Vertebral Osteomyelitis Guideline Team

Team Leader

Carol E Chenoweth, MD
Infectious Diseases

Team Members

Benjamin S Bassin, MD
Emergency Medicine

Sarah E Hartley, MD
Internal Medicine

Megan R Mack, MD
Internal Medicine

Anjly Kunapuli, PharmD
College of Pharmacy

Paul Park, MD
Neurosurgery

Douglas J Quint, MD
Radiology

F Jacob Seagull, PhD
Medical Education

David H Wesorick, MD
Internal Medicine

Consultants

Rakesh D Patel, MD
Orthopaedic Surgery

James Riddell IV, MD
Infectious Diseases

Kathleen M Lanava
UMHS Office of Clinical Safety

Developed:
August, 2013

Inpatient Clinical Guidelines Oversight
Sarah E Hartley, MD
David H Wesorick, MD
F Jacob Seagull, PhD

For more information:
734- 936-9771

Vertebral Osteomyelitis, Discitis, and Spinal Epidural Abscess in Adults

Patient Population: Adult patients with suspected or confirmed vertebral osteomyelitis, discitis, paravertebral abscess or spinal epidural abscess. (This guideline does not address vertebral osteomyelitis associated with hardware placed at a previous surgery.)

Objectives: To improve the timely diagnosis and initial treatment of vertebral osteomyelitis, discitis or paravertebral abscess with or without spinal epidural abscess in adult patients at UMHS. (This guideline does not address antimicrobial adjustments once microorganisms have been identified, or indications for surgery.)

Key Points

Clinical Presentation

For patients presenting with back pain, especially if the patient has suggestive clinical features (see **Table 1)** or known risk factors (see **Table 2**), suspicion should be high for vertebral osteomyelitis/ discitis (VO) with or without spinal epidural abscess.

Diagnosis. Evaluation for VO with or without spinal epidural abscess should include:

Complete neurologic examination (I-C)

Laboratory evaluation (CBC, ESR/CRP, basic chemistry [BMP], urinalysis and culture [UA/UC], and 2 sets of blood cultures) (II-C)

Stat imaging of the spine, ideally within 2 hours if abnormal neurological findings, or within 6 hours if normal neurological findings (see **Figure 1**). (I-C)

- MRI with and without contrast of the complete spine is the ideal imaging study. Omit contrast if contrast would delay imaging.
- If MRI is not possible (e.g., because of body habitus, implanted device, etc.), a stat CT myelogram should be performed (see **Table 4**).
- If CT myelogram not possible, CT with contrast of the complete spine should be performed.

Biopsy. If there is evidence of VO on imaging and negative blood culture, then urgent/emergent biopsy by Neuroradiology using imaging guidance within 24 hours. (I-C)

Treatment (see **Figure 1**)

If abnormal neurological exam or imaging evidence of spinal epidural abscess (I-C)

- Stat antibiotics (**Table 3**)
- Stat imaging, ideally within 2 hours if not already imaged (**Table 4**)
- Stat neurosurgical consult

If imaging evidence of VO (I-C)

- If hemodynamically unstable, stat antibiotics (**Table 3**)
- If hemodynamically stable, hold antibiotics until after biopsy, unless blood cultures are positive
- Consider neurosurgery consult
- Neurological check every 4 hours

If hemodynamically stable, and no positive imaging or microbiological findings (II-D)

- Consider other diagnosis.
- If pain persists, repeat imaging in 2-3 weeks

Consult Infectious Disease Service to assist with antibiotic management and further evaluation (see **Figure 1**). (II-D)

*** Strength of recommendation:**
I = generally should be performed; II = may be reasonable to perform; III = generally should not be performed.
Levels of evidence reflect the best available literature in support of an intervention or test:
A=randomized controlled trials; B=controlled trials, no randomization; C=observational trials; D=opinion of expert panel.

Table 1. Clinical Features Increasing Suspicion for Vertebral Osteomyelitis/Spinal Epidural Abscess (VO/SEA)

- Back pain, often with insidious onset
  - worsening at night,
  - focal
  - associated with other systemic symptoms (anorexia, lethargy, weight loss, vomiting)
- Fever is variably present (35-60% of VO patients). Absence of fever does not eliminate the possibility of VO.
- Focal neurologic symptoms:
  - Limb weakness
  - Dysthesias
  - Radicular pain
  - Gait disturbance
  - Bowel and/or bladder dysfunction
- Symptoms vary with location of VO/SEA, e.g. cervical involvement may present with dysphagia; thoracic involvement may manifest autonomic dysregulation.

