

Focal Infections Due to Non-*typhi* *Salmonella* in Patients with AIDS: Report of 10 Cases and Review

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Bacteremia due to non-*typhi* *Salmonella* is frequent in human immunodeficiency virus (HIV)-infected patients; however, focal complications rarely have been reported. Ten of 38 HIV-infected patients (26.3%) with salmonellosis documented over a period of 9 years had focal suppurative complications; only 19 (3.9%) of 490 adults without HIV infection who were seen during the same period had focal complications ($P = .001$). Infections of the urinary tract, lungs, and soft tissue, followed by arthritis, endocarditis, and meningitis were most frequently seen. Although salmonellosis occasionally heralded HIV infection, most patients were severely immunocompromised and had CD4 cell counts of $<100/\text{mm}^3$. The mortality rate was 50%, equivalent to that observed among patients with other immunosuppressive disorders (52.6%). Major emphasis must be put on intensive therapy for salmonella bacteremia and prevention of its complications.

Disseminated infections with non-*typhi* *Salmonella* were recognized early in the HIV epidemic. Individuals infected with HIV have been shown to have a risk at least 20 times higher than that among the general population of acquiring salmonella infections, and bloodstream invasion is 100 times more prevalent in HIV-infected patients than in immunocompetent ones [1–3]. Bacteremia is the most common manifestation of salmonellosis in these patients, and when recurrent it is considered an AIDS-defining illness [4–9]. On the other hand, bacteremia occurs in $<5\%$ – 10% of immunocompetent individuals with gastroenteritis [10, 11].

Despite this high rate of salmonella bacteremia in HIV-infected patients, focal or suppurative infections have been rarely described. Single case reports of infection of the urinary tract [12], lungs [13], bones and joints [14, 15], vascular system [16], CNS [17], abdominal cavity [18], and soft tissue [19] have been published. However, a comprehensive review on the spectrum of the focal manifestations of salmonella infection in HIV-infected patients has not been published. We describe herein 10 such cases and report on an extensive review of the English- and Spanish-language literature.

Patients and Methods

We reviewed the bacteriologic records of all patients admitted to a 700-bed teaching hospital from January 1987 to September 1995 from whom non-*typhi* *Salmonella* was isolated. A brief medical history was obtained at the time of diagnosis

as part of a system of communication to local health authorities. For patients with bacteremia or focal infection and with risk factors for HIV infection, blood tests (ELISAs) for antibodies to HIV were performed.

Patients were considered to have a focal infection when clinical, radiological, or pathological evidence was attained in conjunction with the isolation of non-*typhi* *Salmonella* from blood and/or the involved anatomic site. The clinical charts of HIV-infected patients with nontyphoidal salmonellosis were retrospectively reviewed. All these patients had been seen by one or more of the authors. In addition, we conducted a comprehensive analysis of articles and reports published in the literature from January 1983 through May 1995 by means of a computerized search of the MEDLINE database.

The χ^2 test was used for statistical analyses. $P \leq .05$ (two-sided) was considered statistically significant.

Results

Seven-hundred and forty-three patients with nontyphoidal salmonellosis were seen during the study period; 38 patients were infected by HIV. Ten of these 38 patients (26.3%) had a focal complication involving the urinary tract (3 cases), lungs (2), joints (1), meninges (1), vascular system (1), soft tissue (1), and muscles (1). None of these patients had had an episode of salmonellosis, and none were receiving prophylaxis for *Pneumocystis* pneumonia with trimethoprim-sulfamethoxazole.

The mortality associated with focal salmonella infection was 50% (table 1). In the 490 episodes of nontyphoidal salmonellosis in adults in whom HIV infection had not been documented or had been excluded by clinical criteria, only 19 cases of focal infection (3.9%) were identified ($P = .001$). These infections involved the lungs (4), urinary tract (3), bones and joints (3), spleen (2), CNS (1), and cardiovascular system (6). Only patients with endocarditis or aortitis caused by a *Salmonella* species were immunocompetent hosts. The rest of the

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Table 1. Clinical and epidemiological findings in patients with focal infections due to non-typhi *Salmonella*.

