

# Nonfoodborne *Vibrio* Infections: An Important Cause of Morbidity and Mortality in the United States, 1997–2006

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**Background.** Infections due to *Vibrio* species cause an estimated 8000 illnesses annually, often through consumption of undercooked seafood. Like foodborne *Vibrio* infections, nonfoodborne *Vibrio* infections (NFVI) also result in serious illness, but awareness of these infections is limited.

**Methods.** We analyzed illnesses occurring during the period 1997–2006 that were reported to the Centers for Disease Control and Prevention's Cholera and Other *Vibrio* Illness Surveillance system. The diagnosis of NFVI required isolation of *Vibrio* species from a patient with contact with seawater.

**Results.** Of 4754 *Vibrio* infections reported, 1210 (25%) were NFVIs. *Vibrio vulnificus* infections were the most common (accounting for 35% of NFVIs), with 72% of *V. vulnificus* infections reported from residents of Gulf Coast states. Infections due to *V. vulnificus* resulted in fever (72% of cases), cellulitis (85%), amputation (10%), and death (17%). *V. vulnificus* caused 62 NFVI-associated deaths (78%). Recreational activities accounted for 70% of exposures for patients with NFVIs associated with all species. Patients with liver disease were significantly more likely to die as a result of infection (odds ratio, 7.8; 95% confidence interval, 2.8–21.9). Regardless of pre-existing conditions, patients were more likely to die when hospitalization occurred >2 days after symptom onset (odds ratio, 2.9; 95% confidence interval, 1.8–4.8).

**Conclusion.** NFVIs, especially those due to *V. vulnificus*, demonstrate high morbidity and mortality. Persons with liver disease should be advised of the risks associated with seawater exposure if a wound is already present or is likely to occur. Clinicians should consider *Vibrio* species as an etiologic agent in infections occurring in persons with recent seawater exposure, even if the individual was only exposed during recreational marine activities. Immediate antibiotic treatment with aggressive monitoring is advised in suspected cases.

An estimated 8000 people each year in the United States experience an illness caused by infection due to *Vibrio* species [1]. Of these infections, 5200 are foodborne in origin [1]. Less is known, however, about the estimated 2800 nonfoodborne *Vibrio* infections (NFVIs) that occur each year. Except for cholera, which is caused by toxigenic strains of *Vibrio cholerae* serogroups O1 or O139, *Vibrio* species–related illnesses are not nationally

notifiable. The largest case series reported to date describes 189 *Vibrio vulnificus* wound infections reported to the Gulf Coast *Vibrio* Surveillance System during the period 1988–1996 [2]. In that report, wound infections were fatal in 17% of reported cases. During August and September 2005, Hurricane Katrina led to massive flooding in the US Gulf Coast, causing 22 cases of *Vibrio* wound infection and 5 deaths [3]. *Vibrio* wound infections have also been reported outside of the Gulf Coast, but descriptions of these infections are limited to small case series [4–7].

Clinical awareness of NFVIs is limited. Furthermore, disease prevention messages are not well-defined or widely promulgated. This study describes NFVIs from nationwide reports and provides public health recommendations for disease prevention.

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## METHODS

Data were extracted from the Cholera and Other *Vibrio* Illness Surveillance (COVIS), a collaborative effort of the Centers for Disease Control and Prevention, the US Food and Drug Administration, and state and county public health departments [8]. State and county health departments report demographic, clinical, and exposure data to the Centers for Disease Control and Prevention via standardized forms. We included reports of illness with onset from 1997 through 2006 that were received before 1 October 2007.

An NFVI was defined as an infection in which a *Vibrio* species was isolated either from a wound or from another source with documented direct contact with salt water, marine wildlife, raw seafood, or seafood drippings (not including consumption of raw seafood). Patients reporting the consumption of any raw seafood were excluded from the study. An exposure was defined as contact with salt water in persons with a pre-existing wound or a wound occurring at the time of contact. Patients for whom microbiologic culture yielded multiple *Vibrio* species were excluded from the study; those with multiple isolates of the same *Vibrio* species were counted only once.

States were classified into 1 of 4 coastal regions: Atlantic, Gulf Coast, Pacific, and noncoastal. Florida was included in the Gulf Coast region but was not included in the Atlantic region.