Table 2. Risk Factors Increasing Suspicion for Vertebral Osteomyelitis / Spinal Epidural Abscess (VO/SEA)

Diabetes (most common risk factor)

Any risk factor for bacteremia, e.g. IV drug use or an indwelling vascular device

Immunosuppression

Malignancy

Cirrhosis, chronic kidney disease, or alcohol use

HIV/AIDS

Rheumatoid arthritis

History of spinal trauma or fracture

Recent spinal procedure

Other foci of infection

Note: Most patients with VO have at least one risk factor present; If no risk factors are present, consider an alternative diagnosis.

Table 3. Empiric Initial Treatment of Vertebral Osteomyelitis/Spinal Epidural Abscess*

If questions about empiric therapy, consult Infectious Disease.

Preferred

Vancomycin[1] IV per nomogram + Ceftriaxone 2 gm IV q12h

Alternative for Suspected or Documented Pseudomonal Infection

Vancomycin[1] IV per nomogram + Cefepime[1] 2 gm IV q8h

Alternative for Penicillin Allergy (non-anaphylaxis)

Vancomycin IV per nomogram + Meropenem[1, 2] 2 gm IV q8h

Alternative for Severe Penicillin Allergy

Vancomycin[1] IV per nomogram + Aztreonam[1] 2 gm IV q8h

Alternative for Vancomycin Allergy or Intolerance

Linezolid[2] 600 mg IV q12h + other antibiotic as indicated above. Linezolid[2] is contraindicated in patients on medications with serotonergic activity, e.g. SSRI and MAOI. Complete information regarding drug interactions with linezolid available from FDA: www.fda.gov/drugs/drugsafety/ucm265305.htm

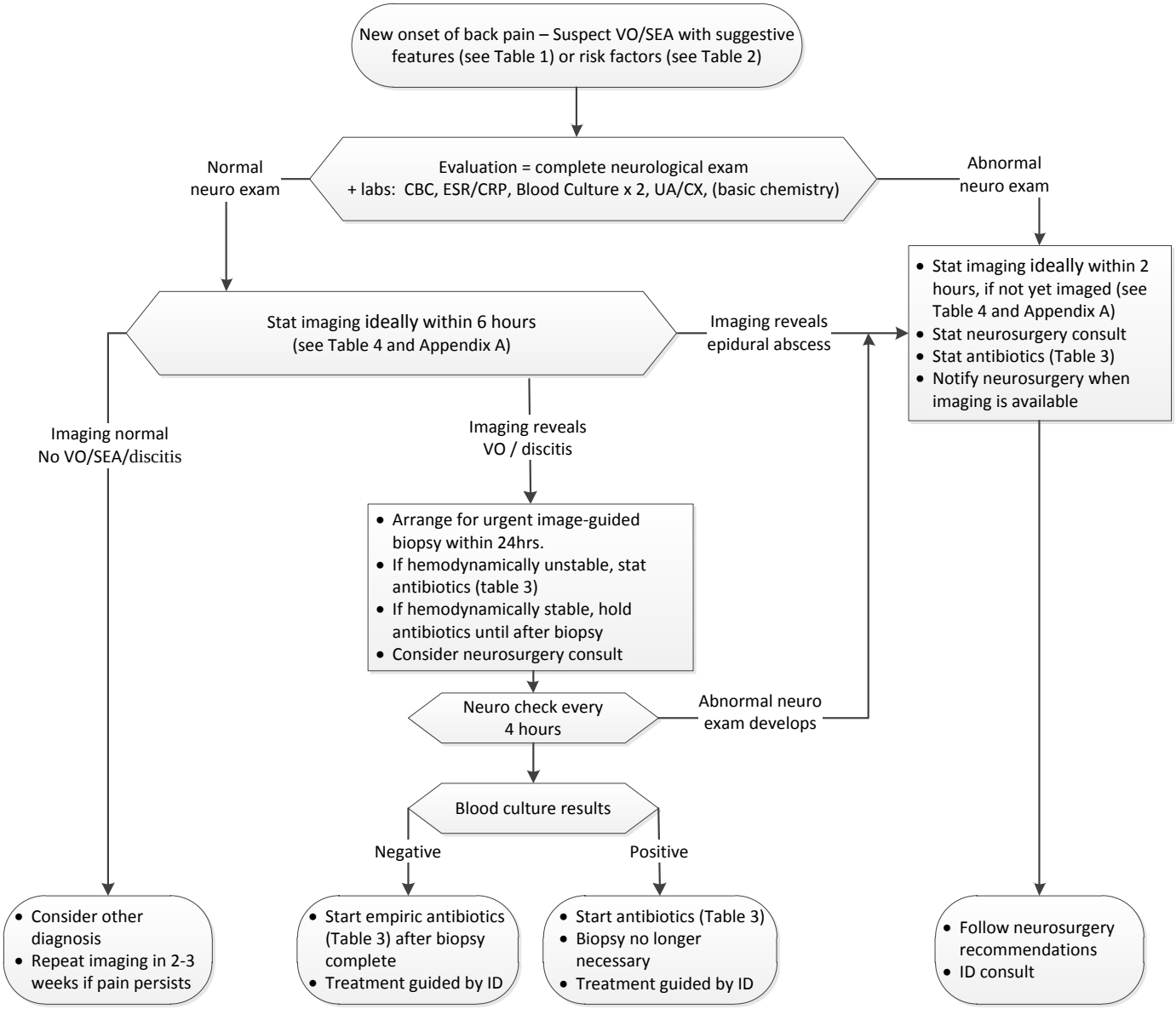
Note: Target vancomycin trough 15-20 mcg/mL

