A spinal epidural abscess (SEA) is a suppurative infection localized to the extradural space. Although SEAs are quite rare, their incidence has been rising gradually over the recent decade, possibly associated with increasing intravenous drug abuse, expanding use of spinal instrumentation, and an aging population with multiple concurrent conditions. Clinical presentation is typically characterized by back or neck pain, fever, and focal neurological deficits; however, recognition and diagnosis of SEAs can often be arduous. SEAs can be either primary or secondary. Primary SEAs result from hematogenous spread of pathogens from a distant focus into the epidural space; secondary SEAs occur after spinal trauma, injections, surgery, or direct inoculation of a pathogen into the epidural space. The pathophysiology of primary and secondary SEAs might be closely associated with comorbidities.

In the past, treatment has consisted of urgent surgical decompression and abscess drainage along with multiple weeks of intravenous antibiotic therapy. Decompression surgery has involved laminectomy, disc-
ectomy, fusion, and corpectomy. Decompression also serves as a way to identify the causative microbe so that appropriate antibiotic therapy can be expeditiously administered. In select patients with mild back pain and without neurological deficits, antibiotic treatment and immobilization alone can be sufficient therapy. These patients, however, need close monitoring because immediate operative intervention can become necessary in cases of subsequent neurological deterioration.

Bacterial SEAs have been characterized in several case reports and case series; their epidemiology, predisposing conditions, diagnostic modalities, and approaches to management have all been described. We analyzed such patient data over an 11-year period and interconnected the results with those in the literature. Our review of the contemporary literature provides an update and sheds light on a condition that has been of great interest and challenge to neurosurgeons.

**Methods**

*Retrospective Study*

After receiving institutional review board approval, we searched the electronic medical record database at Summa Health System for all patients with a discharge diagnosis of SEA from January 2001 through February 2012. The search identified 160 patients. We excluded 54 patients: 46 patients had been readmitted for the original SEA (Fig. 1), and 8 lacked pertinent information or had been transferred to an alternate facility. For the 106 patients included in the study, each chart was reviewed from admission to discharge and assessed for presenting symptoms, predisposing factors, infecting microorganism, mode of diagnosis, mode of treatment, and outcome.

*Literature Review*

A literature search was conducted through the National Library of Medicine search engine, PubMed. Our aim was to find large retrospective or prospective studies of patients with bacterial SEA. Because we intended to obtain recent studies, particularly those published after the last meta-analysis published in 2000, we included only studies that had been published from 2000 on. We excluded case reports and review articles. We included only articles published in the English language and in peer-reviewed journals. Findings from our study were compared with those from studies reported in the literature.

We began the query with the search term “spinal epidural abscess” limited to publications from January 1, 2000, through December 31, 2013. The initial search produced 1264 results. After limiting the search to publications in the English language (1087 articles), abstracts of these articles were reviewed by 3 authors (F.S., K.S., and S.Z.). This review yielded articles for detailed review and inclusion in the analysis. After examining the reference lists from the selected articles for other relevant articles, we included a total of 40 studies in the updated review. The remaining articles were not centered on SEA, discussed a different disease entity, were case reports, or were literature reviews. Data from the chosen articles on research methodology, patient age, demographics, treatments offered, and outcomes at mean follow-up time were recorded.

**Results**

*Retrospective Study*

Of the 106 patients evaluated, most (69 [65.1%]) were male, and the mean ± SD age of patients was 63.3 ± 13.7 years (range 33–89 years). The most frequent presenting symptoms were back pain in 48 (45.3%) and focal neurological findings in 48 (47.1%). Of the patients who had focal neurological findings at initial presentation, 25 (24.5%) complained of paralysis and paresis of the extremities and 23 (22.5%) complained of paresthesias and pain in the extremities. Other presenting signs or symptoms were fever/chills in 34 (33%), urinary or bowel incontinence in 18 (17.6%), altered mental status or lethargy in 13 (12.7%), neck pain in 8 (7.8%), and nausea and/vomiting in 5 (4.9%). These findings are summarized in Table 1.

We designated SEA as primary if the patient had no history of spine surgery, injections, or any other invasive spinal procedure. In our study, the cause of SEA was primary for 85 (80.2%) patients and secondary for 21 (19.8%). Table 2 summarizes results regarding abscess locations. Among primary SEAs, 40 (47.1%) were lumbar, 29 (34.1%) were thoracic, 15 (17.6%) were cervical, and 1 (1.2%) was sacral. Among secondary SEAs, 15 (71.4%) were lumbar, 4 (19.0%) were thoracic, 1 (4.7%) was sacral, and 1 (4.7%) was cervical. Of clinical relevance, 30 (37.5%) of SEAs were dorsal and 47 (58.8%) were ventral. Primary SEAs were slightly more likely than secondary SEAs to involve more levels (2.05 vs 1.81, respectively).

For 36 (34.0%) of the 106 patients, an infectious ori...
gin or source of the SEA was identifiable, such as infectious skin lesions, a genitourinary infectious process, a gastrointestinal focus, and oral lesions (Table 3). Because articles in the literature reported that comorbid and underlying conditions are significant factors associated with patient outcome, we assessed such factors in our patient population (Table 4). In concordance with reports in the literature, the most common comorbid condition was diabetes mellitus, found in 38 (35.8%) patients in our study. The next most common conditions were vascular disease (33 [31.1%]) patients, underlying renal insufficiency or receipt of dialysis (32 [30.2%]), sepsis and/or bacteremia (23 [21.7%]), and drug abuse (23 [21.7%]). Also seen in our patient population, but with lesser frequency, were underlying malignancy, receipt of immunosuppressive therapy, chronic inflammatory diseases, and endocarditis.

