Pyogenic Vertebral Osteomyelitis: Analysis of 20 Cases and Review

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The diagnosis of vertebral osteomyelitis is easily missed, particularly for the elderly in whom signs of sepsis may not manifest. The case records of 20 patients with vertebral osteomyelitis who were treated at our hospital between January 1989 and April 1993 were reviewed. The average age of the patients was 72 years. Infection was most commonly due to intravenous cannula–related sepsis. Eighty-five percent of patients presented with back pain, and only 30% had a fever. Computerized tomography and magnetic resonance imaging were the most useful radiological investigations; nuclear scanning was sensitive but insufficiently specific. *Staphylococcus aureus* was the infecting organism in 13 of 16 patients whose microbiological diagnosis was made by blood or bone cultures. Six (45%) of these 13 patients were infected with methicillin-resistant *S. aureus* (MRSA). Nosocomial infection occurred in 12 (60%) of the patients studied, including all patients with MRSA infections. Vertebral osteomyelitis may be largely preventable if infection-control aspects of intravenous cannulation are improved, attempts at reducing and preventing MRSA colonization are made, and therapy for bacteremias is optimized.

Vertebral osteomyelitis is said to be an uncommon disease [1–3]. At Concord Repatriation General Hospital (Concord, New South Wales, Australia), when we have encountered this disease, it has frequently been a complication of nosocomial bacteremia. Herein we review our experience with vertebral osteomyelitis over the past few years and contrast it with that found in the available English-language literature on this disease.

Methods

The hospital records of 20 patients with vertebral osteomyelitis who were admitted to our hospital between January 1989 and April 1993 were reviewed. The diagnosis of vertebral osteomyelitis was based on a combination of consistent clinical, laboratory, and radiological features confirmed by positive blood or bone cultures or by an appropriate response to antibiotic therapy. The characteristics analyzed included age, sex, predisposing factors, and clinical presentation of patients; results of investigations (including radiological and microbiological tests); treatment; and patients' outcome. The cases of vertebral osteomyelitis were identified by a search through the infectious disease consultation and radiology data bases and the hospital medical records. The literature available on MEDLINE between 1970 and 1992 was reviewed.

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Illustrative Cases

Case 1

A previously well 75-year-old man with a 6-week history of thoracolumbar back pain was admitted to our hospital. There were no abnormal neurological signs. At the time of admission, radiographs showed destruction of the T-12–L-1 vertebrae. The destruction was confirmed by computerized tomography (CT). Bone scanning also revealed abnormalities in this region. The initial white blood cell (WBC) count was 12.7×10^9/L (76% neutrophils), and the erythrocyte sedimentation rate (ESR) was 128 mm/h. A CT-guided fine-needle bone biopsy was performed, and blood for culture was also taken. Culture of the bone biopsy specimen yielded methicillin-sensitive *Staphylococcus aureus* (MSSA). He was treated with intravenous flucloxacillin (12 g/d) for 20 days and then was discharged; his medications at discharge included oral flucloxacillin and probenecid, both of which he continued to take for 102 days. His pain decreased, and the ESR returned to normal (<20 mm/h).

Three weeks after cessation of antibiotic therapy, his pain recurred, and the ESR increased to 78 mm/h. He was readmitted and treated again with intravenous flucloxacillin (18 g/d) for 28 days. His pain remitted, and the ESR again returned to normal. Therapy with oral flucloxacillin was continued for 6 months, and he made a full recovery.

Case 2

A 62-year-old previously well man with *Shigella flexneri* bacillary dysentery complicated by acute renal failure required dialysis via a jugular vascular catheter for 3 weeks. This condition was complicated by jugular vein thrombophlebitis. Cultures of blood and pus from the catheter exit site yielded methicillin-resistant *S. aureus* (MRSA). Therapy