Patient no.	Age (y)/sex	HIV infection risk factor	CD4 cell count (/mm ³)	<i>Salmonella</i> strain	Source	Clinical manifestation	Treatment	Outcome
1	34/M	Homosexual	127	<i>typhimurium</i>	Blood, urine	Pyelonephritis	Ciprofloxacin	Cured
2	21/M	IDVA	ND	<i>enteritidis</i>	Urine	Cystitis	Cefotaxime	Cured
3	44/M	Homosexual	46	Group B	Urine	Cystitis	Ciprofloxacin	Died
4	27/M	IVDA	187	<i>enteritidis</i>	Blood, sputum, pleural fluid, abscess, stool	Lung abscess, empyema	Ampicillin	Died
5	39/M	Homosexual	487	<i>enteritidis</i>	Pleural fluid	Empyema	Cotrimoxazole	Died
6	40/M	Homosexual	30	<i>enteritidis</i>	Blood	Arthritis of hip	Ampicillin, drainage	Loss of motion
7	64/M	Homosexual	242	<i>enteritidis</i>	Blood	Endocarditis, mitral valve	Ofloxacin	Cured
8	34/F	IVDA	162	<i>choleraesuis</i>	Blood, CSF	Meningitis	Ampicillin, cefotaxime	Died
9	28/M	IVDA	95	<i>enteritidis</i>	Blood, abscess	Cutaneous abscesses	Amoxicillin/clavulanate	Cured
10	27/M	IVDA	ND	<i>enteritidis</i>	Blood, muscle	Pyomyositis	Cefazolin, gentamicin, drainage	Died

NOTE. IVDA = intravenous drug abuser; ND = not determined.

patients were immunosuppressed by hematologic malignancies (5), solid cancer (3), collagen vascular disease (3), transplantation (1), or diabetes mellitus (1). Mortality associated with focal salmonella infection in this group of patients was 52.6% (table 2). The outstanding characteristics of focal infections due to salmonellae in HIV-infected patients previously described in the literature are summarized in table 3.

Case Reports

Case 1. A 34-year-old homosexual man was admitted to the hospital because he had had fever, dysuria, and flank pain for the previous 7 days. He was febrile, and the left costovertebral area was tender on deep pressure. The leukocyte count was 8,300/mm³, and the CD4⁺ cell count was 127/mm³. An ELISA for antibodies against HIV was positive. The urinary sediment revealed pyuria, and *Salmonella typhimurium* resistant to ampicillin was isolated in cultures of the urine. Blood cultures also yielded *S. typhimurium*.

Table 2. Mortality associated with focal infections caused by non-typhi *Salmonella* in patients with and without AIDS.

Type of infection	No. of patients (%) who died/ total no. of patients	
	AIDS	Other conditions
Osteoarticular	0/1	3/3 (100)
Urinary tract	1/3 (33)	1/3 (33)
Pleuropulmonary	2/2 (100)	4/4 (100)
CNS	1/1 (100)	1/1 (100)
Cardiovascular	0/1	1/6 (16.6)

He was treated with ciprofloxacin (250 mg b.i.d.) and became asymptomatic within 1 day of treatment. Treatment was extended over 2 weeks, and no relapse was seen during a follow-up of 6 months.

Case 2. A 31-year-old male intravenous drug abuser (IVDA) with HIV infection and tuberculosis was admitted because of 5 days of dyspnea and fever. He also had dysuria for 1 month. The chest radiograph revealed a left-lower-lobe infiltrate. The urinary sediment showed pyuria, and *Salmonella enteritidis* was isolated in cultures of the urine. Treatment with cefotaxime was started and the fever subsided, but he left the hospital against medical advice 4 days later. He died 3 months later of pneumonia due to *Pneumocystis carinii*.

Case 3. A 44-year-old homosexual man with HIV infection and hepatic cirrhosis was admitted because of urgency, dysuria, and suprapubic pain. On examination he was febrile and had hepatosplenomegaly. The hemoglobin level was 5 g/dL, the leukocyte count was 1,580/mm³, the CD4⁺ lymphocyte count was 46/mm³, and the platelet count was 12,000/mm³. The urinary sediment showed pyuria, and cultures of the urine yielded a *Salmonella* group B organism. Blood cultures were negative. He was treated with ciprofloxacin for 10 days, but he developed hepatic and renal failure and died on the twentieth day after admission.

