Aeromonas Bacteremia: Review of 59 Episodes

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Fifty-nine episodes of bacteremia due to *Aeromonas* species occurred within a 5-year period in one medical center in southern Taiwan. Underlying diseases in the 58 patients included hepatic cirrhosis (36%) and cancer (24%). Patients with aeromonas bacteremia more often had underlying hepatic cirrhosis than did those with bacteremia due to other gram-negative bacilli. Males (67%) outnumbered females. The cases appeared to cluster in the summer and fall months. Thirty-two percent were polymicrobial infections; often the *Aeromonas* pathogens were accompanied by other gram-negative bacilli. *Aeromonas hydrophila* was the most common species isolated (69%). In addition to fever, hypotension and jaundice were the common clinical manifestations of aeromonas sepsis. In cirrhotic patients, spontaneous bacterial peritonitis, altered mental status, and jaundice were most common, and aeromonas bacteremia in such patients was monomicrobial and community-acquired more often than in noncirrhotic patients. In vitro aeromonads were generally susceptible to aminoglycosides, cefuroxime, the third-generation cephalosporins, and quinolones. The overall crude fatality rate was 36%. Predictors of fatal outcome for cirrhotic patients included spontaneous bacterial peritonitis, hypotension on admission, diabetes mellitus, and high Pugh scores.

Aeromonas species are gram-negative bacilli with positive catalase and oxidase reactions [1, 2] and are of worldwide distribution; they can cause disease in fish, reptiles, and amphibians [1]. The bacteria have been isolated from fresh water, brackish water, tap water, soil, and nonfecal organic materials [3, 4]. Formerly, aeromonads were believed to be opportunistic pathogens of low virulence. Patients with aeromonas bacteremia have been reported infrequently in the literature, and cases of bacteremia due to *Aeromonas sobria* or *Aeromonas caviae* have been rarely described. We report the clinical characteristics and prognostic factors in 58 cases of aeromonas bacteremia; to our knowledge, our series of 59 episodes is the largest described to date.

Materials and Methods

Gram-negative bacilli obtained from one or more blood culture bottles were identified as *Aeromonas* species on the basis of the following findings: positive oxidase reaction, no growth on thiosulfate-citrate-bile-sucrose agar, growth on MacConkey agar, and resistance to the vibriostatic compound O/129 [2]. Biochemical profiles with the Vitek GNI system (Vitek Systems, Hazelwood, MO) or API-20E system (Analytab Products, Plainview, NY) were utilized for identification of bacilli to the species level. The Kirby-Bauer disk-diffusion method was used for in vitro antibiotic susceptibility testing. Antibiotics tested included tetracycline, chloramphenicol, aminoglycosides, ampicillin, several cephalosporins, and norfloxacin. Medical records from all cases of aeromonas bacteremia occurring during the period of February 1989 to December 1993 in the National Cheng Kung University Hospital (NCKUH; Taiwan) were reviewed, but this analysis excluded two pediatric cases and one other case for which the information in the medical records was insufficient.

Spontaneous bacterial peritonitis in patients with cirrhosis and ascites was defined by (1) the presence of ascitic fluid (total leukocyte count of $>1{,}000/mm^3$ or neutrophil count of $>500/mm^3$) or bacteria in a gram-stained smear or (2) bacterial growth in culture [5]. The Pugh score [6] was used to evaluate the degree of hepatic decompensation in patients with hepatic cirrhosis. Episodes of bacteremia beginning at least 72 hours after admission (in patients who had no evident infection on admission) were categorized as nosocomial; other, true episodes of bacteremia (i.e., those associated with clinical symptoms and signs of sepsis and not to be interpreted as being caused by contamination during the sampling of blood for culture) were categorized as community-acquired. For statistical evaluation we used the χ^2 test and Fisher's exact test for binary data and the Student's *t*-test for continuous scaled data; $P < .05$ was considered significant.