Based on a review of the literature for treatment of *Vibrio* infections, we considered tetracycline, minocycline, doxycycline, ceftazidime, and levofloxacin as effective antimicrobial treatments for *Vibrio* infection, although we are not aware of any randomized, controlled clinical trials addressing this issue [9–11]. Delayed hospitalization was defined as admission to the hospital >2 days after the onset of symptoms.

Statistical analysis was performed using SAS, version 9.0 (SAS). Attributable fraction was calculated as the ratio of the OR minus 1 over the OR ( $\frac{OR-1}{OR}$ ), multiplied by the percentage of patients with exposure [12].

## RESULTS

**Epidemiological observations.** NFVIs accounted for 1210 (25%) of 4754 reported *Vibrio* species–related illnesses. *V. vulnificus* was the species most frequently isolated from patients with NFVIs (428 cases [35%]), followed by *Vibrio alginolyticus* (356 [29%]) and *Vibrio parahaemolyticus* (232 [19%]). The remaining 194 NFVIs (16%) were caused by other species, including *V. cholerae* non-01 (58 cases), *Vibrio fluvialis* (37), *Vibrio damsela* (24), *Vibrio furnissii* (1), *Vibrio hollisae* (4), *Vibrio metschnikovii* (1), *Vibrio mimicus* (11), *V. cholerae* 01 (1), *Vibrio* species that were not identified (53), and other *Vibrio* species (4). NFVIs accounted for 45% of *V. vulnificus* infections, 81%

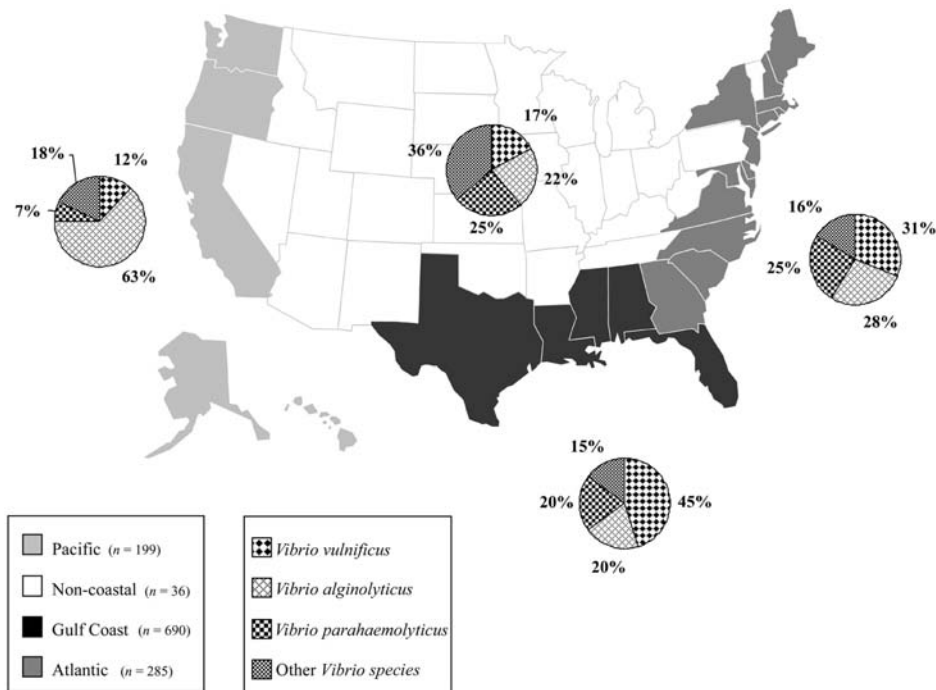
of *V. alginolyticus* infections, 11% of *V. parahaemolyticus* infections, and 16% of infections due to other *Vibrio* species.

The Gulf Coast region reported the largest number of NFVIs (690 cases [57%]), followed by the Atlantic region (285 [24%]), the Pacific region (199 [16%]), and noncoastal regions (36 [3%]) (figure 1). NFVIs due to *V. vulnificus* were most frequently reported from the Gulf Coast region (310 cases [72%]) and accounted for the greatest proportion of NFVIs reported from the Gulf Coast (45%) and Atlantic (31%) regions. *V. alginolyticus* NFVIs were most frequently reported from the Gulf Coast (140 [39%]) and the Pacific (128 [36%]); such cases accounted for the greatest proportion (64%) of NFVIs reported in the Pacific region, with nearly all cases being reported from Hawaii (52%) and California (46%). *V. parahaemolyticus* NFVIs were most frequently reported from the Gulf Coast region (140 cases [60%]).

