends (not significant): Increased # joints, increased time to treatment	Number of joints affected

KANSAS STATE
UNIVERSITY

42

Reasons for Treatment Failure

- Impaired blood supply at site of infection
 - Drugs not delivered
 - Wounds don't heal
- Excessive debris (fibrin, FBs, biofilms)
 - Antimicrobials have decreased efficacy in the presence of debris
- Incorrect use of antimicrobials
 - Using wrong drugs (use culture/sensitivity results)
 - Using wrong dosage
 - Inappropriate route of administration

KANSAS STATE
UNIVERSITY

45

Remember use as many
antimicrobial modalities as
needed!!!

KANSAS STATE
UNIVERSITY

46