Case 4. A 27-year-old male IVDA was brought to the emergency department because he had had fever, dyspnea, cough, and diarrhea for the previous 7 days. He was febrile and tachypneic. The leukocyte count was 4,200/mm³, and the CD4 cell count was 187/mm³. Tests for HIV antibodies were positive. A chest radiograph showed a left-lung abscess and pleural effusion. *S. enteritidis* was isolated from blood, sputum, pleural effusion, and stools. He was treated with intravenous ampicillin but developed acute respiratory failure and died on the 5th day after admission.

Table 3. Summary of characteristics of HIV-infected patients with focal infections due to non-*typhi* *Salmonella* who were previously reported in the literature.

Reference	Patient's age (y)/sex	HIV risk group	CD4 cell count (/mm ³)	<i>Salmonella</i> strain	Source(s) of organism	Clinical manifestation	Treatment	Outcome
[12]	41/M	IDVA	ND	<i>Salmonella</i> species	Blood, urine	Pyelonephritis	Ampicillin	Survived
[20]	33/M	Homosexual	ND	<i>typhimurium</i>	Blood, urine	Cystitis	ND	Relapsed
[14]	17/F	Heterosexual	17	Group B	Both knees	Arthritis	Ceftriaxone	Survived
[15]	35/F	IDVA	9	<i>typhimurium</i>	Bone, stool	Osteomyelitis of parietal bone	Ciprofloxacin, drainage	Survived
[21]	59/F	Hemophiliac	114	<i>Salmonella</i> species	Blood, stool, elbow	Arthritis	ND	Survived
[22]	39/M	Homosexual	ND	<i>enteritidis</i>	Acromioclavicular joint, bone	Arthritis, osteomyelitis of clavicle	Ciprofloxacin	Survived
[23]	ND/M	ND	ND	<i>enteritidis</i>	Joint	Arthritis	ND	ND
	34/F	ND	ND	<i>typhimurium</i>	Joint	Arthritis	ND	ND
[24]	20/M	Hemophiliac	400	Group D9	Left knee	Arthritis	Ampicillin	Limitation of motion
	49/M	Hemophiliac	300	Group D9	Blood, left knee	Arthritis	Ampicillin	Limitation of motion
[25]	66/M	Unknown	ND	<i>choleraesuis</i>	Blood, sternoclavicular joint	Arthritis	Cefoxitin, pefloxacin, cefotaxime	Survived
	17/F	Heterosexual	ND	<i>enteritidis</i>	Right wrist	Arthritis	Gentamicin	Died
[26]	26/F	Heterosexual	ND	<i>enteritidis</i>	Both knees	Arthritis	Ampicillin, cotrimoxazole	Limitation of motion
[27]	ND	ND	ND	Group B	Blood	Arthritis	Ofloxacin, gentamicin	ND
	ND	ND	ND	Group B	Blood	Arthritis	Ofloxacin, gentamicin	ND
[28]	27/M	IVDA	ND	<i>Salmonella</i> species	Bone, stool	Osteomyelitis of parietal bone	Ampicillin, drainage	Survived
[13]	29/M	IVDA	90	<i>enteritidis</i>	BAL fluid, sputum	Pneumonia	Ciprofloxacin	Survived
[29]	41/M	Homosexual	ND	<i>typhimurium</i>	Lung, stool	Pneumonia	Ampicillin	Died
	45/M	Homosexual	ND	<i>typhimurium</i>	Blood, stool, lung	Pneumonia	Cotrimoxazole, gentamicin	Died
	45/M	Homosexual	ND	<i>typhimurium</i>	Blood, stool, lung, liver, heart, kidney, brain	Multiple abscesses	Amoxicillin, cotrimoxazole	Died
[30]	49/M	ND	1	<i>enteritidis</i>	Blood, sputum, stool	Lung abscess	Ceftriaxone, chloramphenicol	Survived
[31]	40/M	IVDA	10	<i>typhimurium</i>	Blood, sputum, stool, BAL fluid	Lung abscess	Ciprofloxacin	Survived
[32]	28/M	IVDA	69	<i>typhimurium</i>	Blood, BAL fluid	Lung abscess	Amoxicillin	Survived
[16]	46/M	IVDA	142	<i>choleraesuis</i>	Blood	Endocarditis of tricuspid valve	Cephapirin, gentamicin, ceftriaxone, cotrimoxazole	Survived
[33]	51/F	Blood transfusions	ND	<i>typhimurium</i>	Blood	Endocarditis of aortic and mitral valve	Ampicillin, netilmicin	Recovered, survived
[34]	19/M	IDVA	ND	<i>Salmonella</i> species	Blood	Endocarditis of tricuspid valve	Penicillin, gentamicin, cephalosporin	Survived
[35]	64/M	Unknown	ND	<i>Salmonella</i> species	Blood, thrombus	Aortic aneurysm	Surgery, ciprofloxacin	Survived
[36]	40/M	ND	185	<i>enteritidis</i>	Blood, thrombus	Aortic aneurysm	Surgery, ceftazidime, amikacin	Survived
[37]	49/M	Bisexual	ND	Group D	Blood, thrombus	Aortic aneurysm	Surgery	Died
[38]	25/M	IVDA	ND	<i>typhimurium</i>	Blood, muscle	Myositis and humeral endarteritis	Excision, ciprofloxacin	Survived
[39]	29/M	ND	ND	<i>typhimurium</i>	Pericardial effusion	Suppurative pericarditis	Drainage	Died
[17]	34/F	ND	ND	<i>heidelberg</i>	Blood, CSF	Meningitis	Ampicillin, ceftazidime, gentamicin	Died
	42/M	IVDA	ND	<i>enteritidis</i>	Blood, CSF, kidney	Meningitis and renal abscess	Ampicillin, chloramphenicol, gentamicin	Died
	47/M	IVDA	ND	<i>enteritidis</i>	Blood, CSF, stool, brain abscess	Meningitis, cerebral abscess	Ampicillin, chloramphenicol, drainage	Relapsed, survived
[40]	42/M	Hemophiliac	ND	Group D	CSF	Meningitis	Chloramphenicol	Survived