The majority of infections occurred from May through September, with the highest number of cases occurring in August. Thirty or fewer cases were reported for each month of December, January, February, and March during the 10-year study period (figure 2).

Patients were predominantly male for all NFVIs (table 1). The median age was 49 years (range, 1–94 years). *V. vulnificus* infection occurred more frequently among older persons (median age, 63 years), whereas *V. alginolyticus* infection occurred more frequently among those <35 years of age (median age, 30 years). The median age was even lower for individuals with *V. alginolyticus* infections of the ear, eye, nose, or sinuses (median age, 15 years). Only 44 (5%) of the 923 patients with listed professions had jobs directly involving fishing or handling seafood. One hundred fifty-eight individuals with *V. vulnificus* infection (46%) listed their occupation as retired, compared with 115 individuals with other *Vibrio* infections (20%). In contrast, the most frequently listed occupation for individuals with *V. alginolyticus* infection was student or child, which was listed for 105 (39%) of the patients with *V. alginolyticus* infection, compared with 63 (10%) of patients with infections due to other species.

**Clinical observations.** *Vibrio* species were cultured from wounds in 818 patients (68%), from blood in 245 (20%), and from “other” sources in 213 (18%); 78 patients had *Vibrio* species cultured from >1 site. The predominant site of infection for most NFVIs was on the extremities. Under “other” sources, *Vibrio* species were cultured from the ear for 126 (35%) of 356 patients with *V. alginolyticus* infection, compared with 13 (6%) of the patients with *V. parahaemolyticus* infection and 2 (<1%) of the patients with *V. vulnificus* infection (table 2). The eye and sinuses were listed as sites of infection for 9 and 6 patients, respectively. Other noteworthy sites of infection, each associated with  $\leq 2$  patients, included *V. vulnificus* cultured from a



**Figure 1.** Nonfoodborne *Vibrio* infections by species and reporting site, United States, 1997–2006

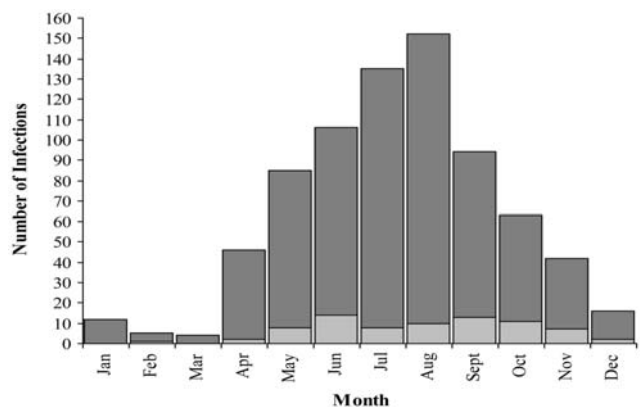
dead fetus in a woman who swam in a lake 2 weeks after losing her mucus plug, *V. vulnificus* isolated from a pelvic abscess requiring a hysterectomy in a woman who had intercourse in the ocean, *V. parahaemolyticus* isolated from sputum after a near-drowning accident, *V. alginolyticus* and unidentified *Vibrio* species isolated from urine in patients who self-catheterized, and *V. vulnificus* and *V. alginolyticus* isolated from chronic indwelling central lines that were in place at the time of exposure.

For those cases with information, the reported signs and symptoms of *V. vulnificus* NFVIs were fever (72%), cellulitis (85%), and bullae (48%) (table 3). Twenty-five percent of patients experienced shock, defined as a systolic blood pressure <90 mm Hg. Thirty (10%) of the patients with information on disease sequelae required amputation. Nearly all of the patients with *V. vulnificus* infection were hospitalized, whereas approximately one-half of patients with NFVIs due to *V. parahaemolyticus* or other *Vibrio* species were hospitalized. *V. alginolyticus* infections caused the fewest number of symptoms and signs, with only 21% of patients with such infections requiring hospitalization.

