
Vibrio gastroenteritis in the US Gulf of Mexico region: the role of raw oysters

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SUMMARY

We examined clinical and epidemiological features of 575 laboratory-confirmed cases of vibrio gastroenteritis in Alabama, Florida, Louisiana, and Texas from 1988 to 1997 (the US Gulf of Mexico Regional *Vibrio* Surveillance System). Illnesses occurred year round, with peaks in spring and autumn. Illnesses lasted a median of 7 days and included fever in half of patients and bloody stools in 25% of patients with relevant information. Seventy-two percent of patients reported no underlying illnesses. In the week before onset, 236 (53%) of 445 patients for whom data were available ate raw oysters, generally at a restaurant or bar. Educational efforts should address the risk of vibrio gastroenteritis for raw oyster consumers, including healthy individuals. Further studies should examine environmental conditions affecting vibrio counts on seafood and processing technologies to enhance the safety of raw oysters.

INTRODUCTION

Vibrio bacteria occur naturally in unpolluted seawater and contribute to the decomposition of marine organisms. Several species are human pathogens including *Vibrio cholerae* O1 and *Vibrio cholerae* O139, the causative agents of cholera epidemics [1], and *Vibrio parahaemolyticus*, a leading cause of foodborne disease outbreaks in Japan and Korea [2]. *Vibrio* species have been estimated to cause approximately 8000 illnesses in the United States each year [3]. In the US Gulf of Mexico region, gastroenteritis is

the most prevalent syndrome of vibrio infection, followed by wound infections through contact with seawater or seafood drippings and primary septicaemia, a fatal syndrome generally effecting patients with liver disease [4, 5]. The US Gulf of Mexico Regional *Vibrio* Surveillance System; which includes Alabama, Florida, Louisiana, and Texas; identified 575 cases of vibrio gastroenteritis between 1988 and 1997. Many other cases of vibrio gastroenteritis were probably missed because clinical laboratories do not routinely test stool specimens for vibrios. In this study, the largest case series of vibrio gastroenteritis of which we are aware, raw oysters were the leading seafood exposure of patients. Surveillance data from the Gulf region are summarized to better understand

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Table 1. *Demographic characteristics of patients with vibrio gastroenteritis, the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97*

	No. of patients	No. with information	(% of patients)	(% of population)*
Male	319	559	(57)	(48)
White	335	506	(70)	(82)
Black	111	506	(22)	(16)
Other	39†	506	(8)	(2)

* Estimates for the combined populations of Alabama, Florida, Louisiana, and Texas; 1992; ($n = 39\,582\,000$) [6].

† Twenty-four patients (5%) were Hispanic and 15 (3%) were Asian/Pacific islanders.

the syndrome of vibrio gastroenteritis and to stimulate research on controls to prevent these illnesses.

METHODS

The US Gulf of Mexico Regional *Vibrio* Surveillance System was established in 1988, following discussions between the seafood industry, medical practitioners, food safety and public health officials on surveillance needs for vibrio infections in the region, and particularly for *V. vulnificus* primary septicaemia. The participating states; Alabama, Florida, Louisiana, and Texas were the first in the nation to make non-cholera vibrio infections reportable. Clinical laboratories chose their own protocols to isolate vibrios and confirmation of strain identity by a public health laboratory was not required. Serotyping was not performed. For each reported vibrio infection, a public health official obtained demographic, laboratory, and clinical information on a standardized vibrio illness surveillance form. A history of seafood consumption was obtained for the 7 days before onset of illness; including the amount of seafood consumed (e.g. number of oysters), how it was prepared, and the location where it was obtained. The state health departments voluntarily provided reports to CDC several times each year. Data were entered into an ASCII file and PC-SAS software (SAS Institute, Cary, NC, 1990) was used to calculate summary statistics.

Gastroenteritis was defined as an illness characterized by enteric symptoms in which a stool culture yielded vibrio, blood cultures were negative if obtained, and there was no evidence of wound infection, thereby excluding patients with primary septicaemia or wound infections. Also excluded from the definition of gastroenteritis were 12 patients with fatal infections

who had vibrios isolated from their stools. (5 patients with *V. parahaemolyticus*, 3 with *V. fluvialis*, and 1 each with non-O1, non-O139 *V. cholerae*, *V. mimicus*, *V. vulnificus*, and a nontyped vibrio) because of uncertainty about their syndromes. Included in the study were 68 patients with additional organisms isolated from stool specimens; principally *Plesiomonas* sp., *Campylobacter* sp., and *Aeromonas* sp. This study includes 213 (37%) cases reported from previous studies (43 from a 1989 study in the Gulf region [4], 142 patients from a 12-year study in Florida [5], and 28 from both studies).