Results

Fifty-nine episodes of aeromonas bacteremia in 58 patients were reviewed; one patient had a recurrence of *Aeromonas hydrophila* bacteremia. There was a predominance of

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male patients (67%). The mean age was 52 years (range, 18–84 years); 23 patients (40%) were aged ≥60 years. Most episodes clustered in the summer and early fall (from June to September: 27 [46%]). Aeromonas bacteremia developed in 18 patients (31%) during hospitalization. One of these 18 patients was transferred from a local hospital, and the original date of admission was not known; however, in most of the other cases (12 of 17; 71%) aeromonas sepsis developed after the first week of hospitalization. Aeromonas bacteremia developed in four patients in surgical wards: two had severe burns, one had undergone urethroplasty, and one had undergone abdominal surgery. Four episodes occurred in the medical oncology ward, seven in other medical wards, and two in the medical intensive care unit. One case of aeromonas sepsis developed in another hospital before referral. During the study period, *Aeromonas* species accounted for 1.6% (59) of all 3,737 episodes of bacteremia, 1.9% (18) of all 955 episodes of nosocomial bacteremia, 1.5% (41) of all 2,782 episodes of community-acquired bacteremia, 1.3% (59) of 4,414 blood isolates of gram-negative bacilli, and 31% (59) of all 189 Vibrionaceae family blood isolates. A total of 93,734 patients were discharged from the hospital during the 5-year period studied; thus, the number of episodes of aeromonas bacteremia per 1,000 discharges was 0.6. Only two patients with community-acquired bacteremia had occupations that had involved frequent contact with water and soil before their illness: one patient (with treated miliary tuberculosis) was a farmer of wetlands, and the other (a cirrhotic patient) raised fish in ponds.

Underlying Diseases

The underlying diseases of the patients are listed in table 1. Chronic hepatobiliary diseases (48%) were the most common: 21 patients (36%) had hepatic cirrhosis, either postnecrotic or alcoholic, of Pugh grade B or C [6]. In patients with bacteremia due to *Escherichia coli* or *Klebsiella* species, two of the most common gram-negative clinical isolates, hepatic cirrhosis is less common than in patients with aeromonas bacteremia, according to the incidence rates noted in investigations of bacteremia due to these pathogens: *E. coli*, 6% (54 of 843; $P < .01$) [7]; *Klebsiella* species, 14% (28 of 194; $P < .01$) [8]; and *Klebsiella pneumoniae*, 10% (9 of 90; $P < .01$) [9]. A similar finding was noted in a multicenter survey of bacteremia conducted by the Taiwan Blood Stream Infection Collaborative Study Group, which included NCKUH and eight other hospitals in Taiwan: in 1991, the proportion of cirrhotic patients among patients with bacteremia due to *Aeromonas* species was 45% (14 of 31); due to *E. coli*, 10% (86 of 872; $P < .01$, as compared with aeromonas bacteremia); due to *K. pneumoniae*, 17% (55 of 329; $P < .01$); due to *Enterobacter* species, 15% (16 of 108; $P < .01$); and due to *Pseudomonas aeruginosa*, 7% (11 of 153; $P < .01$). In the present study, neoplasms (except hepatoma) were present in 14 patients (24%) and were the second most common underlying disease.

Table 1. Underlying diseases and conditions in 58 patients with aeromonas bacteremia.

Underlying disease or condition	No. (%) of patients
Chronic liver disease	28 (48)
Hepatic cirrhosis	21
Cholelithiasis	5
Chronic hepatitis	2
Neoplasm	14 (24)
Lymphoma	2
Leukemia	4
Solid tumor	8
Lung cancer	2
Malignant thymoma	1
Cancer of papilla of Vater	1
Cholangiocarcinoma	3
Colon cancer	1
Diabetes mellitus	6 (10)
Respiratory failure	2 (3)
Uremia	2 (3)
Miliary tuberculosis	1 (2)
SLE* treated with steroids	1 (2)
Burn	2 (3)
Previous surgery	2 (3)

* Systemic lupus erythematosus.

Microorganisms

Among 60 *Aeromonas* strains isolated, 41 (68%) were *A. hydrophila*, 10 (17%) were *A. sobria*, and 6 (10%) were *A. caviae*. One patient had concomitant *A. hydrophila* and *A. sobria* bacteremia. Three strains could not be identified to the species level and were reported simply as *Aeromonas* species. Nineteen bacteremic episodes (32%) were polymicrobial, and the organisms that most frequently coexisted with the *Aeromonas* species were aerobic gram-negative bacilli: *E. coli* (4 cases), *Enterobacter* species (2 cases), *K. pneumoniae* (1 case), *Pseudomonas putrefaciens* (1 case), *E. coli* and *K. pneumoniae* (2 cases), *Enterobacter cloacae* and *K. pneumoniae* (2 cases), *K. pneumoniae* and a nonfermenting gram-negative bacillus (1 case), and *P. aeruginosa* and *Morganella morganii* (1 case). Three cases involved bacteremia associated with a gram-positive coccus (*Staphylococcus aureus* in two cases and an unidentified gram-positive coccus in the other). One patient had concurrent *Bacteroides thetaiotaomicron* bacteremia. Of six *A. caviae* bacteremic episodes, three (50%) were associated with polymicrobial infection, but this association was not more evident than in *A. hydrophila* (28%; 11 of 40) or *A. sobria* (56%; 5 of 9) bacteremias.