[1] adjust dose in patients with renal dysfunction

[2] use requires prior ID approval

* Continued treatment of vertebral osteomyelitis without spinal epidural abscess may be treated with lower doses of antibiotics per Infectious Disease consultation guidance.

Figure 1. Evaluation and Initial Treatment of Vertebral Osteomyelitis/Spinal Epidural Abscess (VO/SEA) (excluding postoperative infections with hardware)



Note: Abnormal neurological findings at any point should precipitate right side of algorithm.

Table 4. Imaging Modality Order of Preference

Select the top ranked modality available and image total spine.

1. Stat MRI[1], with and without IV contrast. If this cannot be performed STAT due to contrast allergy, or if using contrast would delay procedure, use next preference.
2. Stat MRI[1], without contrast. If MRI cannot be performed, e.g. due to body habitus, device, etc., use next preference.
3. CT Myelogram. If not possible, use next preference.
4. CT with IV contrast.[2] If osseous destruction is present in CT with contrast, re-attempt MR or CT myelogram to evaluate epidural space.

[1] See Appendix A for instructions on how to obtain a stat MRI at University of Michigan Hospital.
[2] Technecium bone scan is a non-diagnostic modality due to low spatial resolution and high rates of false positive findings.

Clinical Background

Clinical Problem and Management Issues

Incidence

The annual incidence of vertebral osteomyelitis/discitis (VO) is estimated at 2.4 cases per 100,000 persons. However, the incidence of infection increases with increasing age; for persons under the age of 20 years, vertebral osteomyelitis is uncommon (0.3 per 100,000 persons), but the incidence is more than twenty-fold higher in older patients (6.5 per 100,000 persons over age 70 years).

Diagnosis and Timing Issues

Although VO and spinal epidural abscess (SEA) are rare, they are relatively easy to treat when recognized. However, failure to recognize, diagnose and treat it in a timely manner can lead to permanent paralysis. Unfortunately, diagnostic delays occur frequently, with reports of symptom onset to diagnosis ranging from 11 to 59 days.

Factors contributing to diagnostic delays include:

- The difficulty of the diagnosis. No "classic" history and physical exam findings easily and reliably identify VO/SEA. The primary symptom of back pain is a common complaint frequently associated with many less immediately serious conditions.
- Inconsistent approaches to diagnosis and treatment. Differing approaches to VO/SEA limit the development of standard, evidence-based procedures. For example, when should empiric antibiotics be started and which antibiotic combination should be used?
- Delays in performing needed studies and services. The risk of rapid progression of VO/SEA means that the processes of care such as imaging and consultations must be performed more rapidly than organizational infrastructures may allow. For example, imaging within a few hours is necessary to help confirm the diagnosis and initiate appropriate treatment. However, care systems are often not in place to assure that imaging can occur on evenings or weekends, resulting in delays of a day or longer in performing some "stat" imaging orders.

Rationale for Recommendations

Microbial Etiology

The majority of cases of VO arise from hematogenous seeding of bacteria to the vertebral disc. Inoculation from spinal surgery or spread from contiguous soft tissue infection may also occur. The most common bacterial cause of vertebral osteomyelitis is *Staphylococcus aureus* (32-67%). Occasionally, coagulase-negative staphylococci may cause VO with or without spinal epidural involvement. Gram negative organisms, such as *Escherichia coli* (21%), often from a urinary tract source, are the next most frequent bacteria identified. *Pseudomonas sp.* are associated with approximately 6% of cases, and should be suspected with a history of environmental water exposure or intravenous drug use (IVDU).