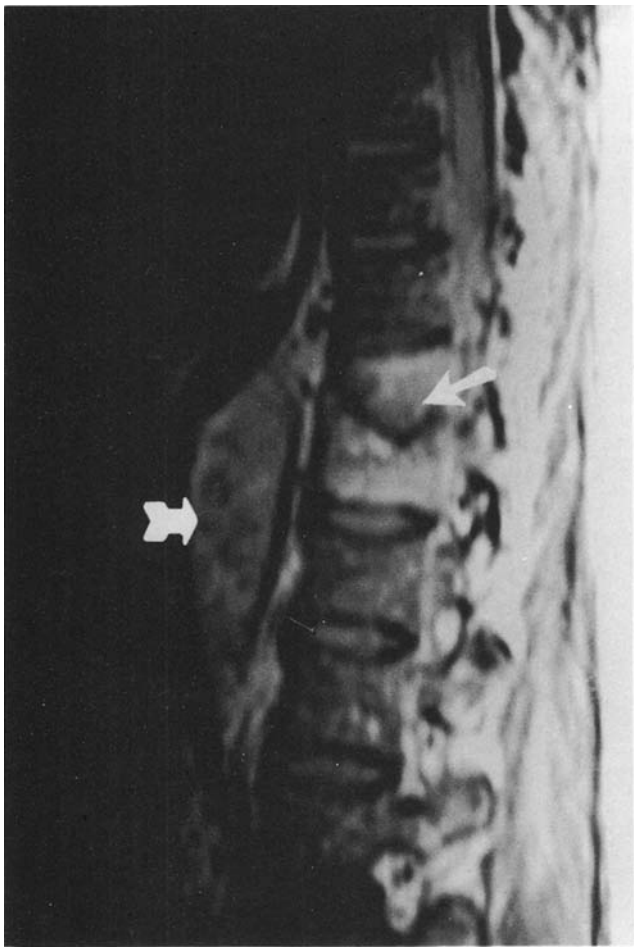

Figure 1. Longitudinal T2-weighted magnetic resonance image showing osteomyelitis of the T-10–T-11 vertebrae (*small arrow*) as well as a paravertebral collection (*large arrow*).

with intravenous vancomycin was started and was continued for 14 days. On day 5 (after the onset of bacteremia), he complained of thoracic back pain. On day 24 technetium-99 bone scanning did not reveal any evidence of vertebral osteomyelitis, and he was discharged.

On day 57 he presented to the hospital again with persisting back pain and fever. CT revealed an ischiorectal abscess. Culture of surgical drainage of the abscess yielded MRSA. Neurological examination revealed mild hip flexor weakness. His WBC count was marginally elevated (11.8×10^9/L), and his ESR was 130 mm/h. Radiography, CT, and bone scanning showed changes consistent with vertebral osteomyelitis of the T-10–T-11 vertebrae and involvement of the intervening disk. A magnetic resonance imaging (MRI) scan also showed osteomyelitis, a small epidural collection, and a paravertebral collection (figure 1). A CT-guided fine-needle vertebral biopsy was done; culture of the biopsy specimen yielded MRSA. Therapy with intravenous vancomycin was given for 21 days. His back pain abated, and he was discharged; his medications at discharge included oral rifampin and fusidic acid. While he was receiving oral therapy, his ESR decreased to 12 mm/h, and this treatment was continued for 6 months.

Two months after ceasing antibiotic therapy, his back pain worsened. CT did not reveal further vertebral destruction, but his ESR increased to 52 mm/h. He was treated again with intravenous vancomycin for 3 weeks. Once again he responded to treatment. The patient was discharged and again received therapy with oral rifampin and fusidic acid for 8 months; he made a complete recovery.

Case 3

A 69-year-old man was admitted to the hospital because of fever, jaundice, and presumed cholangitis. He had a WBC count of 27.2×10^9/L (80% neutrophils) and thrombocytopenia. Abdominal ultrasonography revealed the presence of a liver abscess, which was drained via a percutaneous catheter. Cultures of blood obtained at the time of admission yielded *Clostridium perfringens*, *Escherichia coli*, and *Streptococcus adjacens*. Culture of the liver aspirate yielded *Enterococcus faecalis*, mixed coliform bacteria, and diphtheroids. He was treated with intravenous ceftazidime (which was changed to cefotaxime after 5 days), gentamicin, penicillin, and metronidazole.