Clinical Features

Fever (71%), hypotension (61%), jaundice (53%), and chills (46%) were the most common manifestations of aero-

Table 2. Clinical manifestations of aeromonas bacteremia in 58 patients.

Manifestation	No. (%) of patients
Fever	42 (72)
Hypotension	36 (62)
Jaundice	31 (53)
Chills	27 (47)
Abdominal pain or tenderness	22 (38)
Altered consciousness	17 (29)
Acute renal failure	7 (12)
Disseminated intravascular coagulation	6 (10)
Dyspnea	3 (5)
Diarrhea	3 (5)
Adult respiratory distress syndrome	2 (3)

monas sepsis among the 59 episodes (table 2). Twenty-two patients had abdominal pain or tenderness, with or without rebound tenderness. Of these 22 patients, 11 cirrhotic patients had spontaneous bacterial peritonitis. Only three patients were noted to have diarrhea before admission to the hospital. Altered consciousness was noted in 17 cases, and in nine cases it was attributed to hepatic encephalopathy. Thirty-one patients (53%) had jaundice (total serum bilirubin concentration, >2 mg/dL), and 30 of 38 patients were hypoalbuminemic (serum albumin concentration, <3 g/dL).

Leukocytosis (total WBC count, >12,000/mm^3) was found in 16 cases. Eleven patients had leukopenia (total WBC count, <4,000/mm^3), and their underlying diseases were leukemia (3 patients), gastric lymphoma (1 patient), colon cancer with biliary involvement (1 patient), nongastrointestinal malignancy (2 patients), liver or biliary tract disease (3 patients), and renal disease (1 patient). Thrombocytopenia (platelet count, <100,000/mm^3), related to myelosuppression, splenomegaly, or sepsis, was found in 39 cases. In none of the cases was there evidence of ecthyma gangrenosum.

Foci of Concomitant Infection

Among 21 cirrhotic patients, 11 had spontaneous bacterial peritonitis. Their clinical characteristics are shown in table 3. Bacterial cultures of ascitic fluid were positive in eight cases, and in seven the fluid yielded the same *Aeromonas* species as did the blood. In one case *A. hydrophila* was isolated from blood, ascitic fluid, and urine. One leukemic patient and one uremic patient had aeromonas peritonitis, but it was unclear whether the peritonitis in the two cases was primary or secondary to other intraabdominal processes. Skin and soft-tissue infections were seen in 4 patients: 1 had an ulcer on the left big toe, with underlying osteomyelitis demonstrated on a bone scan, and 3 had rapidly progressive cellulitis and necrotizing fasciitis. Nosocomial pneumonia and bacteremia were noted in two intubated patients.

Treatment

Aminoglycosides, especially gentamicin (number of susceptible strains/number of tested strains: 54/55) and amikacin (54/54), were generally active in vitro, as were cefuroxime (21/21), the third-generation cephalosporins (ceftriaxone [29/36], cefotaxime [48/55], and ceftazidime [31/34]), chloramphenicol (45/55), and norfloxacin (21/21). Aeromonas isolates were usually resistant to ampicillin (1/55) and ampicillin/sulbactam (0/22) and not infrequently resistant to tetracycline (18/31), cephalothin (17/53), cefoxitin (25/53), and cefmetazole (11/19).