Table 3. (Continued)

Reference	Patient's age (y)/sex	HIV risk group	CD4 cell count (/mm ³)	<i>Salmonella</i> strain	Source(s) of organism	Clinical manifestation	Treatment	Outcome
[41]	34/F	IVDA	ND	<i>Salmonella</i> species	Abscess	Brain abscess	Chloramphenicol, surgery	Died
[18]	49/M	IVDA	90	Group B	Blood, ascitic fluid	Spontaneous peritonitis	Cefoxitin, ampicillin	Survived
[39]	31/M	ND	ND	<i>typhimurium</i>	Small intestine	Abscess of small intestine	Chloramphenicol, drainage	Died
[42]	44/ND	ND	ND	Group D	Blood, abscess	Splenic abscess	Splenectomy	Survived
[43]	36/M	ND	ND	Group D	Blood, abscess	Splenic abscess	Splenectomy	Survived
[44]	29/M	Homosexual	ND	<i>typhimurium</i>	Abscess	Splenic abscess	Splenectomy	Survived
				<i>enteritidis</i>	Abscess	Splenic abscess	Splenectomy, ceftriaxone, ciprofloxacin	Survived
[45]	32/M	IVDA	ND	<i>typhimurium</i>	Blood	Liver abscess	Cefotaxime	Survived
[46]	31/F	ND	58	<i>enteritidis</i>	Blood, gallbladder fluid, urine	Cholecystitis	Ciprofloxacin, cholecystectomy	Survived
[6]	29/M	IVDA	ND	<i>enteritidis</i>	Blood, urine, abscess	Cutaneous abscess	Ampicillin	Survived
[19]	36/M	Homosexual	56	<i>typhimurium</i>	Abscess	Thoracic subcutaneous abscess	Amoxicillin, ofloxacin, drainage	Relapsed, died
[39]	18/F	ND	ND	<i>bonn</i>	Abscess	Abscess of psoas	Ampicillin, gentamicin	Relapsed
[47]	ND/ND	ND	ND	<i>enteritidis</i>	Abscess	Facial subcutaneous abscess	ND	ND
[48]	48/M	ND	260	<i>enteritidis</i>	Pus	Suppurative thyroiditis	Amoxicillin, drainage	Survived

NOTE. BAL = bronchoalveolar lavage; IVDA = intravenous drug abuser; ND = no data given or not determined.