One week after admission he complained of lumbar back pain. His WBC count remained elevated, and his ESR was 130 mm/h. Plain radiography showed changes consistent with degenerative joint disease in the lumbar spine. A CT scan showed bulging of and gas within the disk between the L-4–L-5 vertebrae but no collections. Bone scanning showed increased uptake of tracer in the area of the L-4–L-5 vertebrae. However, neither CT nor bone scanning was thought to be diagnostic of infection. Two weeks after admission the patient was noted to have bilateral leg weakness. An MRI scan clearly revealed osteomyelitis of the L-4–L-5 vertebrae, inflammation of the disk between these vertebrae, and a small epidural collection. Surgical drainage of this collection was not performed, nor was bone biopsy. His therapy was changed to ticarcillin/clavulanate. He received intravenous therapy for a total of 51 days and then was discharged; his medications at discharge were oral ciprofloxacin and amoxicillin.

He presented again 2 weeks later because of acute renal failure; renal biopsy revealed interstitial nephritis. Antibiotic therapy was discontinued, and his creatinine level returned to normal. Antibiotic therapy with clindamycin and trimethoprim was started 9 days later. He received these antibiotics for just over 3 months and made a full recovery.

Table 1. Presumed source of infection and frequency of occurrence in patients with vertebral osteomyelitis.

Presumed source of infection	No. (%) of patients
Intravenous access device–related	8 (40)
Peripheral venous cannula	4
Central venous catheter	1
Subclavian dialysis catheter	2
Arteriovenous fistula cannulation	1
Wound infection from laminectomy	2 (10)
Urinary tract infection or genitourinary tract instrumentation	3 (15)
Primary bacteremia	3 (15)
Secondary bacteremia	2 (10)
Biliary sepsis	1
Dental work	1
Not known	2 (10)

Results

Demographics

Of the 20 patients, 19 (95%) were male and one (5%) was female. The age of the patients at the time of presentation ranged from 62 to 79 years (mean age [± SE], 72 ± 1 year). There were an average of 17,000 admissions per year in our hospital between 1990 and 1993; these patients stayed in the hospital for >2 days. Twenty cases of pyogenic vertebral osteomyelitis were identified between 1989 and 1993.

Risk Factors

None of the patients in this study were diabetic or injection drug users. Two patients were receiving oral steroid therapy: one patient was receiving this therapy before the onset of infection, and the other patient was mistakenly treated for polymyalgia rheumatica because of back pain. The presumed sources of the vertebral infection are summarized in table 1. Three patients were considered to have a urinary source: one had a permanent indwelling urinary catheter, one recently underwent urethrotomy and had subsequent bacteremia, and one had recent enterococcal pyelonephritis. In two patients osteomyelitis was contiguous to a wound infection obtained during laminectomy. In both of these patients, the vertebral region was subsequently infected during episodes of bacteremia.

Eight cases of vertebral osteomyelitis were thought to be due to cannula-related sepsis (four of these cases were caused by MRSA). Three of these eight patients were undergoing hemodialysis. Five patients had community-acquired sepsis unrelated to cannulation. One patient had polymicrobial bacteremia secondary to biliary sepsis, and another patient had *Staphylococcus epidermidis* bacteremia following dental work. Three other patients had primary *S. aureus* bacteremia without an identifiable source. Two patients had no apparent source of infection. Culture of the bone biopsy specimen from one of these patients yielded *S. aureus*, but both blood and urine cultures were negative; all cultures for the other patient were negative, and he was treated empirically for staphylococcal osteomyelitis.

Clinical Presentation

Seventeen patients (85%) presented with back pain as the predominant symptom. Of the remaining three patients, two presented with leg weakness without pain, and one presented with fever alone. Only six patients (30%) were febrile. Eleven patients had limb weakness; one of these patients had complete lower limb paralysis. Of these 11 patients four complained of dysesthesias, and three had objective sensory loss. Three patients had acute retention of urine.

The duration of symptoms before hospital admission was poorly documented, but many patients' symptoms had been present for some weeks. The average period in the hospital

Table 2. Radiological investigations of patients with vertebral osteomyelitis and frequency of abnormalities.

Radiological investigation, result	No. of patients
Plain radiography	20
Degenerative changes	3
Loss of disk height	6
Loss of disk alignment	1
Loss of vertebral height and collapse	1
Loss of disk and vertebral height	1
Disk destruction	2
Vertebral destruction	6
CT	19
Disk narrowing	2
Disk destruction	1
Disk bulging and soft-tissue swelling	1
Disk destruction and soft-tissue mass	1
Vertebral destruction	5
Vertebral destruction and soft-tissue mass	5
Soft-tissue mass	2
Disk and vertebral destruction and soft-tissue mass	1
Uninterpretable	1
MRI	5
Osteomyelitis and epidural and/or paravertebral collection	5
Technetium-99 bone scanning	15
Increased uptake of tracer	13
Normal	2
Gallium scanning	3
Increased uptake of tracer	3

NOTE. CT = computerized tomography; MRI = magnetic resonance imaging.