Infections of the spine result in a spectrum of disease with varying clinical presentation. Vertebral infection usually arises from bacterial seeding of the disc (discitis). Infection then spreads to contiguous vertebral bodies (vertebral osteomyelitis). Frequently the paravertebral muscles are involved with muscle abscess. In 17% of cases, disc infection spreads to the epidural space resulting in spinal epidural abscess. Timely identification of spinal epidural abscess is essential, as one fourth of patients with this condition develop motor weakness or paralysis.

Diagnosis

History

Vertebral osteomyelitis most commonly occurs in the sixth and seventh decades, more often in males (male to female predominance ranging from 1.5-3.1:1). Clinical features are listed in **Table 1**.

Since the most common mode of infectious spread in VO patients is hematogenous, any risk factor for bacteremia should remain the most important screening tool.

Physical Examination

A detailed neurologic exam is essential for any patient suspected of having VO/SEA. Objective neurologic findings are the exception rather than the rule; when present they can range from mild (radicular pain corresponding to a nerve root) to moderate (motor weakness/sensory loss/ bowel or bladder dysfunction) to severe (paralysis).

In the presence of an abnormal neurologic exam, point tenderness should prompt urgent investigation for possible SEA, as delay in diagnosis can result in permanent neurologic deficits. Progression of severity suggests infectious spread into the epidural space with nerve root and eventual cord compression. Point tenderness to spinal palpation may help differentiate VO from other causes of back pain.

No pathognomonic signs or symptoms confirm the diagnosis of VO/SEA. A normal exam does not exclude the diagnosis. The classic triad of fever, back pain, and neurologic deficit in SEA are insensitive markers; in one case series, sensitivity was 7.9%, specificity 99%, positive predictive value 83%, and negative predictive value 68%.

The potential consequences of a missed diagnosis of VO/SEA are devastating. Therefore, when VO/SEA is being considered in the differential diagnosis, further diagnostic testing with laboratory and possibly radiologic evaluation is necessary.

Laboratory Testing

Blood tests. Common blood tests utilized to aid in the diagnostic workup for patients with suspected spinal epidural abscess or vertebral osteomyelitis include:

- complete blood count (CBC) with differential
- erythrocyte sedimentation rate (ESR)
- C-reactive protein (CRP)

These tests can be obtained rapidly with results available usually within 1-2 hours of arrival in the central laboratory. Blood cultures are also drawn on initial evaluation; however, results will not be immediately available. These tests are not completely reliable indicators of disease presence, but should be used in conjunction with:

- clinical suspicion
- history and physical exam findings
- diagnostic imaging to confirm the diagnosis

Leukocytosis. The presence of leukocytosis is widely variable (38-80%). Moderate WBC elevation (11.0-17.0) is most common. However, wide ranges have been noted and degree of elevation does not predict severity of disease. This marker is highly non-specific and lack of leukocytosis should not be used to exclude the diagnosis from the differential.

ESR. ESR is significantly more sensitive than leukocytosis for the early detection of the disease process and should be obtained on all patients in whom VO or SEA is considered. Sensitivity ranges from 68-100% however in the case series with 68% sensitivity, only ESR > 50 mm/hr was considered positive (normal range 0-20 mm/hr). If any value > 20 mm/hr is considered abnormal, sensitivity climbed to 84-100% and was noted to be 94% at initial evaluation in a meta-analysis of 915 patients with confirmed spinal epidural abscess.

CRP. CRP has a similar sensitivity of 84-100% in cases of confirmed SEA but may be a more effective marker of early disease as its serum concentrations rise faster than ESR or WBC and is less influenced by other plasma factors. Concentrations also decrease rapidly with disease resolution and may be used to guide time to treatment completion.

Blood Cultures. Blood culture sensitivity varies from 31-68%. Positive cultures likely indicate more severe, disseminated infection compared to localized infection (discitis). *Staphylococcus aureus* is the most common pathogen isolated, although there is an increasing prevalence of gram-negative organisms seen in intravenous drug abusers. Cultures should be obtained from two separate peripheral venipuncture sites whenever possible. Results will not be available for 24-48 hours and therefore rarely guide initial diagnostic or treatment decisions. However, results can be used in conjunction with direct tissue culture to confirm the causative organism as well as help tailor antibiotic treatment in cases when biopsy culture is negative.

Other laboratory tests. Additional laboratory tests on all patients with suspected VO/SEA should include a basic metabolic panel and urinalysis. There is a significantly higher incidence of VO/SEA in patients with diabetes, uncontrolled hyperglycemia and uremia. Urinary tract infection is a frequently missed source of bacteremia and urine culture should be ordered on all patients. Consideration should also be given to placing a PPD at the time of initial evaluation of any patient with suspected VO/SEA and risk factors for having active tuberculosis.