Of 59 episodes of aeromonas bacteremia, two culminated in death within 12 hours of the patients' admission; no antibiotics were administered to these patients. Ten patients were treated with antibiotics that were not tested for in vitro susceptibility and thus were excluded from evaluation of the efficacy of therapy. Effective therapy was defined as treatment with agents that were active in vitro against *Aeromonas* species for at least 48 hours following positive blood culture results. Effective monotherapy was administered with regimens of the following agents: an aminoglycoside (13 cases; gentamicin, tobramycin, netilmicin, or amikacin), cefotaxime (7 cases), ceftriaxone (1 case), cefuroxime (1 case), and ciprofloxacin (1 case). Effective combination therapy included the following agents: cefuroxime plus an aminoglycoside (7 cases), cefamandole plus an aminoglycoside (7 cases), cefotaxime plus an aminoglycoside (3 cases), cefoxitin plus an aminoglycoside (3 cases), ceftazidime plus an aminoglycoside (2 cases), and cefmetazole plus an aminoglycoside (1 case). There was no significant difference in the case fatality rate between the two groups (combination group, 29%; monotherapy group, 39%; OR, 1.6; 95% CI, 0.5–12; P = .34).

Fatality

Among 59 episodes of aeromonas bacteremia, the crude fatality rate was 36%. The case fatality rate was determined for two major patient groups: 41% (9 of 22) in the cirrhosis group and 36% (5 of 14) in the neoplasm group. Nineteen of these 21 patients died within 48 hours of the first positive blood culture result. Statistically significant associations were found between fatality and hypotension (systolic blood pressure, <90 mm Hg) and altered consciousness (table 4). The fatality rate among patients with nosocomial bacteremia was not significantly different from that among patients with community-acquired bacteremia. Of cirrhotic patients with aeromonas bacteremia, those who died were significantly more likely to have a higher Pugh score, be in shock on admission, and have diabetes mellitus and spontaneous bacterial peritonitis (table 5).

Table 3. Characteristics of 11 cirrhotic patients with aeromonas bacteremia and spontaneous bacterial peritonitis.

Patients age (y)/sex	Pugh score*	Blood culture isolate(s)	Ascitic fluid			Outcome
			Culture isolate(s)	PMNs	Gram stain finding	
40/F	12	*A. hydrophila*	NG	1,622	NA	Died
37/F	13	*A. hydrophila*	*A. hydrophila*	NA	Negative	Lived
53/M	13	*A. hydrophila*	NG	18,612	NA	Lived
58/M	15	*A. hydrophila, K. pneumoniae, UNFGNB*	*A. hydrophila, Proteus mirabilis*	26,970	GNB	Died
61/M	14	*A. hydrophila, E. coli*	*UNFGNB, E. coli*	7,031	NA	Died
39/M	15	*A. hydrophila*	NG	4,789	NA	Died
60/M	12	*A. hydrophila*	*A. hydrophila*	NA	Negative	Died
65/M	15	*A. hydrophila*	*A. hydrophila*	5,292	GNB	Died
45/M	12	*A. sobria, S. aureus*	*A. sobria*	17,363	NA	Lived
78/M	13	*A. sobria*	*A. sobria*	2,303	Negative	Died
42/M	12	*Aeromonas* species	*Aeromonas* species	12	NA	Died

NOTE. NG = no growth; NA = not available; UNFGNB = unidentified nonfermentative gram-negative bacillus; GNB = gram-negative bacilli.
* Used to evaluate the severity of hepatic decompensation on the basis of serum bilirubin and albumin concentration, presence of ascites, prothrombin time, and presence of encephalopathy [6].

Comparison of Cirrhotic and Noncirrhotic Patients

Aeromonas bacteremia in cirrhotic patients (vs. that in noncirrhotic ones) was significantly more likely to be monomicrobial (86% vs. 57%; OR, 4.8; 95% CI, 1.3–17.9; $P < .05$) and community-acquired (91% vs. 57%; OR, 7.6; 95% CI, 1.8–32.3; $P < .05$), and cirrhotic patients because jaundiced (91% vs. 30%; OR, 23.6; 95% CI, 6.1–91.9; $P < .001$) and had an alteration of consciousness (45% vs. 19%; OR, 3.57; 95% CI, 1.1–11.2; $P < .05$) significantly more frequently than did noncirrhotic patients. The frequency of fever, chills, abdominal pain, and hypotension was similar in the two groups.

Discussion

The spectrum of aeromonas infection in humans has expanded with the reports of associated acute gastroenteritis, cholecystitis, cholangitis, liver abscess [10, 11], pneumonia [12], empyema, meningitis [13], septic arthritis, osteomyelitis, endocarditis [4], myonecrosis [14], and necrotizing fasciitis [3]. Aeromonas bacteremia has occurred in both children [15] and adults [10, 12, 13, 16] and has been most often due to *A. hydrophila*, but bacteremia due to other *Aeromonas* species, usually *A. sobria* and *A. caviae*, has been infrequently described [17, 18]. Most patients have an underlying illness, such as chronic liver disease [2, 10, 11, 13, 18–20], a hematological neoplasm, a solid tumor [2, 4, 15–17, 20–24], or AIDS [24]. However, even healthy persons [12, 14, 25, 26] may acquire bacteremic infection due to an *Aeromonas* species.