Table 3. Frequency of vertebral sites infected among patients with vertebral osteomyelitis.

Vertebral level affected	No. of patients
Cervical	2
C-8–T-1	1
Thoracic	6
T-1–L-1	2
Lumbar	9

between the onset of symptoms and a clinical diagnosis of vertebral osteomyelitis was 11 days (range, 0–40 days).

Investigations

Radiological Tests

All patients underwent plain radiography of the spine; 19 underwent vertebral CT; 15 underwent technetium-99 bone scanning; 3 underwent gallium scanning; and 5 underwent MRI (table 2). Plain radiography of all 20 patients revealed abnormalities in the affected vertebral region. The most common initial abnormality was loss of disk height. Initial radiography of only eight patients showed bone or disk destruction. CT was more specific than radiography. CT of 16 patients demonstrated changes consistent with infection. CT of two patients showed only narrowing of disk space. Initial CT of 12 patients revealed disk and bone destruction. MRI of five patients showed definite osteomyelitis and soft-tissue collections (epidural or paravertebral). CT had failed to detect the soft-tissue collections in two of these patients.

Thirteen (87%) of 15 bone scan examinations showed increased uptake of tracer in the affected region. Gallium scanning of three patients revealed abnormalities in the affected vertebral region. Bone scans that had already been done for two of these patients were abnormal. For neither of these patients was gallium scanning reported to show a disproportionate uptake of tracer in relation to bone scanning. The frequency with which the various vertebral regions were affected is shown in table 3.

Laboratory Tests

Other investigations performed included complete blood cell count, ESR (Westergren method), and measurement of the C-reactive protein (CRP) level. A complete blood cell count was performed for all patients, and the mean WBC count (± SE) at the time of diagnosis was 13.1 ± 1.37 × 10^9/L (range, 4.7–27.2 × 10^9/L). Eight patients had a normal WBC count. An initial ESR was performed for 19 patients. Another ESR was performed before discharge for 13 patients. The mean initial ESR was 88.6 ± 10.19 mm/h (range, 12–143 mm/h). The mean ESR decreased to 58.5 ± 10.85 mm/h at the time of discharge. Only one patient had a normal ESR throughout the hospital stay. The CRP level was measured in nine patients. In all nine patients the level was abnormally elevated (mean, 114.7 ± 31.9 mg/L; range, 28.3–364 mg/L). Cultures of bone biopsy specimens from 15 patients were performed. Three of these specimens were obtained during open operations, and 12 were obtained during CT-guided fine-needle biopsies. Cultures of blood from 10 (62.5%) of 16 patients were positive, and cultures of bone specimens from 11 (73%) of 15 patients who underwent vertebral biopsies were positive. Two patients with negative bone cultures had begun antibiotic therapy. The organisms isolated are listed in table 4. Mycobacterial cultures of all vertebral biopsy specimens were negative.

All but one of the patients with MRSA infection had been previously hospitalized. Only one of these patients was known to be previously colonized with MRSA. Three patients with MRSA infection had undergone recent surgery, two were receiving hemodialysis, and one had a protracted hospitalization before acquiring central venous catheter–related sepsis due to MRSA.

Treatment and Outcome

The mean duration of intravenous therapy (± SE) was 34 ± 5 days (range, 0–92 days). One patient did not receive intravenous therapy. All patients with MRSA infection received intravenous therapy with vancomycin alone. All but one patient who died while receiving intravenous therapy continued treatment with oral antibiotics. The duration of oral antibiotic therapy ranged from 21 days to >240 days.

In both cases of vertebral infection secondary to local contiguous spread, surgical debridement was performed. Surgical decompression and aspiration were also performed in another three cases.

Outcome varied greatly. One patient with MSSA infection died of overwhelming septicemia. Three patients had a relapse of infection: one had a recurrence of back pain, one had a rise in ESR, and one had progressive radiologically evident abnormalities. Two of these patients were infected with MRSA, and one was infected with MSSA (table 5). All three patients responded to a second course of therapy with intravenous and oral antibiotics. All patients were followed up for >1 year, and none had further recurrences.