RESULTS

Patient information

Of the 1296 vibrio infections that were reported to state health departments participating in the Gulf Coast Regional *Vibrio* Surveillance System, almost half (575) were patients with gastroenteritis. Most patients were adults (median age, 39 years), male, and white. A higher proportion of patients were males and of racial origin other than white than in the general population (Table 1) [6]. By state; 245 (43%) reports were from Florida, 237 (41%) from Louisiana, 48 (8%) from Texas, and 45 (8%) from Alabama (Table 2). Most infections were sporadic; 12 (2%) were linked to outbreaks, all of which involved fewer than 4 reported infections.

Laboratory information

V. parahaemolyticus and non-O1, non-O139 *V. cholerae* were the predominant species isolated from patients (Table 2). Approximately 10% of patients each were infected with *V. mimicus*, *V. fluvialis*, and *V. hollisae*; respectively. Infrequently isolated were *V.*

Table 2. Species of vibrio isolated from patients with gastroenteritis; the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97

	Florida	Louisiana	Texas	Alabama	Total (%)
<i>V. parahaemolyticus</i>	91	64	15	11	181 (31)
<i>V. cholerae</i> (non-O1, non-O139)	42	68	15	12	137 (24)
<i>V. mimicus</i>	5	38	5	18	66 (12)
<i>V. fluvialis</i>	32	14	5	6	57 (10)
<i>V. hollisae</i>	30	16	0	4	50 (9)
<i>V. vulnificus</i>	9	4	4	2	19 (3)
<i>V. alginolyticus</i>	5	9	1	0	15 (3)
<i>V. damsela</i>	2	1	0	0	3 (< 1)
<i>V. furnissi</i>	0	0	1	0	1 (< 1)
Multiple*	7	15	1	0	23 (4)
Not specified	9	8	1	5	23 (4)
Total	245	237	48	45	575 (100)

* 5 patients had *V. cholerae* (non-O1, O139) and *V. mimicus* isolated from stool, 4 *V. parahaemolyticus* and *V. mimicus*, 3 *V. parahaemolyticus* and *V. hollisae*, 3 *V. parahaemolyticus* and *V. fluvialis*, 3 *V. parahaemolyticus* and *V. alginolyticus*, 2 *V. parahaemolyticus* and *V. cholerae* (non-O1, O139), 1 *V. parahaemolyticus* and *V. vulnificus*, 1 *V. cholerae* (non-O1, O139) and *V. hollisae*, and 1 *V. parahaemolyticus*, *V. mimicus*, and *V. alginolyticus*.

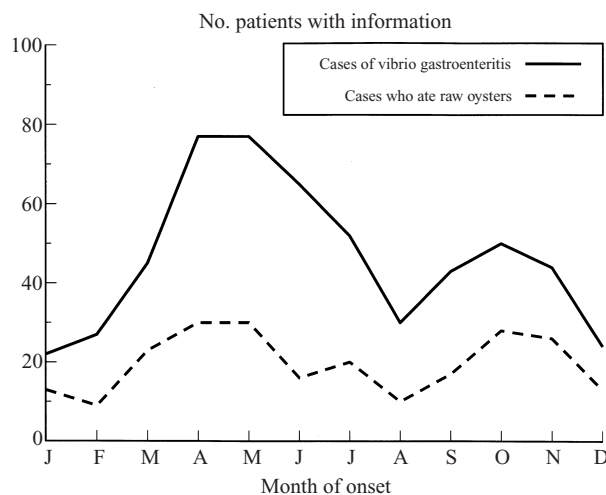


Fig. 1. Seasonality of vibrio gastroenteritis for 554 patients with information on month of onset and for 235 patients who ate raw oysters in the week before illness onset whose month of onset was known (the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97).

vulnificus, *V. alginolyticus*, *V. damsela*, and *V. furnissi*. Predominant isolates from patients who ate raw oysters were non-O1, non-O139 *V. cholerae* (26%), *V. parahaemolyticus* (25%), *V. hollisae* (14%) and *V. mimicus* (13%).

Seasonality

A bimodal seasonality in the onset of vibrio gastroenteritis was observed, with a large spring peak and

smaller autumn peak. A higher proportion of patients who did not report eating oysters had onsets of illness in the spring than in the autumn (Fig. 1).

Clinical characteristics

Among patients with information, diarrhoea was the predominant symptom, followed by abdominal cramps, nausea, vomiting, fever, and bloody stools (Table 3). For *Vibrio* species with 10 or more reports, the highest proportion of bloody stools was among patients with *V. fluvialis* infections [13 of 43 (30%)]; followed by *V. parahaemolyticus* (38 of 135), *V. mimicus* (13 of 47), and *V. hollisae* (10 of 36) (each with 28% of patients reporting bloody stools); and non-O1, non-O139 *V. cholerae* [20 of 100 (20%)]. Two of 12 patients with *V. vulnificus* isolates (17%) reported bloody stools.