Among environmental samples, motile aeromonads have been isolated from both chlorinated water [27–29] and fresh water [28]. In Taiwan, motile *Aeromonas* species were found in 88% of seafoods from the retail markets and supermarkets in Taipei [30], and their abundance in the biological surroundings were very likely to contribute to a higher incidence of aeromonas bacteremia in our country. Picard and Goullet isolated *A. hydrophila* in hospital water supplies [31] and noted that the high prevalence in summer of nosocomial *A. hydrophila* infections coincided with periods when the counts of *Aeromonas* species organisms in water from storage tanks and from the hospital water supply were high. We were unable to determine an environmental source of nosocomial infections at NCKUH because culture samples were not obtained from all suspected locations. Cultures of the hospital water and of the food that patients were sometimes given by their families should be considered in future epidemiological investigations.

Investigators studying 13 episodes of aeromonas bacteremia in New York [18] found that all but one patient acquired the infection in the community. In contrast, nearly one-third (31%) of our cases were nosocomial, a finding similar to that of another study, in which 50% of the bacteremic cases were nosocomial [20]. The reason for the striking epidemiological difference is not clear. We found a seasonal variation in occurrence of aeromonas infection similar to that described in other reports [3, 24, 27, 31, 32], with some clustering in the summer and fall seasons in Taiwan. This clustering may be related to an increasing frequency of contact with sea water or fresh water (because of more outdoor recreational activities) and to the floods resulting from typhoons in the hot season.

Aeromonads have been subclassified as three phenotypic entities: *A. hydrophila*, *A. sobria*, and *A. caviae*. In recent

Table 4. Factors related to fatality in cases of aeromonas bacteremia.

Factor	No. of fatalities/no. of episodes (%)	RR of death within each category*
Sex		
Male	14/39 (36)	1
Female	7/20 (37)	1
Age		
15–40 y	7/14 (50)	2.8
41–60 y	8/22 (36)	1.6
>60 y	6/23 (26)	1
Acquisition		
Hospital	5/18 (28)	1
Community	16/41 (39)	1.7
Polymicrobial infection	9/19 (47)	2.1
Monomicrobial infection	12/40 (30)	1
Causative organism†		
A. caviae	1/6 (17)	1
A. hydrophila	13/40 (33)	2.4
A. sobria	5/9 (56)	6.3
Aeromonas species	1/3 (33)	2.5
Hypotension		
Yes	21/32 (66)	102.8‡
No	0/27 (. . .)	1
Altered consciousness		
Yes	15/22 (68)	11‡
No	6/37 (16)	1
Major underlying illness		
Hepatic cirrhosis	9/22 (41)	1.2
Neoplasm	5/14 (36)	1
Diabetes mellitus	3/6 (50)	2.8

* Within each category the subdivision with the lowest fatality rate is arbitrarily assumed to have an OR of 1; while the value of one cell is zero, 0.5 is added to each cell of a two-by-two table for estimation of the RR.

† One episode of concurrent *A. hydrophila* and *A. sobria* sepsis was not included.

‡ $P < .001$.

taxonomic studies based on DNA-DNA hybridization investigations, researchers have recognized 13 hybridization groups [33]. Although it is possible to identify most aeromonads to the genospecies level (DNA group) [33, 34], 19–24 biochemical reactions are required, and this is not practical for most clinical laboratories. The different species have distinct biochemical properties that may be clinically significant [17]. Most enterotoxin-producing isolates have been either *A. hydrophila* or *A. sobria* [17, 18, 35]. *A. sobria* has been most frequently isolated from bacteremic patients and has been regarded as the most pathogenic in mice and the most invasive in tissue culture studies [17]. *A. caviae* bacteremia has been most often associated with polymicrobial infections, a finding suggesting that this species is less pathogenic [18]. Most reported infections have been caused by *A. hydrophila* [3, 32, 36]; indeed, in our series *A. hydrophila* was the most frequent species isolated, and the propensity of *A. caviae* bacteremia to be associated with polymicrobial infection was not more obvious than that of bacteremia caused by two other *Aeromonas* species. Further work on the relative virulence of different *Aeromonas* species in humans is needed.