Tuberculous epidural abscess is less prevalent in the United States compared with many Asian countries, however it must be considered as a potential etiology in the appropriate at-risk patient.

Imaging Modalities and Approach

The preferred order for selecting an imaging modality is presented in **Table 4**. The characteristics of modalities and sequenced preference among them are explained below.

MRI with and without contrast. Contrast-enhanced whole spine MRI should be performed on an urgent basis when an infectious process involving the spine is of clinical concern. MRI is the examination of choice due to its superior contrast resolution, multiplanar capabilities and lack of ionizing radiation. Other imaging modalities are reserved for "problem-solving" (i.e. further characterization of abnormalities incompletely delineated on MRI).

Early MR imaging (within the first 2 weeks of onset of symptoms) may not demonstrate any abnormalities or might show only subtle abnormalities that could be attributed to chronic degenerative change. Therefore, if clinical suspicion for a spinal infectious process persists in the setting of a negative or near-negative initial MRI, repeat contrast-enhanced MRI should be considered as scans can become positive as soon as 1-3 weeks after an initial negative study.

A non-contrast MRI is still an excellent test to identify VO/SEA and/or spinal epidural abscess. Therefore, evaluation for such a suspected inflammatory process should not be delayed 12 hours to complete a corticosteroid "prep" (so that contrast-enhanced scans can be obtained in patients with known or suspected contrast allergies). A non-contrast spine MRI can essentially rule in or out a spinal, disc, or spinal canal infectious process, even though contrast-enhanced imaging may ultimately be necessary to

delineate better the true extent of an abnormality or to identify a subtle vertebral endplate abnormality.

If a patient with lower back symptoms potentially consistent with an infectious process has only been evaluated with a lumbosacral spine MRI study, consider repeat imaging including the thoracic spine. Mid and lower thoracic spinal infectious processes can present with lower back pain.

CT / myelograph. Patient body habitus or indwelling devices may contraindicate MRI. If so, consider a myelogram followed by CT scanning to look for compression of neural structures – the most serious potential complication of a spinal infection. The myelogram/CT will also evaluate for osseous destruction.

Myelography followed by CT scanning is as good as MRI for delineating spinal cord or cauda equina compression, though it is a more invasive process and utilizes ionizing radiation. Discal and/or spinal canal involvement by an inflammatory process that has not yet encroached on the thecal sac is poorly evaluated with myelography/CT. Myelography/CT can demonstrate some of the bony changes of osteomyelitis and even some paraspinal phlegmons/abscesses, but still not as well as MRI.

Non-contrast computed tomography (CT) best demonstrates destructive bony changes of osteomyelitis and even some paraspinal phlegmons/abscesses. However, the discs and spinal canal are poorly evaluated with CT. One cannot use CT alone (i.e. without intrathecal contrast) to rule out spinal canal invasion by any process.

In the absence of an "interventional" MR suite, CT for guidance of a discal, vertebral or paravertebral biopsy is the imaging modality of choice. In some cases, fluorscopically-guided biopsy can be performed.

True reactions to myelographic contrast media are extremely rare. Consider the risk/benefit of waiting 12 hours to complete a corticosteroid "prep" vs. acutely ruling out a spinal cord compression with an emergent myelogram should be considered.

CT with IV contrast. If neither an MRI nor a myelogram/CT can be performed, a spine CT with intravenous contrast administration may be used. Contrast CT is preferable to non-contrast CT because contrast may enhance the epidural venous plexus or the periphery of an inflammatory process within the spinal canal, the spine, a disc or in the paraspinal region.

Incidentally noted spinal pathology (e.g., bone destruction noted on a PE CT) which could explain symptoms should be followed by urgent imaging at that region per protocol (see **Figure 1** & **Table 4**).

Nuclear Medicine**.** Nuclear medicine imaging (3-phase technetium bone scan) performed in the absence of other imaging findings has been reported as highly specific and sensitive for spinal infection. However, technetium scans are not recommended because the contrast resolution and spatial resolution of these scans, even with SPECT technique, remains inferior to that of MRI (i.e. poor specificity), particularly as it pertains to spinal canal invasion (and possible spinal cord or cauda equina compression). A further limitation of technetium bone scan is that in older patients with other co-morbidities (e.g. extensive degenerative changes), scans may be positive, but do not represent VO/SEA.