For each of the 106 patients, the causative organism was determined (Fig. 2). The most common causative organism was methicillin-sensitive Staphylococcus aureus (39.6%), followed by methicillin-resistant S. aureus (MRSA) (31.10%), Streptococcus spp. (6.60%), and coagulase-negative Staphylococcus spp. (3.80%). Also found in some patients were Klebsiella spp. (2.80%), Escherichia coli (1.90%), Aspergillus spp. (1.90%), and Enterobacter spp. (0.94%). Cultures were negative for 6 (5.6%) patients. In terms of imaging modalities used, MRI was used most frequently (81 patients [76.4%]), followed by CT-guided biopsy (15 [14.2%]), and CT (7 [6.6%]). Surgical exploration was also used for diagnosis in 3 (2.8%) patients.

With regard to treatments offered and chosen surgical procedures (Table 5), 63 (59.4%) patients were offered a combination of antibiotics and surgery. Of these patients, 2 (3.2%) died and 61 (96.8%) were ultimately discharged. Of the 33 (31.1%) patients offered antibiotics alone, 4 (12.1%) died and 29 (87.9%) were discharged. All surgical patients received drainage, decompression, and debridement, and some also underwent fusion, corpectomy, and/or discectomy. As outlined in Table 5, 19 (30.2%) patients underwent spinal fusion; 14 (22.2%) underwent discectomy; 9 (14.3%) underwent corpectomy; and 46 (73.0%) underwent decompressive laminectomy (with drainage and/or debridement) only.

To tangibly describe outcomes with regard to neurological function, we reported outcomes objectively, based on a previously reported objective score (Table 6). Patients were placed accordingly into 1 of 5 categories at time of most recent follow-up examination: full recovery of neurological function (29 patients), able to ambulate independently and without sphincter disturbance (8 patients), able to ambulate with assistance only and possible associated sphincter disturbance (9 patients), paraplegic or minimal recovery but bedridden (10 patients), or expired (6 patients). These outcomes were recorded at mean ± SD follow-up time of 8.4 ± 26 weeks (range 0–192 weeks); most were obtained at discharge. The other patients were lost to follow-up or discharged to another facility; thus, their records could not be obtained and reported.

**Literature Review**

Most studies reviewed were institutional case series (Table 7). Almost all were retrospective studies.

**Epidemiology.** The incidence of SEA has been in-

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**TABLE 1:** Frequency of common presenting signs and symptoms among 106 patients with SEA

<table>
<thead>
<tr>
<th>Sign or Symptom</th>
<th>Frequency, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>back pain</td>
<td>48 (47.1)</td>
</tr>
<tr>
<td>neck pain</td>
<td>8 (7.6)</td>
</tr>
<tr>
<td>acute</td>
<td>25 (24.5)</td>
</tr>
<tr>
<td>progressively worsening</td>
<td>23 (22.5)</td>
</tr>
<tr>
<td>fevers/chills</td>
<td>34 (33)</td>
</tr>
<tr>
<td>altered mental status/lethargy</td>
<td>13 (12.7)</td>
</tr>
<tr>
<td>focal neurological findings</td>
<td>48 (47.1)</td>
</tr>
<tr>
<td>paralysis/paresis in extremities</td>
<td>25 (24.5)</td>
</tr>
<tr>
<td>paresthesia/pain in extremities</td>
<td>23 (22.5)</td>
</tr>
<tr>
<td>nausea/vomiting</td>
<td>5 (4.9)</td>
</tr>
<tr>
<td>urinary/bowel symptoms</td>
<td>18 (17.6)</td>
</tr>
</tbody>
</table>

* Some patients presented with more than 1 sign or symptom. Percentages calculated out of 102 patients with complete data.

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**TABLE 2:** Location of SEA with regard to primary or secondary causes in 106 patients

<table>
<thead>
<tr>
<th>Location</th>
<th>Frequency, No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>primary cervical</td>
<td>15 (17.6)</td>
</tr>
<tr>
<td>thoracic</td>
<td>29 (34.1)</td>
</tr>
<tr>
<td>lumbar</td>
<td>40 (47.1)</td>
</tr>
<tr>
<td>sacral</td>
<td>1 (1.2)</td>
</tr>
<tr>
<td>total</td>
<td>85 (80.2)</td>
</tr>
<tr>
<td>secondary cervical</td>
<td>1 (4.7)</td>
</tr>
<tr>
<td>thoracic</td>
<td>4 (19.0)</td>
</tr>
<tr>
<td>lumbar</td>
<td>15 (71.4)</td>
</tr>
<tr>
<td>sacral</td>
<td>1 (4.7)</td>
</tr>
<tr>
<td>total</td>
<td>21 (19.8)</td>
</tr>
<tr>
<td>ventral*</td>
<td>47 (58.8)</td>
</tr>
<tr>
<td>dorsal*</td>
<td>30 (37.5)</td>
</tr>
<tr>
<td>lateral/circumferential</td>
<td>3 (3.8)</td>
</tr>
</tbody>
</table>

* Ventral or dorsal location data were missing for 26 patients; percentages are based on 80 patients.