Two patients had persistent back pain without evidence of a relapse. Two patients had residual leg weakness, and neither recovered bladder control. All other patients made a good recovery. Four patients had other complications of bacteremia; two of these had hepatic abscesses, one had an ischiorectal abscess, and one had bacterial endocarditis. In one of these patients, osteomyelitis and endocarditis were both

Table 4. Organisms isolated from patients with vertebral osteomyelitis.

Specimen	No. of patients with organisms isolated from indicated specimen						
	S. aureus	MRSA	CNS	*E. faecalis*	*E. coli*	Polymicrobial*	Total
Blood	2	...	1	...	...	1	4
Bone	3	2	1	...	...	...	6
Urine	1	...	...	1	1	...	3
Blood and bone	1	2	1	...	...	...	4
Blood and urine	...	1	...	...	...	...	1
Blood, bone, and urine	...	1	...	...	...	...	1
Total	7	6	3	1	1	1	19

NOTE. MRSA = methicillin-resistant *S. aureus*; CNS = coagulase-negative *Staphylococcus*; ... = no organisms isolated.
* Organisms isolated from blood culture were *S. adjacens*, *C. perfringens*, and *E. coli*.

thought to be complications of bacteremia following dental work, but it cannot be proven that osteomyelitis was not a complication of endocarditis. Vancomycin therapy was complicated by vasculitis in one patient and persistent hearing loss in another. Other adverse reactions included cholestatic hepatitis secondary to fusidic acid therapy and interstitial nephritis possibly due to either ciprofloxacin or amoxicillin therapy.

Discussion

Vertebral osteomyelitis is said to be uncommon [1–3], but the incidence of this disease is increasing [4–6]. Some studies have correlated this increase with the growing number of injection drug users [5–8]. However, in an elderly population such as our study group, it relates more to the increasing use of intravenous access devices and resultant nosocomial bacteremia [5, 6, 9]. Vertebral involvement accounts for 2%–4% of all cases of pyogenic osteomyelitis [2]. The vertebral region is the most commonly involved area in patients with osteomyelitis who are older than 50 years [9–11], but vertebral osteomyelitis is very uncommon in younger populations [4, 12]. Our study population was an older age group with a more narrow age range than most other reviews of vertebral osteomyelitis. Since our institution was a veterans' hospital

Table 5. Comparison of patients with vertebral osteomyelitis who were grouped according to infecting organism.

Characteristic	Data for indicated characteristic			
	S. aureus (n = 7)	MRSA (n = 6)	CNS (n = 3)	Others (n = 4)
Mean age (y)	74.4 (69–79)*	70.3 (62–79)	70.3 (66–73)	72 (69–75)
No. with community-acquired infection	4	0	1	3
No. with nosocomial infection	3†	6‡	2§	1‖
No. with bacteremia	3	4	2	1
Duration (d) in hospital from symptom onset to diagnosis	4.9	14	10.3	2
No. with neurological signs	5	5	1	4
Mean WBC count ($\times 10^9$/L)	11.7 (5.8–24.3)	12.6 (9.6–19.2)	8.2 (4.7–12.6)	15.1 (7.9–27.2)
Mean ESR (mm/h)	75.9 (12–143)	101.4 (7–135)	77.3 (48–117)	103.5 (45–130)
Mean duration of iv therapy (d)	18.7 (0–55)	56 (19–92)	32 (20–48)	46 (14–76)
Mean duration of hospitalization (d)	27 (9–50)	74.8 (44–111)	73.3 (29–97)	29.5 (10–51)
Mean duration of oral therapy (d)	107.4 (0–370)	110.2 (14–210)	176.3 (109–270)	99.8 (90–120)
Outcome	5 cured; 1 died; 1 relapsed	4 cured; 2 relapsed; 2 had leg weakness	3 cured; 2 with ongoing pain	4 cured

NOTE. MRSA = methicillin-resistant *S. aureus*; CNS = coagulase-negative staphylococcus; WBC = white blood cell; ESR = erythrocyte sedimentation rate; IDC = indwelling urinary catheter.
* Numbers in parentheses represent ranges.
† iv cannulation (2 patients) and wound infection (1).
‡ iv cannulation (2 patients), vascular hemodialysis catheter (2), IDC (1), and wound infection (1).
§ iv cannulation (2 patients).
‖ Urethrotomy (1 patient).

at the time of the study, most of our patients were male. Vertebral osteomyelitis does, however, have a male preponderance, with a male:female ratio as high as 2:1 [10, 13].