Of the 369 total deaths occurring due to any *Vibrio* species-associated illness reported to COVIS, NFVIs accounted for 79 (21%). Of these, 62 (78%) were associated with *V. vulnificus*. The case-fatality rate for *V. vulnificus*-associated NFVIs was 17%. All but 10 deaths occurred after the development of symptoms during the period May through October (figure 2). The case-fatality rate was 9% in the Gulf Coast region, 5% in both

the Pacific and Atlantic regions, and 3% in the noncoastal region.

Among patients with information available, 74% of patients with *V. vulnificus* had a concurrent health condition (table 1). The most common comorbidities were heart disease (34%), diabetes (23%), alcohol use (22%), and liver disease (20%); 26% denied any pre-existing health problems. In contrast, no pre-existing medical conditions were reported in more than one-half of patients with infections due to other species. Among those patients with comorbid conditions, heart disease was the



**Figure 2.** Nonfoodborne *Vibrio* infections (dark gray) and death (light gray) by month, United States, 1997–2006. Data were available for 706 (58%) of 1210 cases.

**Table 1. Characteristics of patients with nonfoodborne *Vibrio* infections by species, United States, 1997–2006.**

Variable	<i>Vibrio</i>			
	<i>Vibrio vulnificus</i> (n = 428)	<i>Vibrio alginolyticus</i> (n = 356)	<i>parahaemolyticus</i> (n = 232)	Other <i>Vibrio</i> species (n = 194)
Male sex	376/424 (89)	249/346 (72)	174/229 (76)	129/191 (68)
Liver disease	69/340 (20)	3/273 (3)	14/190 (7)	7/142 (5)
Alcoholism	74/342 (22)	15/279 (5)	20/185 (11)	10/140 (7)
Diabetes	81/353 (23)	27/282 (10)	26/189 (14)	24/149 (16)
Peptic ulcer disease	24/330 (7)	2/276 (1)	12/181 (7)	2/140 (1)
Heart disease	118/346 (34)	34/285 (12)	30/188 (16)	24/145 (17)
Hematologic disorder	21/327 (6)	2/275 (2)	11/179 (6)	5/140 (4)
Immunodeficiency	22/319 (7)	7/273 (3)	6/181 (3)	4/138 (3)
Malignancy	39/325 (12)	8/276 (3)	8/184 (4)	8/143 (6)
Renal disease	52/333 (16)	14/274 (5)	10/185 (5)	11/142 (8)
Any comorbid condition	291/393 (74)	102/297 (34)	94/202 (47)	78/161 (48)
Age, median years (range)	63 (1–94)	30 (1–86)	48 (3–92)	43 (1–94)

**NOTE.** Data are proportion (%) of patients, unless otherwise indicated.

most frequently reported condition, occurring in 16% of patients with *V. parahaemolyticus* infection, 12% of patients with *V. alginolyticus* infection, and 17% of patients with infections due to other *Vibrio* species.

On bivariate analysis, patients were more likely to die from *V. vulnificus* infection if they had liver disease (27 [44%] of 62 affected vs. 22 [9%] of 248 unaffected; OR, 7.9; 95% CI, 4.1–15.4), alcohol use (25 [36%] of 69 affected vs. 26 [11%] of 245 unaffected; OR, 4.8; 95% CI, 2.5–9.1), peptic ulcer disease (7 [35%] of 20 affected vs. 35 [12%] of 283 unaffected; OR, 3.8; 95% CI, 1.4–10.2), or hematologic disease (7 [37%] of 19 affected vs. 37 [13%] of 280 unaffected; OR, 3.8; 95% CI, 1.4–10.4). Patients were also more likely to die if they were from the Pacific region (8 [36%] of 22 from the Pacific region vs. 54 [15%] of 352 from other regions; OR 3.2; 95% CI, 1.3–7.9). Only liver disease remained statistically significant on multivariate analysis, with an OR of 7.8 (95% CI, 2.8–21.9). The attributable risk of liver disease for death was 38%. Hepatitis C was specified for 10 (45%) of 22 patients who died and for whom the type of liver disease was indicated.

Antibiotics were administered to 1027 patients (85%). Of these patients, only 31% received an effective antimicrobial drug at any time during their illness, and 14% received one of these drugs as the initially prescribed antimicrobial therapy. There was a trend toward increased risk of death if effective antibiotics were not administered within 24 h after clinical presentation (OR, 1.7; 95% CI, 1.0–2.9). Delayed hospitalization occurred in 27 (35%) of the patients who died and was statistically associated with death (OR, 2.9; 95% CI, 1.8–4.8), regardless of pre-existing medical conditions.