Plain radiographs of the spine. Plain radiographs of the spine do not demonstrate soft tissues (discs, inflammatory soft tissue) and do not even demonstrate minimal osseous changes for at least 2 weeks. They have no role in the urgent evaluation of patients with suspected spinal infection with the possible exception of assessing for spinal stability (e.g. lateral flexion/extension imaging). Even such imaging should be performed with caution particularly in a patient with a suspected pseudoarthrosis. When MRI demonstrates essentially complete involvement of a disc or vertebral body, fluroscopy (i.e. "real-time" plain radiography) may be used to guide a vertebral body or disc biopsy.

If a diagnosis of VO is made by other imaging (e.g., PE CT, non-con CT, etc.), further imaging with MRI or CT/myelography is still indicated to evaluate the epidural space.

Biopsy

In a suspected inflammatory process in or around the spine, urgent/emergent biopsy may be needed for timely identification of the etiologic agent to start appropriate antibiotic coverage. Urgent/emergent biopsy by Neuroradiology using imaging guidance within 24 hours is a reasonable goal. This should be requested by primary service in consult with ID and neurosurgery.

Treatment

Empiric Antibiotic Therapy

Initiating antibiotic therapy. Whether to initiate empiric treatment or hold antibiotics until biopsy can be performed depends on the stability of the patient and the associated balance of risk and benefit.

- In a hemodynamically unstable patient, patients with positive blood cultures, a patient with an abnormal neurological exam or a patient with imaging evidence of SAE, initiate antibiotic treatment immediately despite timing of biopsy.
- In a patient without hemodynamic instability, positive blood cultures, abnormal neurological exam or imaging evidence of SAE, hold antibiotics until biopsy can be

performed; this includes patients with VO with epidural thickening but no frank abscess.

Delay of empiric treatment may result in rapid progression of the infection. However, the early empiric administration of antibiotics might alter the results of subsequent biopsy to identify the etiologic agent. While evidence is limited regarding the effects of antibiotics on the sensitivity of biopsy culture, most literature/experts recommend(s) withholding antibiotics for biopsy in stable patients.

At least one study addresses the yield of biopsy in the setting of antibiotics. In 150 patients with hematogenous-derived vertebral osteomyelitis, 92 (61%) underwent biopsy at a median of 3 days after admission (0-69 days). Sixty-five patients had antibiotics started prior to biopsy. There was no association of culture results with previous administration of antibiotics. The authors concluded that vertebral biopsy should be performed in patients with VO despite previous receipt of antimicrobial therapy.

Selection of empiric antibiotic drugs. Combination therapy with vancomycin and ceftriaxone is generally recommended, unless information on etiology is known from blood cultures or other previous cultures. **Table 3** presents specific recommendations and dosing for drug combinations.

Empiric treatment should be broad enough to treat the most likely bacterial etiologies and have good penetration into the central nervous system. Broad initial treatment reduces the potential for adverse outcomes due to delays in appropriate therapy.

S.aureus is the most common microorganism associated with VO/SEA. Therefore, antimicrobial therapy directed at staphylococci is essential. At the time of this guideline, the rate of methicillin-resistance in *S. aureus* at the UMHS is approximately 50%, therefore, vancomycin is the treatment of choice. Treatment doses should be provided that achieves trough levels of 15-20 mcg/mL.

To treat *E. coli* and other gram negative bacilli:

- Ceftriaxone at meningitis treatment doses, 2 gram every 12 hours, is recommended in addition to vancomycin.
- If Pseudomonas is suspected (history of water exposure or IVDU), then cefepime should be administered with vancomycin.

Alternatives for treatment in patients with vancomycin or cephalosporin allergies are listed in **Table 3.**

Management of Identified Microorganism

Once cultures define a microbial etiology for vertebral osteomyelitis, then antimicrobial therapy should be directed at the known organism. Directed antimicrobial therapy should be guided by the Infectious Diseases Consult Service.

Management of Abnormal Neurological Findings or Epidural Abscess

Abnormal neurological findings or epidural abscess can rapidly progress, requiring urgent assessment and treatment. Therefore, timely action is necessary to avoid permanent disability. Neurological deficit or progressive spinal deformity with/without neurologic symptoms is an indication for urgent surgery. Asymptomatic spinal epidural abscesses may also be treated surgically or drained percutaneously with interventional radiology guidance to prevent the development of neurologic deficits. Drainage of paravertebral abscesses is indicated if abscesses are accessible, however, this intervention is not urgent.

As indicated on the right side of **Figure 1,** stat imaging should be obtained within 2 hours, stat antibiotics initiated (see **Table 3**), and a stat neurosurgical consult should be obtained in any patient with suspected vertebral osteomyelitis and/or spinal epidural abscess with neurological symptoms of possible spinal cord compression.