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**TABLE 3:** Identified infectious origin of SEA in 36 patients among a series of 106 patients

<table>
<thead>
<tr>
<th>Origin</th>
<th>Primary</th>
<th>Secondary</th>
</tr>
</thead>
<tbody>
<tr>
<td>skin lesion</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>oral lesion/focus</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>gastrointestinal focus</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>genitourinary focus</td>
<td>9</td>
<td>3</td>
</tr>
</tbody>
</table>
creasing. Recent estimates are around 2–3 cases per 10,000 hospital admissions.\(^1\)\(^,\)\(^{11}\)\(^,\)\(^{37}\)\(^,\)\(^{46}\) Spinal epidural abscesses can be classified into primary versus secondary. Secondary SEAs occur in patients with a history of invasive spinal procedures.\(^46\) Some have defined secondary SEA as being associated with vertebral osteomyelitis.\(^20\) Most patients are in the 50- to 70-year age range; men are more likely to be afflicted.\(^23\) Origins or foci of infection have been identified and include pathogens in skin, oral mucosa, genitourinary system, and bowel.\(^46\) Frequently reported concurrent conditions are diabetes mellitus, previous spine surgery, intravenous drug abuse, epidural anesthesia, alcoholism, renal failure, hemodialysis, systemic chronic disorders, and immunosuppression.\(^3\)\(^,\)\(^{17}\)\(^,\)\(^{21}\)\(^,\)\(^{33}\)\(^,\)\(^{43}\) Factors that can be associated with a worse prognosis are older age, diabetes mellitus, neurological and mental deterioration, and dorsal location of the SEA.\(^1\)\(^,\)\(^{8}\)\(^,\)\(^{9}\)\(^,\)\(^{19}\)\(^,\)\(^{23}\)\(^,\)\(^{32}\) Additionally, higher reoperation and mortality rates are associated with renal failure and hemodialysis.\(^44\)\(^,\)\(^{45}\) In terms of pathogenic microorganisms, overwhelmingly the most common is \(S.\)\(\)\(^{\text{aureus}}\), followed by \(S.\)\(\)\(^{\text{streptococcus}}\) spp. and gram-negative bacteria.\(^4\)\(^,\)\(^{16}\)\(^,\)\(^{17}\)\(^,\)\(^{30}\)\(^,\)\(^{38}\) Mortality rates are 5%–23%\(^,\)\(^{1}\)\(^,\)\(^{9}\)\(^,\)\(^{11}\)\(^,\)\(^{30}\) and morbidity rates are 33%–47%.\(^9\)\(^,\)\(^{10}\)

Presentation and Diagnosis. The most common signs and symptoms are neck and back pain, fever, and neurological deficits.\(^4\)\(^,\)\(^{28}\) Others, such as altered mental status and incontinence, can also be present.\(^4\)\(^,\)\(^{28}\) However, presentation is variable and can be ambiguous, leading to delayed diagnosis.\(^7\)\(^,\)\(^{12}\)\(^,\)\(^{14}\)\(^,\)\(^{18}\)\(^,\)\(^{27}\)\(^,\)\(^{37}\)\(^,\)\(^{41}\) Reportedly, SEA usually occurs in the thoracolumbar spine, dorsally.\(^19\)\(^,\)\(^{30}\)\(^,\)\(^{31}\) In one study, systemic symptoms were more common among those with ventral lesions, and focal deficits were more common among those with dorsal lesions.\(^19\) In the absence of contraindications, the standard imaging modality is MRI; CT myelography is an equivalent option.\(^10\)\(^,\)\(^{33}\)\(^,\)\(^{41}\) Ultrasonography has been used intraoperatively to ensure complete abscess clearance.\(^42\) Along with increased white blood cell count, inflammatory markers such as C-reactive protein and erythrocyte sedimentation rate are usually also increased; both markers can be used to monitor treatment success\(^10\)\(^,\)\(^{12}\)\(^,\)\(^{18}\)\(^,\)\(^{43}\) and have also been found to predict treatment success and outcomes.\(^32\)\(^,\)\(^{38}\)