**Circumstances of exposure.** Of the 875 individuals with a complete wound history, 440 (50%) obtained a wound at the time of exposure, 269 (31%) had a pre-existing wound, 60

(7%) did not know when the wound was obtained, and 106 (12%) had no known wound. Among patients who had infections with no known wound, 69 (65%) had infections of the ear; 57 (90%) of *V. alginolyticus* infections with no known wound involved the ear.

Among those with a pre-existing wound or a wound obtained at the time of exposure, marine recreational water activities, including boating, surfing, swimming, and shore walking, accounted for 70% of exposures for NFVIs due to all serotypes (table 4). For *V. vulnificus* infections, handling or cleaning seafood was the most frequent single activity at the time of exposure (58% of cases), followed by recreational activities, such as swimming or wading; boating, surfing, or water skiing; and walking on the beach (table 4). Among all patients with infections in which “other” exposures were noted, fishing, handling or cleaning seafood, and handling fishing equipment were described by 70 (43%).

## DISCUSSION

This case series—to our knowledge, the largest to date and the first to include data from a national surveillance system on all *Vibrio* species—demonstrates that just as for the foodborne *Vibrio* infections, the most severe NFVIs were associated with *V. vulnificus* and underlying liver disease [2, 13–15]. In earlier studies, liver disease has been identified as a risk factor for primary septicemia from *Vibrio* infections [14, 16], but its involvement with nonfoodborne infections was less clear. The fatality rate associated with *V. vulnificus* infection in this series (17%) was similar to rates reported in previous series (17%–24%) [2, 9, 17], and liver disease could account for most fatalities. Hepatitis C virus infection was listed as the cause of liver disease for a high proportion (45%) of patients who died.

**Table 2. Source of isolation for nonfoodborne *Vibrio* infections by species, 1997–2006.**

Source	No. (%) of patients			
	<i>Vibrio vulnificus</i> (n = 428)	<i>Vibrio alginolyticus</i> (n = 356)	<i>Vibrio parahaemolyticus</i> (n = 232)	Other <i>Vibrio</i> species (n = 194)
Wound	282 (66)	208 (58)	183 (79)	131 (68)
Blood	192 (45)	9 (3)	23 (10)	21 (11)
Other				
Overall	16 (4)	139 (39)	22 (9)	41 (21)
Ear	2 (0.4)	126 (35)	13 (6)	28 (14)

Although this number could be an overestimation of the incidence of disease because of reporting bias and nonstandardized data collection concerning the type of liver disease, it may also underestimate the incidence of disease, because clinicians might be unaware of this diagnosis in a patient. Hemochromatosis has been cited in other studies as a risk factor for *Vibrio* infections [18, 19], and animal models support this finding [20, 21]. We were unable to assess this risk factor, because the COVIS data collection tool did not specifically inquire about this risk factor.

Because of the strong association of liver disease with death, patients with liver disease should be advised to avoid activities in which they will be exposed to warm seawater if they have a pre-existing wound or if a wound is likely to occur. If a wound is exposed to seawater, such patients should seek immediate medical attention for any symptoms or signs suggesting infection, such as cellulitis, fever, or other constitutional symptoms. Seawater should not be used to clean wounds.

Most infections occurred during the warmer months. Because oysters harvested in temperatures >15°C and >22°C have been shown to be associated with foodborne *V. parahaemolyticus* and *V. vulnificus* infection [2, 22], respectively, it is not surprising that exposure to warmer seawater in the summer months might account for a higher number of NFVIs. This is also the time when more people engage in water activities. The reported exposures for many patients were recreational water activities, rather than handling or cleaning seafood. This dissociation with shellfish is in contrast to foodborne vibriosis, in which the consumption of raw or undercooked seafood is the primary means of exposure [19, 23]. Activities as simple as walking on the beach and cutting one's foot on a shell or rock or wading in seawater with a pre-existing wound were enough to cause infection. The evidence of NFVIs obtained via normal beach activities by patients without any underlying medical condition highlights the possibility that all persons are at some risk for infection and indicates that *Vibrio* can exist in beach environments at levels high enough to cause infection [24].