In patients without neurological symptoms, if imaging reveals a possible mass or abscess, urgent neurosurgical consultation should be obtained. The neurosurgical consultant will ultimately determine the need for surgery.

In select cases, spinal epidural abscesses are managed medically, in a similar manner as for VO (see below) with biopsy and antibiotics. Reported criteria for non-operative management include known pathogenic organism, neurologically stable, availability of MRI/CT for rapid follow-up, and close, serial neurosurgical/nursing evaluation. Patients with pre-existing paralysis for an extended duration (>36-48 hours) also may not be treated surgically. Finally, significant medical comorbidities may preclude urgent surgical intervention. Management of these patients should be done with Infectious Diseases consultation.

Management of Neurologically Stable Patients, with Vertebral Osteomyelitis

These patients, while neurologically stable, must be managed promptly. Therefore, appropriate care includes advancing diagnostic work while monitoring neurological status. When VO is revealed in imaging, arrange for emergent image guided biopsy within 24 hours. Consider neurosurgery consult.

Whether to initiate antibiotics empirically depends on the overall stability of the patient. If patient is hemodynamically unstable, has abnormal neurological findings, or a positive blood culture, initiate stat antibiotics (**Table 3**). In a patient without these findings, hold antibiotics until image-guided biopsy can be performed. If blood cultures are positive, biopsy of the spine is not

necessary, as the bloodstream organism is usually the organism in the VO/SEA.

Continue neurological checks every 4 hours until biopsy is performed and patient has been treated with antibiotics and symptoms are improving. Development of abnormal neurological findings should trigger management for patient with abnormal neurological findings (above).

Once image guided biopsy has been performed, empiric antibiotics should be initiated. Infectious Diseases consultation should be made to help with long-term management. If image guided biopsy is negative, consider consultation with neurosurgery for open biopsy.

Imaging Normal, No Evidence of VO/SEA

When no evidence of VO/SEA is present (as shown on the left side of **Figure 1**), consider other diagnosis. If pain persists, imaging should be repeated in 2-3 weeks.

Infectious Disease Consult for Long-term Management

ID consultation should be obtained on all patients with confirmed VO for long-term management of antibiotics and monitoring of response to treatment. No studies examine the benefit of Infectious Diseases consultation in the setting of vertebral osteomyelitis. ID consultation is available to assist with antibiotic selection and timing of administration for suspected cases of vertebral osteomyelitis.

Several studies have shown that ID consultation on patients with *S. aureus* bacteremia is associated with improved adherence to evidence-based therapies and up to 56% decrease in mortality. ID consultation is recommended for all patients with *S. aureus* bacteremia, with or without vertebral osteomyelitis, because of the high risk for secondary sites of infection, including vertebral osteomyelitis or endocarditis.

Strategy for Literature Search

The literature search for this guideline was conducted prospectively using the major keywords of:

Osteomyelitis with spinal cord diseases, Epidural Abscess, Discitis. Results were limited to human adults, and published in the English language, and January 2002 to September 2013 on Medline. Additional key words included: clinical protocols, physician practice patterns, algorithms, consensus development conferences, practice guidelines, guidelines, outcomes and process assessment (health care); clinical trials, controlled clinical trials, multicenter studies, randomized controlled trials, cohort studies, metaanalysis or meta-analysis; diagnosis, diagnostic use, sensitivity and specificity, false negative reactions, false positive reactions, likelihood functions, sensitivity, specificity; predictive value therapy, drug therapy, antibiotics, staphylococcus aureus bacteremia and biopsy; Diagnostic Imaging, MRI, CT; Neurosurgery consultation, Neurosurgical Procedures; Infection Control consultation, infectious disease medicine.

The search was conducted in components each keyed to a specific causal link in a formal problem structure (available upon request). The search was supplemented with very recent clinical trials known to expert members of the panel. The search was a single cycle. Conclusions were based on prospective randomized clinical trials if available, to the exclusion of other data; if randomized controlled trials were not available, observational studies were admitted to consideration. If no such data were available for a given link in the problem formulation, expert opinion was used to estimate effect size.

No Cochrane Systematic Reviews were found for vertebral osteomyelitis, epidural abscess, or discitis.

Related National Guidelines

The literature search revealed no established national guidelines specifically addressing Vertebral Osteomyelitis / Spinal Epidural Abscess.

Related National Performance Measures

At this time no major national programs have clinical performance measures related to VO/SEA. These programs include: Centers for Medicare & Medicaid Services (Physician Quality Reporting Measures for Group Practice Reporting option, Clinical Quality Measures for financial incentive for Meaningful Use of certified Electronic Health Record technology), National Committee for Quality Assurance: Healthcare Effectiveness Data and Information Set, and programs in our region (Blue Cross Blue Shield of Michigan: Physician Group Incentive Program clinical performance measures, Blue Care Network: clinical performance measures).