Case 5. A 39-year-old homosexual man with AIDS and Kaposi's sarcoma was admitted because of fever, dyspnea, and pleuritic chest pain during the previous month. He was febrile and had rales and decreased breath sounds in the right lung. The leukocyte count was 5,900/mm³, and the CD4⁺ cell count was 487/mm³. A chest radiograph showed an infiltrate in the right lower lobe and pleural effusion. Thoracentesis revealed empyema, and culture samples yielded *S. enteritidis*. He was treated with chest tube drainage and parenteral cotrimoxazole for 15 days and became afebrile within 5 days of antimicrobial therapy. However, his condition deteriorated; he developed delirium and renal failure and died 20 days after admission.

Case 6. A 43-year-old homosexual man was admitted because of spiking fever during the previous week. He had a history of treatment with zidovudine for HIV infection. Examination findings were unremarkable except for oral candidiasis. Blood cultures were positive for *S. enteritidis*. He was treated with ciprofloxacin and the fever subsided. He was discharged while receiving oral quinolone therapy, but he discontinued treatment and was admitted 1 week later because of fever and pain in the left groin.

Examination showed a blocked hip with excruciating pain on mobilization. Blood cultures were again positive for *S. enteritidis*. The CD4⁺ cell count was 30/mm³. MRI studies showed fluid in the joint of the left hip and lytic lesions on the femoral head. Treatment with intravenous ampicillin was started, and open drainage of the joint was done after 10 days

of antimicrobial therapy. The synovial fluid was turbid and contained many polymorphonuclear leukocytes, but cultures were negative. He completed 6 weeks of antimicrobial therapy and was discharged while receiving oral therapy with ofloxacin every other day. Ten months later he was doing well but had not regained full motion of the joint.

Case 7. A 64-year-old homosexual man was admitted because of fever of 7 days' duration. On examination, enlargement of the liver and edema were noted. A systolic murmur was audible at the left parasternal border. The leukocyte count was 3,500/mm³, the CD4⁺ cell count was 242/mm³, the hemoglobin level was 5 g/dL, and the platelet count was 90,000/mm³. A chest radiograph revealed cardiomegaly. A bone marrow biopsy showed myeloid dysplasia. The patient was found to be HIV-positive.

All blood cultures performed during 3 consecutive days yielded *S. enteritidis*, which was resistant to ampicillin and susceptible to ofloxacin. Echocardiography showed a prolapse of the mitral valve and vegetations. He was treated with intravenous ofloxacin (400 mg/12 h), blood transfusions, and diuretics. Within 24 hours of the start of therapy, fever subsided. Treatment was continued for 4 weeks, and he was discharged while receiving oral ofloxacin (200 mg b.i.d., for 3 months). Although the endocarditis did not relapse, he suddenly died 6 months later because of hematemesis.

Case 8. A 34-year-old woman with HIV infection who was a former IVDA was admitted because of fever and chills that

had lasted 24 hours. Her CD4 lymphocyte count was $162/\text{mm}^3$ 1 year before admission. The examination revealed fever and enlargement of the liver and spleen. The hemoglobin level was 10.7 g/dL, the leukocyte count was $2,000/\text{mm}^3$, the platelet count was $80,000/\text{mm}^3$, and the serum creatinine concentration was 1.4 mg/dL. After 12 hours of hospitalization she developed stupor, stiffness of the neck, and mucocutaneous hemorrhage. The patient was anuric, had a systolic blood pressure of 50 mm Hg, and developed renal failure. The CSF contained 40 leukocytes/mL and 75 mg of proteins per dL.

Gram staining showed many gram-negative rods. Treatment with dopamine, fluids, and a combination of cefotaxime and ampicillin was started. Her condition deteriorated and she died 24 hours after admission. *Salmonella choleraesuis* was isolated from blood and CSF.

Case 9. A 28-year-old male IVDA with HIV infection was admitted because he had had a fever for the previous few days. He was cachectic. Enlargement of the liver and cutaneous abscesses in his arms and legs were noted. The leukocyte count was $1,600/\text{mm}^3$, the hemoglobin level was 6.1 g/dL, and the CD4⁺ cell count was $95/\text{mm}^3$. Cultures of the cutaneous abscesses yielded *S. enteritidis*, *Staphylococcus aureus*, and anaerobic microorganisms. *S. enteritidis* was also isolated in blood cultures. Treatment with intravenous amoxicillin/clavulanate was started. He had an uneventful course, with resolution of the abscesses. He was followed up for 9 months without relapse.