Vibrio gastroenteritis was a serious illness as indicated by the number of patients with multiple symptoms, the number of loose stools on the worst day of illness, and the duration of illness (Table 4). Among patients with information, 43% were hospitalized and the median hospital stay was 4 days. The median interval between seafood consumption and onset of illness was 1 calendar day and 90% of patients had onsets of illness within 3 days of eating seafood.

Overall, 28% of patients reported selected underlying illnesses or use of gastric acid medications,

Table 3. *Symptoms reported by patients with vibrio gastroenteritis, the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97*

Symptom	No. of patients with symptom	No. with information	(%)
Diarrhoea	506	531	(95)
Cramps	427	487	(88)
Nausea	365	495	(74)
Vomiting	282	501	(56)
Fever	232	437	(53)
Bloody stool (by history)	116	420	(28)

Table 4. *Clinical features of vibrio gastroenteritis, the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97*

Clinical feature	Observation	No. of patients with information
No. of patients with multiple symptoms	504	541
No. of symptoms (median)	4	541
No. loose stools/day (median)	10	188
Median duration of illness (no. days)	7	432
No. patients hospitalized	235	549
Median hospital stay (no. days)	4	194
Incubation period (no. days), 90% of patients	≤ 3	288

Table 5. *Selected underlying illnesses and gastric medications used by patients with vibrio gastroenteritis; the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97*

	No. patients	No. with information	(%)
Antacids past month	56	435	(13)
Peptic ulcer	42	456	(9)
Heart disease	43	461	(9)
H ₂ -blocker past month	29	432	(7)
Gastric surgery	31	464	(7)
Diabetes	31	467	(7)
Alcoholism	17	460	(4)
Liver disease	14	430	(3)
Any condition listed above	159	570	(28)

conditions that are frequently reported for patients with *V. vulnificus* primary septicemia (Table 5) [4]. Among patients with information, 4% reported alcoholism and 3% reported liver disease.

Seafood history

A total of 445 patients (77%) reported eating seafood in the week before onset of illness. Among these

patients, 63% ate molluscan shellfish (oysters or clams), 49% ate crustacean shellfish (e.g. crab, shrimp, crayfish), and 22% ate finfish (Fig. 2). A subset of 277 patients reported eating one seafood item in the week before onset of illness: 64% ate molluscan shellfish, 28% crustacean shellfish, and 8% finfish. Information on seafood consumption was not available for 88 patients (15%) and 42 (7%) denied having eaten seafood.

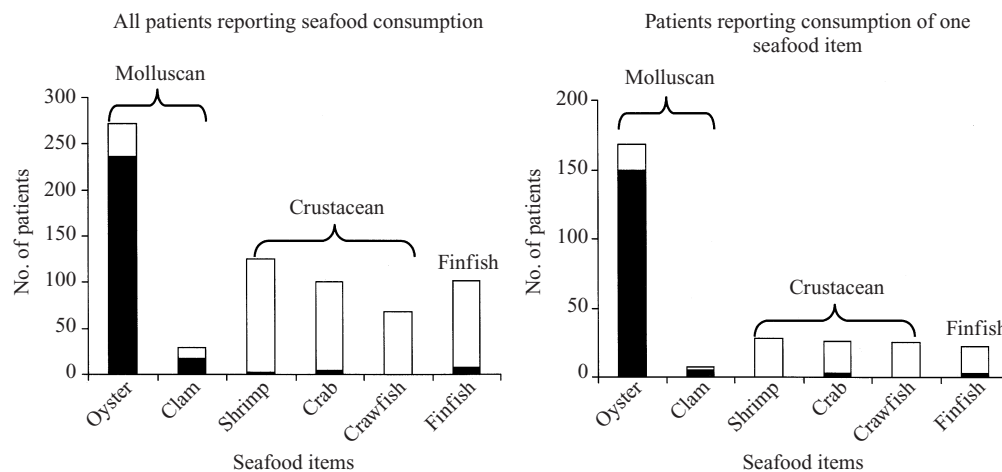


Fig. 2. Seafood consumption reported by all patients with vibrio gastroenteritis and by patients reporting consumption of only one seafood item in the week before illness onset (the US Gulf of Mexico Regional *Vibrio* Surveillance System, 1988–97). (Classified by molluscan shellfish, including oysters and clams; crustacean shellfish, including shrimp, crab, and crawfish; and finfish. Black shading indicates product was consumed raw, white indicates product consumed cooked or information on cooking not available.)

Raw seafood

Among 272 patients who ate oysters, 236 (87%) ate them raw, consuming a median of 12 raw oysters (range, 2 to > 70). Of 29 patients who ate clams, 17 (59%) ate them raw. Eight patients reported eating raw finfish, 4 raw crab, and 2 raw shrimp.