It is well recognized that there may be an inordinate delay between symptom onset and diagnosis of vertebral osteomyelitis [4, 14–17]. This fact has changed little over the past 50 years [1, 5, 11]. The results of this study compare favorably with those of other studies of vertebral osteomyelitis, with an average in-hospital diagnostic delay of 11 days. There were delays, however, in the period before hospital presentation.

The pathogenesis of vertebral osteomyelitis is relatively well understood [2, 7, 10–12, 18, 19]. The most common factors predisposing patients to vertebral osteomyelitis include diabetes mellitus [14, 16], immunocompromise [7], drug addiction [5], old age [4, 16], oral steroid therapy, dialysis [7], urinary tract infection or genitourinary tract instrumentation [14], antecedent bacteremia due to other causes, and previous back surgery [5]. Certainly in this study many of these factors were identified. None of our patients were diabetic or injection drug users, unlike patients in other studies [5, 14, 16, 20]. Although the genitourinary tract is usually cited as the major focus of infection [2, 4, 7, 13, 15], in our study it was the source of infection in only 15% of patients. Bacteremia secondary to intravenous cannulation was the predominant predisposing factor in 40% of our patients. In common with other studies, back pain was by far the most common presenting symptom [1, 4, 5, 7, 10, 13, 15, 16]. If spinal cord injury is present, pain may be blunted or absent [6], which occurred in two patients. Tenderness over the affected region is often reported [2, 5, 11, 19]. Pyrexia was not a prominent feature in our patients; only 30% had a fever. This finding is consistent with other studies that have described the presence of fever in 21%–50% of patients [10, 12, 14]. This finding also illustrates the fact that sepsis in the elderly may not be associated with fever [21]. Bacteremia may also have occurred some months earlier or may have been unrecognized [9].

The patients in this study underwent a great number of radiological investigations. Debate continues about the relative merits of radiological investigations for vertebral osteomyelitis. In our study, all results of plain radiography were abnormal; however, the abnormalities were often nonspecific, and infection, malignancy, and degenerative joint disease were not distinguished. Radiologically evident abnormalities take at least 10 days to appear [7, 22], often longer [3, 15, 22, 23]. Soft-tissue swelling is frequently the first radiological sign but can be subtle [13, 22]. Narrowing of disk space is also an early radiological finding but is nonspecific in the elderly.

The sensitivity of bone scanning for detecting inflammation is >90% [7, 10], and bone scanning is often positive within 24 hours of the onset of infection [23]. In our study bone scanning revealed abnormalities in 87% of patients who underwent this procedure. The specificity of bone scanning, however, is only about 78%, and it cannot reliably differentiate infection from malignancy or trauma. Combining this investigation with gallium scanning is said to provide greater specificity and sensitivity [10, 15, 20], but false-positive results of gallium scanning are also well recognized [20].

CT was found to be the most useful radiological investigation, as MRI was less readily available. CT has the additional advantage of playing a major role in the guidance of fine-needle biopsies for microbiological diagnoses [7]. CT frequently shows specific changes consistent with vertebral osteomyelitis and often (as in the majority of our patients) shows destruction of the end plates and adjacent vertebral bodies as well as soft-tissue swelling. Follow-up CT is very useful in monitoring a patient's progress and usually shows increasing bone density and diminution of soft-tissue swelling if treatment is successful [6].

Although CT may be superior to MRI in demonstrating bone cortex [23], MRI is reported to have a sensitivity of at least 96% and a specificity of 93% in detecting vertebral osteomyelitis [3, 7, 15, 16, 23, 24] and can detect early soft-tissue inflammation well before destructive bony changes occur [23]. This ability to detect early inflammation is evidenced by the fact that MRI of all five patients revealed soft-tissue collections; CT of two of these patients did not show the collection. The vertebral regions most affected by osteomyelitis in this study were, in decreasing order of frequency, lumbar, thoracic, and cervical; this distribution is similar to that reported in other studies [3, 10, 17].