Disclosures

The University of Michigan Health System endorses the Guidelines of the Association of American Medical Colleges and the Standards of the Accreditation Council for Continuing Medical Education that the individuals who present educational activities disclose significant relationships with commercial companies whose products or services are discussed. Disclosure of a relationship is not intended to suggest bias in the information presented, but is made to provide readers with information that might be of potential importance to their evaluation of the information.

Team Member	Relationship	Company
Benjamin S Bassin, MD	(none)	
Carol E Chenoweth, MD	(none)	
Sarah E Hartley, MD	(none)	
Kathleen M Lanava		
Megan R Mack, MD	(none)	
Anjly Kunapuli, PharmD	(none)	
Paul Park, MD	Consultant	Medtronic, Globus Medical
Rakesh D Patel, MD		
James Riddell IV, MD	(none)	
Douglas J Quint, MD	(none)	
F Jacob Seagull, PhD	(none)	
David H Wesorick, MD	(none)	

Review and Endorsement

Drafts of this guideline were reviewed in clinical conferences and by distribution for comment within departments and divisions of the University of Michigan Health System to which the content is most relevant: Emergency Medicine, Family Medicine, General Medicine, Infectious Disease, Neurosurgery, Orthopedic Surgery, Pharmacy Services, and Radiology. Medication recommendations were reviewed by the Pharmacy and Therapeutics Committee. The final version was endorsed by the Clinical Practice Committee of the University of Michigan Faculty Group Practice and the Executive Committee for Clinical Affairs of the University of Michigan Hospitals and Health Centers.

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Appendix A. Obtaining Stat Imaging and Related Sedation/Anesthesia at the University of Michigan Health System

Obtaining Stat MRI or CT Myelography

Stat MRI:

Call the Lead MRI Tech at 6-8876. Be prepared to discuss special needs such as sedation/anesthesia (see more below), metal implants or foreign bodies, or large body habitus.

If Lead MRI Tech cannot facilitate the study within the recommended time frame:

During day hours (8:00 am to 6:00 pm), ask to speak to the Neuroradiology attending **for MRI**.

After hours (Weekdays 6:00 pm – 8:00 am, and all day on weekends and holidays), call the Radiology Superchief (ext 3-1800 or pager 1800). If this person cannot facilitate the study within the recommended time frame, ask to speak to the **Diagnostic** Neuroradiology Attending on call *.

Stat CT myelography:

During day hours (7:00 am to 5:00 pm), call the Lead Neuroradiology Procedure Nurse at 5-3774.

After hours (Weekdays 5:00 pm – 7:00 am, and all day on weekends and holidays), call the Radiology Superchief (ext 3-1800 or pager 1800). If this person cannot facilitate the study within the recommended time frame, ask to speak to the **Procedure** Neuroradiology Attending on call *.

Arranging Sedation or General Anesthesia for MRI

Nurse-monitored sedation (e.g., for patients with claustrophobia, pain, or inability to remain still):

Discuss need for sedation with the Lead MRI Tech (6-8876). The Lead Tech may be able to facilitate the procedure with sedation provided by the radiology nurses.

If the Lead Tech is unable to facilitate the procedure with sedation in a timely manner (e.g., lack of radiology nurse capacity, or off-hours), the two options for provision of sedation are:

Contact SWAT (pager 8000). The SWAT nurse can provide moderate sedation for MRI's 24/7, but this will require that a physician who is credentialed in conscious sedation be present in the MRI area during the scan. During regular hours, a radiologist is present who can perform this role. During off-hours a physician from the primary service will be required to be present to perform this role.

Contact the Anesthesia UH OR Clinical Director (pager 8003). The anesthesiologists can provide moderate sedation in some situations (e.g., the primary hospital physician is not credentialed for moderate sedation), but their availability is limited.

General anesthesia (e.g., patient required general anesthesia for MRI in the past or failed imaging using lighter sedation):

Discuss the need for general anesthesia with the Lead MRI Tech (6-8876), as above. The Lead Tech may be able to facilitate the procedure directly with Anesthesiology.

If the Lead Tech is unable to facilitate the procedure directly with Anesthesiology in a timely manner, the Lead Tech may direct you to page Anesthesia UH OR Clinical Director (pager 8003) to discuss the case.

* The phone numbers for radiology on-call from 5PM to 8AM, as well as holidays and weekends are available at http://www.med.umich.edu/rad/oncall/