Case 10. A 27-year-old male IVDA with AIDS was admitted because of having a cough and diarrhea for 3 days. He was febrile and had oropharyngeal candidiasis and a painful swelling in the left lumbar area. The hemoglobin level was 7.6 g/dL and the leukocyte count was $3,260/\text{mm}^3$, with 20% lymphocytic cells. A CT scan showed a lumbar abscess in the paravertebral muscle. It was drained, and cultures of the purulent fluid yielded *S. enteritidis* and *S. aureus*. Blood cultures were also positive for *S. enteritidis*. He was treated with cefazolin and gentamicin, but his clinical condition deteriorated and he died 48 hours after admission.

Discussion

HIV infection causes serious impairment in T cell function and macrophage phagocytosis that predisposes to infection by bacteria such as *Salmonella* species that depend on cell-mediated immunity for eradication [49, 50]. Abnormalities in B cells and in HIV-infected monocytes and macrophages may also play a role in the development of *Salmonella* infections [51]. Alterations in local intestinal mucosal immunity with decreased numbers of lymphocytes and IgA-secreting plasma cells may contribute to systemic spread of salmonellae from the gut [52].

Although both trimethoprim-sulfamethoxazole and zidovudine have some antibacterial effect on salmonellae, there is no evidence of a decrease in the prevalence of infections caused

by nontyphoidal salmonellae, which still cause considerable morbidity among HIV-infected patients [2, 3]. As shown by this series, focal salmonella infection also causes considerable mortality.

Focal infections caused by non-typhi *Salmonella* may involve any organ system [53, 54]. In the general population, suppurative complications have been recognized in 7%–10% of all cases of salmonellosis [53, 54]. However, our findings show that focal infections account for one-quarter of cases of salmonellosis affecting HIV-infected patients; this is a much more common occurrence than previously reported and equivalent to that seen in other immunocompromised hosts, such as renal transplant recipients or patients with systemic lupus erythematosus who have systemic salmonellosis [55, 56].

After the stool and blood, urine is the third most frequent clinical specimen from which nontyphoidal salmonellae are isolated [5]. The isolation of salmonellae from urine may be the consequence of perineal contamination as well as of asymptomatic excretion in patients with bacteremia [57–59]. Salmonellae have been found in the urine in up to 16% of cases of bacteremia in HIV-infected patients, but only a few cases were symptomatic infections [60–62].

Cystitis, pyelonephritis, and renal abscesses caused by non-typhi *Salmonella* have been noted in HIV-infected patients [20, 29, 62]. Renal stones and urinary obstruction are major factors in the development of salmonella infection of the urinary tract in immunocompromised hosts [57, 63]. However, none of our cases or of those previously reported involved abnormalities predisposing to infection; most cases were easily cured, and chronic or recurrent infections did not occur in patients with AIDS.

Pleuropulmonary infections caused by non-typhi *Salmonella* were occasionally described in the era before AIDS [63–65]. Three clinical presentations in HIV-positive patients have been described: pulmonary abscess, lobar pneumonia, and empyema [30–32, 66, 67]. Diagnosis is based on the isolation of salmonellae in blood cultures, simultaneous with the presence of radiographic abnormalities, or better yet, isolation of salmonellae directly from pulmonary specimens. Diagnosis based on blood cultures alone may lead to overdiagnosis.

Roca et al. [61] have documented radiographic abnormalities in 20 of 36 HIV-positive patients with bacteremia due to non-typhi *Salmonella*. These authors performed bronchoalveolar lavage and transthoracic fine-needle aspiration on their patients, but the cause of the lung infiltrate was determined in only 11 cases. It is noteworthy that all these patients had pathogens other than salmonellae isolated. For these reasons, we believe that the diagnosis of pleuropulmonary disease caused by salmonellae should be confirmed by isolation of the microorganisms from respiratory specimens.