Treatment and Outcome. Generally, antibiotics should be initiated as soon as SEA diagnosis is suspected. For 25% of patients, antibiotic therapy for less than 4 weeks is associated with treatment failure.\(^4\)\(^,\)\(^{38}\) Therapy should be culture specific, and peripheral blood cultures can be possibly used as indicators of the pathogen.\(^10\)\(^,\)\(^{33}\)\(^,\)\(^{41}\) Computed to-
<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Type &amp; Duration of Study</th>
<th>No. of Patients</th>
<th>Treatment (no. of patients)</th>
<th>Special Aspects</th>
<th>Outcomes†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adogwa et al., 2014</td>
<td>retrospective, 14 yrs</td>
<td>82</td>
<td>op + antibiotics (30) w/o op (52)</td>
<td>all patients &gt;50 yrs</td>
<td>good: 12 (15%), 7 underwent op unchanged: 41 (50%), 10 underwent op death: 20 (25%), 9 underwent op</td>
</tr>
<tr>
<td>Patel et al., 2014</td>
<td>retrospective, 6 yrs</td>
<td>128</td>
<td>antibiotics alone (51) op (77)</td>
<td>NA</td>
<td>medical management failed &amp; op required: 4%</td>
</tr>
<tr>
<td>Kim et al., 2013</td>
<td>retrospective, case controlled, 18 yrs</td>
<td>355</td>
<td>op (214) nonop (142)</td>
<td>largest study in the literature</td>
<td>nonop management failed: 54/142; risk factors for failure age &gt;65 yrs, diabetes, MRSA</td>
</tr>
<tr>
<td>Connor et al., 2013</td>
<td>retrospective, 11 yrs</td>
<td>77</td>
<td>op (57) nonop (20)</td>
<td>NA</td>
<td>operative w/ significant improvement: 78.2% nonoperative w/ significant improvement: 82.4%</td>
</tr>
<tr>
<td>Chen et al., 2011</td>
<td>retrospective, 6 yrs</td>
<td>45</td>
<td>antibiotics (19) antibiotics + op (26)</td>
<td>used the Barthel Index</td>
<td>good prognosis: 28 poor prognosis: 17</td>
</tr>
<tr>
<td>Huang et al., 2012</td>
<td>retrospective, 5 yrs</td>
<td>29</td>
<td>antibiotics + op (16) antibiotics (29)</td>
<td>used the Barthel Index</td>
<td>good prognosis: 21 poor prognosis: 8</td>
</tr>
<tr>
<td>Oktenevci et al., 2011</td>
<td>retrospective, 13 yrs</td>
<td>14</td>
<td>op (12) drainage of abscess (1) CT-guided biopsy (1)</td>
<td>not applicable</td>
<td>full recovery: 7 improvement: 4 no change: 1</td>
</tr>
<tr>
<td>Wu et al., 2011</td>
<td>retrospective, 4 yrs</td>
<td>41</td>
<td>antibiotics antibiotics + op group I: w/ ESRD (12) group II: w/o ESRD (29)</td>
<td>comparison study of patients w/ &amp; w/o ESRD</td>
<td>mortality rates Group I: (11.1%) Group II: (6.9%) prognosis same for patients w/ and w/o ESRD</td>
</tr>
<tr>
<td>Zimmerer et al., 2011</td>
<td>prospective observational, 4 yrs</td>
<td>36</td>
<td>surgical removal of abscess + decompression (34) antibiotics (36)</td>
<td>dental examinations conducted for all patients</td>
<td>full recovery: 22 (61%) neurological function better than at admission: 34 (100%)</td>
</tr>
<tr>
<td>Wong et al., 2011</td>
<td>retrospective, 6 yrs</td>
<td>19</td>
<td>10/19 = op (10, decompression &amp; laminctomy [8], discectomy [2]) percutaneous drainage (2)</td>
<td>largest literature review of SEA in ESRD patients</td>
<td>all-cause mortality rate: 25%</td>
</tr>
<tr>
<td>Huang et al., 2011</td>
<td>retrospective, 6 yrs</td>
<td>12</td>
<td>not specified: medical (antibiotics) &amp;/or surgical</td>
<td>gram-negative bacterial SEAs</td>
<td>mortality rate: 16.7%</td>
</tr>
<tr>
<td>Wang et al., 2010</td>
<td>retrospective, 7 yrs</td>
<td>41</td>
<td>antibiotics + op (39) antibiotics (2)</td>
<td>excluded patients w/ Hx of spine op, spinal anesthesia, TB, or trauma</td>
<td>mortality rate: 5%</td>
</tr>
<tr>
<td>Koo et al., 2009</td>
<td>case–control review, 5 yrs</td>
<td>29</td>
<td>observation of AIS motor score improvement (SEA vs traumatic SCI)</td>
<td>rehabilitation outcomes study</td>
<td>motor recovery better for SEA patients than for traumatic SCI patients</td>
</tr>
<tr>
<td>Karikari et al., 2009</td>
<td>retrospective, 10 yrs</td>
<td>104</td>
<td>CT-guided aspiration or blood culture + antibiotics (64) surgical decompression (40)</td>
<td>ventral or dorsal SEA should be considered when deciding on treatment plan</td>
<td>no significant difference in outcome in the 2 treatment groups</td>
</tr>
<tr>
<td>Boström et al., 2008</td>
<td>retrospective, 15 yrs</td>
<td>46</td>
<td>antibiotics + op (37) CT-guided drainage (9)</td>
<td>used Frankel grading system</td>
<td>mortality rate: 6.5%</td>
</tr>
</tbody>
</table>