Aeromonads were consistently susceptible in vitro to aminoglycosides. Among the cephalosporins, cefuroxime, ceftazidime, cefotaxime, and ceftriaxone were often active. The isolates were usually resistant to ampicillin, ampicillin/sulbactam and cephalothin. Reports from the United States [37] and Australia [38] demonstrated that *Aeromonas* species of human origin were uniformly susceptible in vitro to tetracycline; however, only 58% of our clinical isolates were susceptible. The quinolones have been found to be active in vitro against aeromonads [24, 32, 36], and ciprofloxacin has been proven to be effective in anecdotal cases of nonbacteremic aeromonas infection [24]. One of our cirrhotic patients was treated with intravenous ciprofloxacin for *A. hydrophila* bacteremia, and another patient (in a surgical ward) was treated with oral norfloxacin for *A. caviae* bacteremia. Both patients recovered. Clinical treatment of aeromonas sepsis with the quinolones should be evaluated further.

Clinically, the fulminant course of patients with aeromonas sepsis who die, even after the administration of one or two antibiotics with in vitro activity, is very impressive. Pending the advent of therapeutic agents with clinically proven efficacy, it would seem to be useful and cost-effective to prevent aeromonas infections in susceptible individuals, especially cirrhotic patients. One rational strategy would be to reduce the acquisition of *Aeromonas* species organisms by reducing or preventing the consumption of raw or undercooked foods and discouraging water-related recreational activities.

Kuo and his colleagues in northern Taiwan studied 228 episodes of all types of bacteremia in cirrhotic patients [39]. They found that among the isolates of gram-negative bacteria, *A. hydrophila* was the third most common pathogen causing bacteremia in these patients and that spontaneous bacterial peritonitis was the most common source of pathogens; in addition, the incidence of and mortality associated with bacteremia increased with the severity but not according to the etiology of hepatic cirrhosis. Our survey in southern Taiwan revealed similar results: among patients with aeromonas sepsis, hepatic cirrhosis (36%) was the most common underlying disease rather than neoplasm (24%), which in many reports [4, 17, 20, 22, 36] is described as the most common, and *A. hydrophila* was the most common *Aeromonas* species implicated in cirrhotic patients. Moreover, the underlying illness of hepatic cirrhosis was more common in patients with aeromonas bacteremia than in those with bacteremia due to *E. coli*, *K. pneumoniae*, *Enterobacter* species, or *P. aeruginosa*. Perhaps this distribution is related to the high prevalence of chronic liver disease in Taiwan, which in turn is linked to a large population of hepatitis B virus carriers, or perhaps it implies that cirrhotic patients are particularly susceptible to aeromonas infections. Much effort will be

Table 5. Correlation between clinical parameters and outcomes for cirrhotic patients with aeromonas bacteremia.

Parameter	Lived (n = 12)*	Died (n = 9)	P value (95% CI)
Age (y)	50.7 ± 4.3	56.3 ± 11.8	NS (−1.6–12.8)
Pugh score	11.3 ± 1.9	13.3 ± 1.5	<.05 (.5–3.5)
Serum bilirubin (mg/dL)	10.4 ± 9.9	12.7 ± 10.8	NS (−6.8–11.4)
Serum albumin (g/dL)	2 ± 0.7	2.3 ± 0.6	NS (−.3–.9)
Clinical finding (no. of patients)			
Diabetes mellitus	0	4	.02†
Shock of admission	7	9	.02†
Spontaneous bacterial peritonitis	3	8	.004†

* Thirteen episodes of bacteremia in 12 patients.
† Fisher's exact test.

required to clarify the interaction between hepatic cirrhosis and aeromonas infections.

According to our findings, patients with aeromonas sepsis are usually febrile (72%), often appear extremely ill, and may have hypotension (62%), jaundice (53%), and chills (47%) (table 2). Our patients' clinical manifestations were not specific enough for differentiation of their illness from sepsis due to other gram-negative bacilli sepsis, except in three cases in which severe soft-tissue infection occurred. Characteristically, multiple hemorrhagic bullous lesions occur in the trunk or extremity and rapidly evolve to extensive necrotizing fasciitis, and profound shock supervenes. However, such lesions are indistinguishable from those caused by *Vibrio vulnificus*, a not uncommon marine microorganism with a similar geographic distribution and seasonal variation in Taiwan [40].