Flood conditions can increase not only the number of *Vibrio* organisms normally present in an environment but also the

likelihood that persons with medical conditions predisposing them to disease will be exposed to these agents. After landfall of Hurricane Katrina in the Gulf Coast states in 2005, there was an increase in the incidence of *Vibrio* infections and deaths from that region [3]. Early recognition of NFVIs and appropriate treatment is paramount to limit morbidity and mortality in such situations when large numbers of persons are exposed.

Clinical suspicion of *Vibrio* species as possible causative organisms in wound infections may alter antibiotic choices and enhance vigilance for systemic complications, thereby possibly preventing severe consequences of the disease. Although the most effective antibiotic for the treatment of *Vibrio* infections has not been established, less than one-third of patients received one of the antibiotics recommended in treatment guidelines. This suggests that clinicians are not considering *Vibrio* species as a likely causative organism at the time of antibiotic selection. Delayed hospitalization was associated with death and highlights the need for aggressive medical care when an NFVI is suspected in an individual at high risk.

*V. alginolyticus*, a species not commonly associated with foodborne vibriosis, was the second most common cause of NFVIs; 35% of these infections involved the ear. *V. alginolyticus* was most likely to affect younger individuals on the Pacific coast, where ocean swimming and surfing were frequent exposures. This was especially true for those individuals presenting with ear infections. *V. alginolyticus* causing ear infections was described by Morris [25]. Health care providers should consider *Vibrio* species as potential causative agents for ear infections in individuals with recreational seawater exposures.

Unlike *V. alginolyticus*, *V. parahaemolyticus* has been linked to several foodborne outbreaks [22, 26]. Although only 11% of all *V. parahaemolyticus* infections in the COVIS database were nonfoodborne, *V. parahaemolyticus* still caused 19% of all NFVIs. Compared with NFVIs due to *V. vulnificus*, fewer cases of *V. parahaemolyticus* infection resulted in shock, amputation, or death. The deaths of 2 of 3 patients infected with *V. parahaemolyticus* after exposure to flood waters from Hurricane

**Table 3. Signs, symptoms, and outcomes of patients with nonfoodborne *Vibrio* infections by species, United States, 1997–2006.**

Sign, symptom, or outcome	Proportion (%) of patients			
	<i>Vibrio vulnificus</i> (n = 428)	<i>Vibrio alginolyticus</i> (n = 356)	<i>Vibrio parahaemolyticus</i> (n = 232)	Other <i>Vibrio</i> species (n = 194)
Fever	255/352 (72)	54/259 (21)	79/186 (42) <sup>A</sup>	54/133 (41) <sup>A</sup>
Nausea	130/344 (38)	26/271 (10) <sup>A</sup>	31/184 (17) <sup>AB</sup>	29/142 (20) <sup>B</sup>
Vomiting	89/343 (26) <sup>A</sup>	13/267 (5) <sup>B</sup>	16/185 (9) <sup>BC</sup>	24/139 (17) <sup>BC</sup>
Diarrhea	61/334 (18) <sup>A</sup>	16/263 (6) <sup>B</sup>	25/187 (13) <sup>AB</sup>	18/139 (13) <sup>AB</sup>
Cramps	35/322 (11) <sup>A</sup>	14/261 (5) <sup>A</sup>	15/181 (8) <sup>A</sup>	18/139 (13) <sup>A</sup>
Headache	76/299 (25) <sup>A</sup>	37/253 (15) <sup>B</sup>	26/176 (15) <sup>AB</sup>	19/128 (15) <sup>AB</sup>
Muscle pain	142/305 (47)	28/250 (11) <sup>A</sup>	50/175 (29) <sup>B</sup>	30/131 (23) <sup>AB</sup>
Cellulitis	313/369 (85)	119/272 (44) <sup>A</sup>	124/186 (67) <sup>B</sup>	84/144 (58) <sup>AB</sup>
Bullae	142/293 (48)	24/246 (10) <sup>A</sup>	15/155 (10) <sup>A</sup>	19/119 (16) <sup>A</sup>
Shock	72/291 (25)	4/249 (2) <sup>A</sup>	6/171 (4) <sup>AB</sup>	13/128 (10) <sup>B</sup>
Amputation	30/314 (10)	3/291 (1) <sup>A</sup>	5/176 (3) <sup>A</sup>	6/139 (4) <sup>A</sup>
Hospitalization	363/407 (89)	70/329 (21)	98/217 (45) <sup>A</sup>	87/177 (49) <sup>A</sup>
Death	62/375 (17)	2/330 (1) <sup>A</sup>	6/216 (3) <sup>A</sup>	9/170 (5) <sup>A</sup>

**NOTE.** Differences between values with the same superscript letter in the same row are not statistically significant.

Katrina in the Gulf Coast region, however, serve as a reminder that these infections can be virulent.