(continued)
<table>
<thead>
<tr>
<th>Authors &amp; Year</th>
<th>Type &amp; Duration of Study</th>
<th>No. of Patients</th>
<th>Treatment (no. of patients)</th>
<th>Special Aspects</th>
<th>Outcomes†</th>
</tr>
</thead>
<tbody>
<tr>
<td>McKinley et al., 2008</td>
<td>retrospective, 10 yrs</td>
<td>34</td>
<td>comparison of outcomes after infection-related SCI vs traumatic SCI</td>
<td>rehabilitation outcomes study for acute-care stays longer &amp; discharge to home less often for patients w/ infection-related SCI than w/ traumatic SCI</td>
<td></td>
</tr>
<tr>
<td>Savage et al., 2005</td>
<td>retrospective, 10 yrs</td>
<td>52</td>
<td>antibiotics (29) surgery + antibiotics (23)</td>
<td>medical Rx failed more often for thoracic SEAs</td>
<td>excellent outcome for medically treated group: 83%</td>
</tr>
<tr>
<td>Kumar &amp; Hunter, 2005</td>
<td>retrospective, 5 yrs</td>
<td>20</td>
<td>antibiotics + surgery (18) antibiotics (2)</td>
<td>outcome scores assigned on a scale of 1 to 5</td>
<td>good: 15/20 poor: 5/20</td>
</tr>
<tr>
<td>Chen et al., 2004</td>
<td>retrospective, 7 yrs</td>
<td>17</td>
<td>antibiotics + surgery (17)</td>
<td>9 of 17 SEAs were caused by spinal procedures</td>
<td>good: 53% fair: 18% poor: 29%</td>
</tr>
<tr>
<td>Siddiq et al., 2004</td>
<td>retrospective analysis, 14 yrs</td>
<td>57</td>
<td>antibiotics (25) antibiotics + CT-guided aspiration (7) surgery (28)</td>
<td>NA</td>
<td>clinical outcomes comparable for antibiotics alone or antibiotics + CT-guided drainage compared w/ op</td>
</tr>
<tr>
<td>Löhr et al., 2005</td>
<td>retrospective review, 10 yrs</td>
<td>27</td>
<td>interlaminar approach (14) laminectomy (13)</td>
<td>used intraop ultrasonography</td>
<td>no deficit: 9 ambulatory w/ deficit: 12 nonambulatory w/ deficit: 1 paraplegic: 4</td>
</tr>
<tr>
<td>Davis et al., 2004</td>
<td>retrospective case-control study, 10 yrs</td>
<td>63</td>
<td>SEA (63) vs 126 controls w/ spine pain</td>
<td>emergency department study in emergency department, ESR can be potential screening tool before MRI</td>
<td>outcomes worse after conservative Rx w/ antibiotics alone compared w/ early op</td>
</tr>
<tr>
<td>Curry et al., 2005</td>
<td>retrospective review, 6 yrs</td>
<td>48</td>
<td>antibiotics initially (11 then required op after decompensating): 23 surgery: 25</td>
<td>presentation/rationale given for 11 patients initially treated conservatively</td>
<td>no or minimal paresis: 51% severe paresis or paraplegia w/o incontinence: 23% incontinence: 18% death: 8%</td>
</tr>
<tr>
<td>Joshi et al., 2003</td>
<td>retrospective review, 10 yrs</td>
<td>39</td>
<td>surgical decompression (39, 13 of which required stabilization)</td>
<td>outcomes measured after 1 yr</td>
<td>no or minimal paresis: 51% severe paresis or paraplegia w/o incontinence: 23% incontinence: 18% death: 8%</td>
</tr>
<tr>
<td>Tang et al., 2002</td>
<td>retrospective review, 10 yrs</td>
<td>46</td>
<td>posterior decompression &amp; drainage (25) antibiotics (21)</td>
<td>thrombocytopenia may be a risk factor for a poor outcome</td>
<td>accurate initial SEA Dx rate: only 26%</td>
</tr>
<tr>
<td>Soehle &amp; Wal- lenfang, 2002</td>
<td>retrospective review, 7 yrs</td>
<td>25</td>
<td>op (25, 23 patients treated w/in 24 hrs after admission)</td>
<td>WBC and CRP levels were prognostic for outcomes</td>
<td>mortality rate: 20%</td>
</tr>
</tbody>
</table>

* AIS = American Spinal Injury Association Impairment Scale; CRP = C-reactive protein; Dx = diagnosis; ESR = erythrocyte sedimentation rate; ESRD = end-stage renal disease; Hx = history; NA = not applicable; Rx = medical treatment; SCI = spinal cord injury; TB = tuberculosis; WBC = white blood cell count.
† Data expressed as number or percentage of patients unless otherwise indicated.
Update on spinal epidural abscess

mography–guided percutaneous aspiration can be both
diagnostic and therapeutic.9 In previous years, surgical inter-
vention was the mainstay of management of this infection
process, particularly when symptoms had not been present
for longer than 36–72 hours.1,5,9,13,31,36 Later studies have
shown successful outcomes with medical management
alone.6,10,36,37 However, other more recent studies have indi-
cated that early surgery has better outcomes.9,26,32,33 Others
have demonstrated that medical treatment alone is more
likely to fail among elderly patients or those with diabetes
mellitus and/or MRSA infection.23 The operative approach
should be guided by the spatial orientation of the abscess.29
Instrumentation and fusion are usually avoided but might
be required in rare cases.19,31 Outcomes are mostly reported
objectively, and obtaining long-term follow-up information
for all patients can be difficult (Table 7). A few studies re-
porting long-term rehabilitative outcomes showed contra-
dictory results.24,29

Discussion

It is widely acknowledged that diagnosis and treat-
ment of SEAs should be conducted as soon as possible
because of their potentially devastating neurological se-
quelae. Regarding diagnosis, the literature describes the
most common presenting complaints as neck and back
pain, but other reported signs and symptoms are neuro-
logical deficits, fever, altered mental status, and inconti-
nence.4,10,19 Our study confirms all signs and symptoms
described in the literature; back pain and neurological
deficits (or both) were most common among patients in
our study (experienced by almost half of patients).