In summary, aeromonads, although not common pathogens, caused notable rates of morbidity and mortality among immunocompetent and immunocompromised persons during the period we studied. In southern Taiwan, aeromonas bacteremia occurred most often in patients with hepatic cirrhosis. One-third of the cases of aeromonas bacteremia apparently occurred in the hospital, accounting for 1.9% of all nosocomial bacteremias in our hospital in the 5-year study period.

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References

1. McGowan JE Jr, Del Rio C. Other gram-negative bacilli. In: Mandell GL, Douglas RG Jr, Bennett JE, eds. Principles and practice of infectious diseases. 3rd ed. New York: Churchill Livingstone, **1990**:1782–93.
2. von Graevenitz A, Altwegg M. *Aeromonas* and *Plesiomonas*. In: Balows A, Hausler WJ Jr, Herrmann KL, Isenberg HD, Shadomy HJ, eds. Manual of clinical microbiology. 5th ed. Washington, DC: American Society for Microbiology, **1991**:396–401.
3. Gold WJ, Salit IE. *Aeromonas hydrophila* infections of skin and soft tissue: report of 11 cases and review. Clin Infect Dis **1993**; 16:69–74.
4. Davis WA II, Kane JG, Garagusi VF. Human aeromonas infections: a review of the literature and a case report of endocarditis. Medicine **1978**; 57:267–77.
5. Wilcox CM, Dismukes WE. Spontaneous bacterial peritonitis: a review of pathogenesis, diagnosis and treatment. Medicine **1987**; 66: 447–56.
6. Pugh RN, Murray-Lyon IM, Dawson JL, Pietroni MC, Williams R. Transection of the oesophagus for bleeding oesophageal varices. Br J Surg **1973**; 60:646–9.
7. Gransden WR, Eykyn SJ, Phillips I, Rowe B. Bacteremia due to *Escherichia coli:* a study of 861 episodes. Rev Infect Dis **1990**; 12:1008–18.
8. Watanakunakorn C, Jura J. *Klebsiella bacteremia:* a review of 196 episodes during a decade (1980–1989). Scand J Infect Dis **1991**; 23:399–405.
9. Wang LS, Lee FY, Cheng DL, Liu CY, Hinthorn DR, Jost PM. *Klebsiella pneumoniae* bacteremia: analysis of 100 episodes. J Formos Med Assoc **1990**; 89:756–63.
10. DeFronzo RA, Murray GF, Maddrey WC. Aeromonas septicemia from hepatobiliary disease. Am J Dig Dis **1973**; 18:323–31.
11. Kratzke RA, Golenbock DT. Pyomyositis and hepatic abscess in association with *Aeromonas hydrophila* sepsis. Am J Med **1987**; 83:347–9.
12. Reines HD, Cook FV. Pneumonia and bacteremia due to *Aeromonas hydrophila*. Chest **1981**; 80:264–7.
13. Ellison RT III, Mostow SR. Pyogenic meningitis manifesting during therapy for *Aeromonas hydrophila sepsis*. Arch Intern Med **1984**; 144:2078–9.
14. Heckerling PS, Stine TM, Pottage JC Jr, Levin S, Harris AA. *Aeromonas hydrophila* myonecrosis and gas gangrene in a nonimmunocompromised host. Arch Intern Med **1983**; 143:2005–7.
15. Pearson TA, Mitchell CA, Hughes WT. *Aeromonas hydrophila* septicemia. Am J Dis Child **1972**; 123:579–82.
16. Tapper ML, McCarthy LR, Mayo JB, Armstrong D. Recurrent aeromonas sepsis in a patient with leukemia. Am J Clin Pathol **1975**; 64:525–30.
17. Dryden M, Munro R. Aeromonas septicemia: relationship of species and clinical features. Pathology **1989**; 21:111–4.
18. Janda JM, Brenden R. Importance of *Aeromonas sobria* in *Aeromonas* bacteremia. J Infect Dis **1987**; 155:589–91.
19. Krovacek K, Conte M, Galderisi P, Morelli G, Postiglione A, Dumontet S. Fatal septicemia caused by *Aeromonas hydrophila* in a patient