There are several limitations to this study. Our inclusion of patients with *Vibrio* species isolated from a wound might include patients with primary septicemia who had *Vibrio* species isolated from a bullae. Trying and Lee [27] demonstrated that isolation of *V. vulnificus* from bullae was possible whether the patient had a wound infection or primary septicemia following shellfish ingestion. In addition, there were patients with primary septicemia without a documented wound culture who participated in beach recreational activities and sustained a wound but also ingested seafood, thereby making it impossible to know which exposure caused illness. We attempted to limit this con-

fusion by excluding patients who had eaten raw seafood, because most patients who develop foodborne *Vibrio* infection have eaten undercooked or raw seafood [26]. Our study also may overestimate severity of disease, because both microbiologic diagnosis and reporting to COVIS may result in selection bias towards patients with more-severe illness. Awareness of and participation in COVIS varies from state to state, and those participating for a longer period (e.g., Gulf Coast states) may submit information more regularly to COVIS and shift regional focus of disease incidence. In addition, the data submitted on each form are not always complete, thereby changing the denominator for any reported item. We do not know if data are omitted because of lack of inquiry, lack of available data, or

**Table 4. Risk factors of patients with nonfoodborne *Vibrio* infection at time of exposure, limited to individuals with pre-existing wounds or wounds obtained at time of exposure, United States, 1997–2006.**

Risk factor	Proportion (%) of patients			
	<i>Vibrio vulnificus</i> (n = 302)	<i>Vibrio alginolyticus</i> (n = 154)	<i>Vibrio parahaemolyticus</i> (n = 162)	Other <i>Vibrio</i> species (n = 91)
Handling seafood	108/186 (58)	16/105 (15) <sup>A</sup>	27/98 (28) <sup>A</sup>	13/57 (23) <sup>A</sup>
Swimming	95/177 (54) <sup>A</sup>	98/117 (84) <sup>B</sup>	64/105 (61) <sup>A</sup>	41/61 (67) <sup>AB</sup>
Walking	58/170 (34) <sup>A</sup>	59/107 (55) <sup>B</sup>	50/103 (49) <sup>AB</sup>	29/54 (54) <sup>AB</sup>
Boating	67/166 (40) <sup>A</sup>	37/100 (37) <sup>A</sup>	29/99 (29) <sup>A</sup>	21/57 (37) <sup>A</sup>
Construction	18/158 (11) <sup>A</sup>	2/99 (2) <sup>A</sup>	4/95 (4) <sup>A</sup>	2/52 (4) <sup>A</sup>
Bite	19/155 (12) <sup>A</sup>	10/99 (10) <sup>A</sup>	11/95 (12) <sup>A</sup>	9/57 (16) <sup>A</sup>
Other	79/140 (56) <sup>A</sup>	28/82 (34) <sup>B</sup>	35/79 (44) <sup>AB</sup>	19/43 (44) <sup>AB</sup>

**NOTE.** Differences between values with the same superscript letter in the same row are not statistically significant.

negative responses from the patient. The large number of patients included in this study helps to offset this limitation. Finally, because of the nature of COVIS as a case series reporting system, it is not possible to identify from this data which individuals were more likely than others to acquire infection for a given risk factor or exposure.

Noncholera vibriosis was not a nationally notifiable condition during the period of this study, and it is certain that the number of NFVIs in the United States each year is much higher than was reported to the Centers for Disease Control and Prevention, but the extent is not known. Beginning in 2007, noncholera vibriosis was added to the list of nationally notifiable diseases, and this will aid in monitoring trends and geographic differences and will improve our understanding of environmental factors leading to this disease, so that prevention measures can be effectively implemented.

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