Because of the nonspecific findings for SEA, a high
index of suspicion is essential for patients with such
symptoms.1719 Such suspicion, along with early neuroim-
aging studies, is crucial for diagnosis and management.17
Certain predisposing conditions can further increase
clinical suspicion. The literature cites the most common
predisposing factor as being diabetes mellitus, along with
previous spinal intervention, intravenous drug abuse, al-
coholism, renal failure, bacteremia, and chronic inflam-
matory conditions.17,33 The patient data from our study
parallel these findings. Epidural anesthesia has a well-
established association with SEA (responsible for around
5% of all SEAs).3,5,21 A reported source of bacteremia
and sepsis that can lead to development of SEAs is vascu-
lar access–related infection, notably in hemodialysis pa-

tients; they attributed this finding to hematogenous or
contiguous spread from a paravertebral infection as well
as the larger epidural space and venous plexus in this seg-
ment of the spine.2,21 Ventrally located SEAs are thought
to be more rare and are usually associated with spondy-
ritis or diskitis, although in that small retrospective study
of 14 patients, the location was dorsal in only 6 patients.
Patient data from our series revealed a prevalence of ven-
tral SEAs (47 patients); SEAs were dorsal for only 30
patients (Table 2). These findings may be the result of a
relatively high prevalence of osteomyelitis and diskitis in
the studied population.

As has been found in other studies, S. aureus
was the most common pathogen among patients in our study.
A total of 75 (70.0%) patients with SEAs had S. aureus
infection, followed much further by Streptococcus spp.
infection. Our data support the recommendation that
antibiotic therapy including an antistaphylococcal agent
should be initiated as soon as SEAs are diagnosed and
then should be adjusted according to culture results.4,38
Although the period of antibiotic treatment is debatable,
therapy should last longer than 4 weeks because therapy
for less than 4 weeks is associated with a 25% rate of
relapse.4,15,38 The neuroimaging study of choice is MRI
because it provides the ability to visualize soft tissues as
effectively as CT myelography with a comparable sen-
sitivity for SEA (91%–92%); it offers the advantages of
superior identification of perimedullary lesions and does
not pose the risk of introducing pathogens into the the-
cal sac.41 MRI helps distinguish SEAs from other condi-
tions in the differential diagnosis, which include tumor
and subdural abscess.72 A characteristic description of an
SEA on MR images includes a collection in the epidural
space that is isointense or hyperintense on T1 images that
enhances with gadolinium contrast and a T2 image with
nonhomogeneous and hyperintense signal.33 A study by
Tung et al. found that a poor outcome and/or lack of re-
covery to normal was associated with 50% narrowing of
the spinal canal on initial MR images (p = 0.03), periph-
eral contrast enhancement (p = 0.05), abnormal cord sig-
nal intensity, and an abscess longer than 3 cm (p = 0.01).41
In patients for whom MRI is contraindicated, other diag-
nostic modalities can be used, such as CT scanning, CT-
guided biopsy, and surgical exploration when none of the
less invasive strategies are conclusive.

Surgical decompression has been suggested as the
mainstay of therapy because symptoms result mainly
from direct constriction of neural elements or the resul-
tant ischemia.7,10,13,35,42 Most authors suggest that the upper
time limit for consideration to intervene surgically is 36–
72 hours from onset of neurological sequelae.1,9,19,23,32,36,39
Although for select patients a conservative approach of
antibiotics alone might be appropriate,11,36,37 in our study,
patients with focal neurological signs or symptoms were
offered immediate surgical intervention. Those who had
no response to antibiotics (as deemed by follow-up MRI)
were also surgical candidates. Among those who received
surgery along with antibiotics, 3.2% died; among those
who received antibiotics alone, 12.1% died, suggesting
a potential mortality rate reduction with an aggressive
surgical treatment approach. Nonetheless, such a finding
needs to be further verified with future evidence through much larger studies.

In a larger study by Karikari et al., the operative approach was guided by the location of neural tissue compression. Dorsal SEAs were treated with posterior decompressive laminectomy with or without fusion. Ventral SEAs, particularly ventral cervical SEAs typically occurring in association with osteomyelitis or diskitis, were more likely to be treated by using an anterior approach because it allowed more thorough debridement and facilitated reconstruction of the anterior column. When an abscess was located dorsally, the treatment of choice was laminectomy, which has been identified as the most common procedure for thoracolumbar SEAs. These reported treatment approaches are similar to those used for the 106 patients in our study.

According to the literature, when dealing with an infected surgical site, spinal instrumentation is contraindicated because of increased risk for infection; however, spinal instrumentation might be necessary when extra support is needed for stabilization or when spinal stability is compromised from decompression. In the Oktenoglu et al. study, metallic instrumentation was applied to 5 of 14 patients; the SEA was successfully treated for 4 of these patients. In our cohort, among the 19 patients who underwent fusion, the SEA was more likely to be ventral (12 [63.2%]) and/or thoracic (10 [52.6%]). Additionally, outcome was good for less than one-third of the patients (6 [31.6%]). Only 1 patient experienced SEA recurrence; however, obtaining long-term results with regard to reinfections and rehospitalizations in our patient population was difficult because many patients were lost to follow-up or received follow-up care at other institutions.