Twelve patients (60%) had elevated WBC counts at presentation; these counts varied widely. The ESR was elevated in 95% of patients. All patients who had their CRP level measured had an increased concentration. The ESR is very sensitive for detecting vertebral osteomyelitis [1, 15], and it is more helpful than the WBC count in the evaluation and monitoring of patients [1, 2, 4, 14, 19]. In the majority of studies, including ours, the average ESR ranged from 80 to 90 mm/h [1, 14]. The CRP level may be more specific and may decrease more rapidly in association with treatment than the ESR.

In the absence of a positive blood culture, a bone biopsy is critical for the diagnosis of vertebral osteomyelitis and for appropriate therapy. The results of bone biopsy may be negative for various reasons, including sampling error and prior antibiotic therapy. Twenty-seven percent of bone biopsies in our study were negative; this finding is not unusual [10]. Hence, both blood and bone cultures are important in providing a microbiological diagnosis. In one review [10], 24% of patients had positive blood cultures. In our study, 50% of patients were bacteremic. This finding probably relates to the high rate of intravenous cannula–related sepsis predisposing patients to vertebral osteomyelitis. Vertebral infection is rarely polymicrobial, and it is reasonable to assume that a blood isolate is responsible for the bone infection [8,

10]. There are few data on the correlation between urine and bone isolates. All three of our patients who were thought to have a urinary source of sepsis responded to therapy directed against the urinary isolate.

In our study and in most investigations [1, 3, 5, 7, 10, 13–15, 17, 19, 23, 25], *S. aureus* was the most common infecting organism, followed by coagulase-negative staphylococci and gram-negative organisms (usually of urinary origin). Of the seven patients infected with MSSA, three (43%) were considered to have nosocomial infections; two of these infections were cannula-related. Of the six patients infected with MRSA, all had nosocomial infections; four patients had documented bacteremia, and four infections were cannula-related (table 5).

There are few reports of MRSA vertebral osteomyelitis in the literature. When MRSA osteomyelitis is reported, it is usually an uncommon complication contiguous to a site of trauma or orthopedic surgery [26]. In contrast, our patients with MRSA vertebral osteomyelitis had more iatrogenic complications of hematogenous seeding from cannula-related infection and instrumentation than from local surgery. During the study period, 48%–52% of all *S. aureus* isolates from wounds of hospital inpatients were MRSA. This finding has important therapeutic consequences.

Intravenous vancomycin may not penetrate bone adequately [27] and may not be an ideal drug for the treatment of osteomyelitis [26, 28]. Combination therapy with rifampin and intravenous vancomycin for MRSA osteomyelitis is based on studies of animal models that have shown that the combination sterilizes bone better than does vancomycin alone [29, 30]. However, vancomycin does not protect against the emergence of rifampin resistance [29, 30]. Following initial therapy with vancomycin, our therapeutic approach for vertebral osteomyelitis due to MRSA is prolonged oral therapy against the organisms, particularly with a combination of rifampin and fusidic acid. As combination oral therapy is relied upon for a successful outcome, the development of resistance limits the choice of oral antibiotics. Patients with MRSA vertebral osteomyelitis had the longest delay in diagnosis (average, 14 days), required the longest duration of hospitalization and intravenous therapy (average, 56 days), and had the most complicated treatment courses. The prolonged hospital stay of patients with MRSA vertebral osteomyelitis imposes a greater reliance on effective infection-control measures to prevent secondary spread of MRSA.

It is difficult to draw conclusions about treatment for vertebral osteomyelitis from this study. The number of patients is small, and some patients who received what was considered inadequate initial intravenous therapy were cured. Conversely, others who had what was considered an appropriate amount of initial intravenous therapy relapsed. The recommended duration of intravenous antibiotic therapy for vertebral osteomyelitis varies greatly in the literature [1, 4, 10, 14]. It is generally agreed that intravenous therapy for at least 4 weeks is optimal [7, 10, 15]. The ESR may be predictive of response, and the initial value should decrease by one-third after a 4-week course of intravenous therapy. If the ESR is persistently elevated, it is suggested that parenteral therapy should be continued for a minimum of 2 weeks [6]. However, the interpretation of the ESR in the elderly may be confounded by the patient's concurrent medical problems.