with cirrhosis. Comp Immunol Microbiol Infect Dis **1993**; 16:267–72.
20. Lee LN, Luh KT, Hsieh WC. Bacteremia due to *Aeromonas hydrophila:* a report of 40 episodes. J Formos Med Assoc **1986**;85:123–32.
21. Harris RL, Fainstein V, Elting L, Hopfer RL, Bodey GP. Bacteremia caused by *Aeromonas* species in hospitalized cancer patients. Rev Infect Dis **1985**;7:314–20.
22. Wolff RL, Wiseman SL, Kitchens CS. *Aeromonas hydrophila* bacteremia in ambulatory immunocompromised hosts. Am J Med **1980**;68:238–42.
23. Ketover BP, Young LS, Armstrong D. Septicemia due to *Aeromonas hydrophila:* clinical and immunologic aspects. J Infect Dis **1973**;127:284–90.
24. Rolston KV, Zandvliet SE, Rodriguez S, Nguyen HT, Bodey GP. Spectrum of *Aeromonas* and *Plesiomonas* infections in patients with cancer and AIDS. Experientia **1991**;47:437–9.
25. Golik A, Leonov Y, Schlaeffer F, Gulskin I, Lewinsohn G. *Aeromonas* species bacteremia in nonimmunocompromised hosts: two case reports and a review of the literature. Isr J Med Sci **1990**;26:87–90.
26. Lynch JM, Tilson WR, Hodges GR, Barnes WG, Bopp WJ, Watanabe I. Nosocomial *Aeromonas hydrophila* cellulitis and bacteremia in a nonimmunocompromised patient. South Med J **1981**;74:901–2.
27. Burke V, Robinson J, Gracey M, Peterson D, Partridge K. Isolation of *Aeromonas hydrophila* from a metropolitan water supply: seasonal correlation with clinical isolates. Appl Environ Microbiol **1984**;48:361–6.
28. LeChevallier MW, Seidler RJ, Evans TM. Enumeration and characterization of standard plate count bacteria in chlorinated and raw water supplies. Appl Environ Microbiol **1980**;40:922–30.
29. Millership SE, Chattopadhyay B. *Aeromonas hydrophila* in chlorinated water supplies. J Hosp Infect **1985**;6:75–80.
30. Yaun SS, Lin LP. Isolation and characterization of *Aeromonas* from seafoods in Taipei. Chin J Microbiol Immunol **1993**;26:78–83.
31. Picard B, Goullet P. Seasonal prevalence of nosocomial *Aeromonas hydrophila* infection related to aeromonas in hospital water. J Hosp Infect **1987**;10:152–5.
32. Altwegg M, Geiss HK. *Aeromonas* as a human pathogen. Crit Rev Microbiol **1989**;16:253–86.
33. Abbott SL, Cheung WK, Kroske-Bystrom S, Malekzadeh T, Janda JM. Identification of *Aeromonas* strains to the genospecies level in the clinical laboratory. J Clin Microbiol **1992**;30:1262–6.
34. Altwegg M, Steigerwalt AG, Altwegg-Bissig R, Luthy-Hottenstein J, Brenner DJ. Biochemical identification of *Aeromonas* genospecies isolated from humans. J Clin Microbiol **1990**;28:258–64.
35. Turnbull PC, Lee JV, Miliotis MD, et al. Enterotoxin production in relation to taxonomic grouping and source of isolation of *Aeromonas* species. J Clin Microbiol **1984**;19:175–80.
36. Janda JM, Duffey PS. Mesophilic aeromonads in human disease: current taxonomy, laboratory identification, and infectious disease spectrum. Rev Infect Dis **1988**;10:980–97.
37. Motyl MR, McKinley G, Janda JM. In vitro susceptibilities of *Aeromonas hydrophila, Aeromonas sobria* and *Aeromonas caviae* to 22 antimicrobial agents. Antimicrob Agents Chemother **1985**;28:151–3.
38. Koehler JM, Ashdown LR. In vitro susceptibility of tropical strains of *Aeromonas* species from Queensland, Australia, to 22 antimicrobial agents. Antimicrob Agents Chemother **1993**;37:905–7.
39. Kuo CH, Changchien CS, Yang CY, Sheen IS, Liaw YF. Bacteremia in patients with cirrhosis of the liver. Liver **1991**;11:334–9.
40. Chuang YC, Yuan CY, Liu CY, Lan CK, Huang AH. *Vibrio vulnificus* infection in Taiwan: report of 28 cases and review of clinical manifestations and treatment. Clin Infect Dis **1992**;15:271–6.