In our study, patient outcomes were based on long-standing neurological deficits and overall functional capacity. We reported outcomes objectively, in a manner similar to that described previously, which was suitable for the retrospective nature of our analysis. Of the patients not lost to follow-up, the frequency of good outcomes (full recovery, independent ambulation, no sphincter disturbance) was 37 (60.7%); the rest of the patients (39.3%) were determined to have poor outcomes (assisted ambulation, sphincter disturbance, paraplegia, bed confinement, or death).

Literature Review

Our goal for the literature review was to update current knowledge on nontuberculous bacterial SEAs. Particular attention was paid to the medical and surgical management of this condition, which is increasingly encountered by spine surgeons. Most of the studies reviewed were small, retrospective, single-center studies (Table 7). To the best of our knowledge, at the present time there is no consensus or guidelines for the treatment of SEAs. Clinical recommendations are based mostly on results of these studies and on expert opinions.

The most recent study reported results for elderly patients (> 50 years of age). Most (> 85%) of their cohort had either an unchanged condition or a poor outcome. The authors reported that for this age group, early surgical intervention lacked advantage compared with use of antibiotics alone. Although another very recent series showed that ideal treatment included surgery for those with focal deficits, age remains a factor; outcomes are better for younger patients. Yet another article recommends close attentiveness for those with nonoperative treatment because it is associated with a high rate of failure (> 40%). In the largest series reviewed (355 patients), Kim et al. showed that medical treatment is likely to fail for those older than 65 years of age and for those with MRSA infection, diabetes mellitus, and/or neurological symptoms. On the basis of these findings, the authors provide a simple algorithm for determining the likelihood of failed medical management. The latter 2 studies reported high concordance between blood and abscess cultures, enabling clinicians to tailor antibiotics to blood culture results.

In 2011, Chen et al. conducted a 6-year retrospective review of 45 patients treated either with antibiotics alone or with antibiotics and surgery. They noted that the prognosis was worse for patients who at the time of initial presentation had diabetes mellitus, heart disease, higher age, and/or altered mental status. Outcomes were also poorer for those with late-stage disease, defined by the authors as neurological sequelae such as sensory impairment, weakness, bladder or bowel dysfunction, and/or paralysis. Huang et al. reported isolation of S. aureus from 29 (69%) of 42 patients and gram-negative bacteria from 12 (28.5%) of 42. This finding is consistent with findings previously reported in the literature and also with our finding that S. aureus is the most commonly isolated bacterium. Another study noted similar culprit microorganisms and reiterated that MRI should be performed for patients with back pain and fever, especially those with risk factors for a compromised immune system.

Wu et al. compared outcomes for patients with and without end-stage renal disease. An attending neurosurgeon decided whether to treat with antibiotics alone or with antibiotics and surgical decompression. The prognosis remained unchanged for patients with and without end-stage renal disease; however, in this patient population for whom infectious complications were a leading cause for illness and death, end-stage renal disease was a risk factor for repeat surgery. Wong et al. published similar results for a larger study in which mortality rate was higher among hemodialysis patients and likelihood for neurological improvement after medical or surgical intervention was decreased. In our study, 10 (9.3%) SEA patients were receiving hemodialysis at the time of diagnosis. Of the 6 patients who died, 2 had received hemodialysis, adding to the many factors to be considered for SEA patients.

In a 4-year prospective observational study, of 36 patients, Zimmerer et al. described 34 who had undergone surgical SEA removal plus decompression followed by long-term antibiotic administration. This study was unique because all patients underwent clinical dental examinations with CT. Of the 36 patients, 22% had oral pathogenic bacteria. In 2010, Wang et al. conducted a 7-year retrospective study and discovered that poor motor recovery is correlated with poor glycemic control, prolonged muscle weakness before initiation of treatment, and poor response to treatment as measured by trends in
white blood cell counts and C-reactive protein levels. In a larger study, Karikari et al. noted no significant difference in outcomes between 2 treatment groups: CT-guided aspiration plus antibiotics versus surgical decompression. They highlighted the importance of abscess location with regard to decision making. They found that patients with ventral SEA were more likely to show systemic signs and symptoms such as fever before neurological deficits and back pain (because of associated diskitis or osteomyelitis) and that patients with dorsal SEA were more likely to show neurological deficits. The former group can be treated conservatively with antibiotics and CT-guided aspiration, primarily because of early detection and significantly smaller SEAs.

In a series of 27 patients treated operatively, Löhr et al. demonstrated a strong advantage of surgical management. They advocated for an interlaminar decompressive approach, which provided more postoperative spinal stability and a similar likelihood of reoperation for recurrent or residual abscess when compared with laminectomy. In addition, they found that intraoperative ultrasonography enabled visualization of abscesses that might be hidden, thereby helping to reduce the likelihood of recurrence. A 10-year retrospective study noted excellent outcomes for 83% of medically treated patients. Selection criteria for the medically treated group included normal or stable neurological examination for more than 72 hours before admission (including signs and symptoms of radiculopathy or cord compression). Soehle and Wallenfang analyzed outcomes of 25 surgical patients after an average of 11 months. They found that poor outcomes were associated with higher preoperative and postoperative white blood cell counts (> 14,000 cells/μl), higher postoperative levels of C-reactive protein, a cervicothoracic location of the SEA, and lower limb deficits at the time of initial examination.