The contribution of subsequent therapy with oral antibiotics is controversial [5, 15]. We recommend administering oral antibiotics for a minimum of 3 months, but depending on clinical, radiological, and serological improvement in the patient's condition, the duration of this therapy is usually longer. Some investigators [1, 5, 12] believe that if parenteral therapy is given for 6–8 weeks, subsequent therapy with oral antibiotics is not required. The populations studied by these investigators, however, included children and injection drug users. Appropriate treatment of these patient groups may differ from that of elderly patients who may have a slower onset of infection, a more established infection at diagnosis, and a more compromised vascular supply. Bed rest and immobilization with a brace were previously thought to be important [2, 4, 6, 10, 14, 17], but these treatments are now rarely recommended [5, 11, 15, 19, 25]. Surgery is used primarily for the complications of vertebral osteomyelitis (e.g., paraspinal or epidural abscess and progressive paraplegia) [7, 10, 11]. Paraplegia complicates vertebral osteomyelitis in 4.5%–13% of cases [3, 7]. One (5%) of our patients had complete paraplegia, and three patients required surgical decompression and drainage.

The outcome of uncomplicated vertebral osteomyelitis is mostly good [2, 4]. The majority of patients in this study recovered fully. There was one death (due to septicemia), and three patients (15%) had relapses. This relapse rate is consistent with those varying from 3% to 40% [4, 8, 13]. In two of three patients with relapses, the infecting organism was MRSA. Vancomycin may be less effective than β-lactam drugs because the levels and bactericidal activity it achieves in bone may vary [27, 28].

Other complications of bacteremia need to be considered in patients with hematogenous vertebral osteomyelitis. In this study four patients (20%) had other metastatic complications. Two of these patients had *S. aureus* infections. Overall, complications occur in 20%–30% of all cases of *S. aureus* bacteremia; these complications are predominantly bone and joint infections, soft-tissue abscesses, and endocarditis [31–34]. Approximately 60%–87% of cases of *S. aureus* bacteremia are hospital acquired, and most are cannula related [31–33]. Important factors in preventing complications include rapid recognition and removal of the infected cannula and the early institution of antibiotic therapy. The optimal duration of antibiotic therapy for preventing metastatic com-

plications is controversial but should probably be at least 10 days [32, 34].

Conclusions

At Concord Repatriation General Hospital, vertebral osteomyelitis has been recognized most commonly as a complication of staphylococcal bacteremia. The infection was nosocomial in 60% of the patients (secondary to cannulation, instrumentation, or surgery) and thus was potentially preventable. The use of intravenous cannulae and central venous catheters is widespread in the hospital setting, and iatrogenic complications of cannulation or catheterization add to patient morbidity and length of hospital stay. Relevant issues of vertebral osteomyelitis include the following: prevention of cannula-related sepsis by the institution of effective cannulation protocols; prevention of metastatic complications of bacteremia by adequate antimicrobial therapy; and attempts at reducing or preventing MRSA colonization. In many hospitals MRSA is endemic and should be a priority of infection control.

Vertebral osteomyelitis is an important diagnosis to consider for patients who present with back pain and an elevated ESR. Fever may be absent in patients with vertebral osteomyelitis, particularly in the elderly. A history of bacteremia, cannula-related infection, or urinary tract infection should be actively sought. Bone biopsy is the most definitive way of diagnosing vertebral osteomyelitis because it provides tissue both for culture and for histologic examination. The optimal radiological investigations, the optimal duration of parenteral therapy, and the role of subsequent oral therapy for vertebral osteomyelitis are still unknown. Nuclear scanning is of use in excluding the presence of established osteomyelitis but is not diagnostic; thus, this procedure was of limited benefit. CT provides more anatomic detail, is more specific, and can be used to guide fine-needle biopsies and to monitor a patient's progress. MRI is very sensitive and specific but is less readily available.

The documented experience with the management of vertebral osteomyelitis in the elderly is small. The initial therapy for vertebral osteomyelitis should be with appropriate parenteral antibiotics for a minimum of 4 weeks. Vancomycin, with or without rifampin, is currently the parenteral antibiotic of choice for the treatment of MRSA infections. In addition, we have used subsequent oral therapy with rifampin and either fusidic acid or ciprofloxacin for several months. This therapeutic approach may become more difficult because of the increasing emergence of resistance to rifampin and the fluoroquinolones.

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