The bones and joints are commonly involved in systemic salmonellosis [53, 54]. These infections occur in compromised hosts and in patients with hemoglobinopathies [68]. In HIV-infected patients, arthritis due to *Salmonella* species seems to be more common than osteomyelitis [25–28]. In one study

[68], joint infection presented as acute monoarticular or oligoarticular arthritis and did not differ from that seen in individuals without HIV infection [69]. The joint most frequently affected was the knee. Remarkably, three of eight cases reported involved hemophiliacs, a group particularly prone to develop arthritis due to salmonellae [21, 24].

At least three cases of osteomyelitis due to salmonellae in HIV-infected patients have also been reported in the literature [11, 22, 28]. In two cases, salmonellae involved the parietal bone, a location rarely infected in the general population.

Nontyphoidal salmonellae are well-known for their propensity to attach to abnormal vascular walls and diseased valves [70, 71]. To the best of our knowledge, reports of only four cases of endocarditis due to non-*typhi* *Salmonella* in patients with HIV infection have been published [16, 33, 34, 72]. This topic has been the subject of a recent report [73]. In addition, three cases of aortitis with aneurysm formation in HIV-infected patients have been reported so far [35, 37]. Fever and backache were the most common clinical signs. All the patients underwent emergency surgery because of impending rupture of the aneurysms and recovered fully with antimicrobial treatment. A case of endarteritis of the humeral artery in a drug abuser with HIV infection has also been reported [38].

Meningitis due to non-*typhi* *Salmonella* has been most commonly found in infants and the elderly [53, 74]. It is associated with frequent complications and a high mortality rate. Reports on five cases of salmonella meningitis in HIV-infected patients have been published [17, 39, 40]. Fever and obtundation were the most common features, and diarrhea was observed in two of five cases. One patient had two relapses, followed by the formation of a brain abscess [17]. Another patient had polymicrobial meningitis caused by *Salmonella* species and *Cryptococcus neoformans* [40]. The outcome was poor, and 67% of the patients died.

Focal intracranial infections are unusual manifestations of salmonellosis [75]. Brain abscess was noted at the autopsy of one HIV-positive patient [29]. There have been at least four other reports of HIV-infected patients with brain abscess due to non-*typhi* *Salmonella* [17, 41, 76]. In two cases, *S. enteritidis* was found simultaneously with *Nocardia asteroides* [41].

Salmonella infections of the abdominal cavity in patients with AIDS have been described as multiple or solitary splenic abscess, liver abscess, cholecystitis, spontaneous peritonitis, and colonic and small intestine abscess [29, 39, 42–46]. Fortunately, the prognosis seemed to be good, and only one of these patients died [29].

Soft-tissue infection is uncommonly seen in cases of salmonellosis [53]. The spectrum of the infection in patients with AIDS includes abscess at the site of intravenous injection (in drug abusers), abscess of the psoas muscle, and myositis [38, 39, 47, 77]. Suppurative lymphadenitis and thyroiditis have also been described [48, 60].

From the present series and the review of the literature it is clear that salmonellosis is an important cause of morbidity

among patients with AIDS and that the mortality rate among patients with focal complications is high, in the order of 30%. The mortality rate was particularly disturbing for patients with meningitis. Accordingly, major emphasis must be put on prevention of and intensive therapy for salmonella bacteremia.

Health care providers should advise HIV-infected patients not to eat raw or undercooked eggs, poultry, meat, or seafood and unpasteurized dairy products. In cases of travel to countries with poor sanitary conditions, in which prophylaxis is deemed necessary, the use of fluoroquinolones can be considered. Rapid detection of salmonella bacteremia and selection of an effective antimicrobial drug seem paramount to prevention of metastatic complications.

The emergence of resistance to ampicillin and other compounds in strains of non-*typhi* *Salmonella* has complicated the choices for therapy. In some geographic areas 30%–45% of isolates were resistant to ampicillin [78], and although it is still rare, resistance to third-generation cephalosporins and fluoroquinolones has also been reported [79, 80].

Initial therapy should include intravenous administration of a third-generation cephalosporin until susceptibility tests are determined, and then a switch to ampicillin can be made if indicated [81]. When the systemic toxicity subsides, therapy should be continued orally for at least 2 additional weeks. Long-term suppressive therapy for all HIV-infected patients with recurrent salmonella bacteremia is indicated, although with the caveat that resistance may emerge. The fluoroquinolones are compounds easily administered and well tolerated and have been recommended to reduce relapses of bacteremia [82].

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