Studies have shown that misdiagnosis is common and can occur for up to 74% of patients, which leads to poorer outcomes. Chen et al. identified 3 of 17 patients with thoracic SEA who complained of abdominal symptoms, which led to misdiagnosis; they concluded that abdominal symptoms can mask neurological deficits and lead to delayed diagnosis. After a 10-year study, in 2003, Joshi et al. concluded that fever is not mandatory for the diagnosis of SEA. Because typically the first symptom of SEA is back pain, laboratory studies including erythrocyte sedimentation rate and C-reactive protein levels should be obtained. If those values are elevated, urgent MRI would help with early diagnosis of SEA. A later study builds on this finding, reporting that body temperature and white blood cell count within reference ranges do not preclude a diagnosis of SEA. Davis et al. reemphasize that erythrocyte sedimentation rate could be a potential screening tool before obtaining MRI for patients in the emergency room with suspected SEA.

Very few study reports comment on functional outcomes of SEA patients. Koo et al. studied neurological outcomes among patients with SEA-related myelopathy after an inpatient rehabilitation program and compared them with outcomes among patients with traumatic spinal cord injury. According to the American Spinal Injury Association (ASIA) Impairment Scale scores, patients with SEA-related neurological deficits including complete motor or sensory loss showed significant improvement compared with patients with traumatic spinal cord injury. Overall, 73% of patients with SEA compared with only 9% of patients with traumatic spinal cord injury converted from complete ASIA Impairment Scale Grade A to incomplete ASIA Impairment Scale Grade B, C, or D. McKinley et al. compared outcomes of patients with traumatic spinal cord injury to outcomes of those with spinal infections; 85% of those patients with infections had SEAs. Patients with infections stayed in acute care significantly longer than did those with traumatic spinal cord injury; however, the length of stay in rehabilitation did not differ significantly between the 2 groups. In addition, among patients in the infections group, motor score improvements were lower and patients were less often discharged home than were those with traumatic spinal cord injury, reinforcing the importance of early patient and family education regarding potential future outcomes.

Clinical Decision Making

On the basis of our experience and on previous evidence from the literature, we present an algorithm for diagnosis and treatment of SEA (Fig. 3). Patients with suspicious signs and symptoms should undergo appropriate blood testing (e.g., white blood cell counts, erythrocyte sedimentation rates, C-reactive protein levels, cultures) and MRI; those with nonremarkable negative MRI findings should receive conservative treatment and monitoring. If imaging is suggestive of SEA, the decision for operative management should be based on the presence of factors that are highly associated with failure of medical treatment alone (i.e., diabetes mellitus, age > 65 years, neurological deficits [for < 36–72 hours], and MRSA-positive blood culture results). Otherwise, medical treatment with antibiotics only can be confidently started. These patients should undergo CT-guided biopsy of the lesion, especially if blood cultures are inconclusive. They also need to be monitored for signs of medical treatment failure, such as onset of neurological compromise and persistence of elevated inflammatory markers (C-reactive protein levels, white blood cell count), blood culture positivity, and imaging indications of SEA. If signs of medical failure are detected, surgical decompression should be initiated promptly.

Limitations

A limitation encountered in our analysis and in published SEA studies was lack of complete long-term follow-up data. After discharge, a number of patients were transferred to other facilities. These limitations impede the ability to obtain coherent assumptions on outcomes of each treatment modality. In addition, the retrospective nature of these studies further limits their interpretation. Errors in the data and in data collection can and do occur. As best we can determine, advances in imaging modalities and treatment strategies have decreased deaths from this serious infection. As such enhancements continue to expand, future multicenter studies with complete long-term follow-up can augment our understanding of the condition.
Conclusions

Prompt diagnosis and treatment of bacterial SEA can improve outcomes, but the outcome will be poor for a substantial percentage of patients. Those with multiple risk factors—older age, diabetes mellitus, end-stage renal disease, and intravenous drug abuse—are predisposed to this rare infection and to having worse outcomes. The organism most frequently responsible for SEA is *S. aureus* and MRSA has been correlated with a higher rate of treatment failure. Optimum care involves diagnosis with MRI, administration of appropriate antibiotics with or without surgery, and appreciation of the effects of concurrent conditions and risk factors. After the decision to operate has been made, surgery should be performed immediately and no longer than 36–72 hours after onset of neurological symptoms. Although management with surgical decompression was associated with lower mortality rates in our study and better outcomes in studies reported in the literature, multiple studies also support use of antibiotic therapy alone. Undoubtedly, neurological status at the time of presentation is a key factor in decision making and patient outcome. Overall, management decisions entail individual patient considerations. Although this aspect of the condition is a challenge for spine surgeons, an evidence-based algorithm is proposed. We hope that it will be a valuable tool for clinicians. Future large studies with long-term follow-up can verify the utility of this algorithm and can establish a consensus-based protocol for this increasingly prevalent condition.

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Disclosure

The authors report no conflict of interest concerning the materials or methods used in this study or the findings specified in this paper.

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References


![Fig. 3. Algorithm for diagnosis and treatment of SEA.](image-url)
Update on spinal epidural abscess


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