Seafood source

Information on seafood source was available for 299 patients and 179 (60%) ate seafood at a restaurant or bar. Among 184 raw oyster eaters with information on source, 131 (71%) ate them at a restaurant or bar. Sixty-two (21%) patients indicated their source of seafood as 'other', specifying sources including 'from a friend' or 'at a catered event'. Other sources were self harvest (8%), roadside vendors (4%), and food stores (3%).

Other pathogens

A total of 68 reports (11%) listed other organisms isolated from stool specimens. The seafood exposures and illnesses of these patients were similar to those of other patients in the study (see Appendix).

DISCUSSION

Surveillance conducted over 10 years in four states that share more than 90% of the US Gulf of Mexico coastline showed that eating vibrio contaminated seafood is an important cause of gastroenteritis in the

region. Illnesses were not trivial, as evidenced by the frequency of fever, bloody diarrhoea, duration of illness, and the proportion of patients who were hospitalized. As in many [4, 5, 7, 8], although not all reports [9, 10] of vibrio gastroenteritis in the United States, raw oysters were the principal seafood item eaten by patients in the week before onset of illness. Most patients who ate raw oysters obtained them at restaurants or oyster bars.

Cases of vibrio gastroenteritis occurred year round, peaking in spring [4, 5]. The low number of cases reported in August may have been a consequence of human behaviour (e.g. well known advice to eat oysters only in months with an 'R') or the unavailability of fresh seafood. The peak in oyster-associated illnesses in the spring and low number in midsummer corresponded with high and low seasons for oyster harvest [11]; however, an autumn peak in illnesses did not reflect a seasonal increase in the oyster harvest. There is a need to further assess the relationship between the seasonality of human illness, the seasonality of seafood harvest [11], consumption [12], and vibrio counts on seafood [13, 14].

Raw oysters are eaten by approx. 1 in 10 American adults each year [15], emphasizing the need for controls to assure the safety of this seafood commodity. At present, [16] vibrio counts in oyster beds are not routinely monitored and beds are generally closed for harvest only after outbreaks of vibrio gastroenteritis. The severity of illnesses in this study suggests a high threshold for reporting (see below).

Thus, many illnesses can occur before an outbreak is detected. Recently, regulatory policies regarding vibrio contamination in raw oysters received added attention, following a series of large outbreaks of *V. parahaemolyticus* infection in the United States [7, 8]. These outbreaks were associated with eating raw oysters and clams harvested from Pacific, Atlantic, and Gulf of Mexico waters. The El Niño weather phenomenon of 1997 and 1998 may have played a role in these outbreaks by causing shifts in ocean temperature and salinity that favoured the growth of vibrios [12–14].

Control points to prevent vibrio gastroenteritis from raw oysters might include monitoring of harvest waters, identification of processing controls, and consumer education. If monitoring of oyster beds can identify harvest areas with elevated vibrio counts, regulatory action may be possible before an outbreak occurs. Further studies should determine if environmental parameters in harvest areas (e.g. seawater temperatures [13] and salinity levels [14]) can predict vibrio contamination of oysters. Processing controls for raw oysters (e.g. thermal treatment, depuration) [17] have been proposed to reduce vibrios in raw oysters but are not widely employed at present. An assessment of the effectiveness of these technologies is needed. Educational campaigns describing the risk of vibrio infections from raw oysters should include information about the risk of gastroenteritis for healthy individuals [18, 19]. An understanding of the factors linked with raw oyster consumption could strengthen educational efforts. For example, the high proportion of male patients in this study may reflect an association between eating raw oysters, male gender, and risk-taking behaviours [20]. Rates of raw oyster consumption are also elevated in some racial groups (e.g. Whites [20], Hispanics [21], and Asian/Pacific Islanders [15]).

The proportion of patients who were hospitalized suggests that patients with milder illnesses were not detected because their stools were not specifically tested for vibrio, a stool culture was not obtained, or persons did not seek medical care. Furthermore, while vibrio in stools may be detected with media used in most clinical laboratories, use of selective media [e.g. thiosulphate–citrate–bile salt–sucrose (TCBS) agar]

improves detection. In a survey of Gulf coast clinical laboratories conducted in 1998, only 20% routinely used TCBS agar to culture stool specimens (CDC, unpublished observation). Variation in reports per state may have been influenced by variation in seafood consumption, culture practices of clinical laboratories, interest in reporting, or stimulation of reporting by state health departments. In addition, pathogens other than vibrios may have contributed to some illnesses and we cannot prove the causal relationship between vibrio infection and gastroenteritis, particularly for infrequently isolated species (e.g. *V. vulnificus*). Evidence that vibrios caused most illnesses in this study include the similar length of time between eating seafood and the onset of patients' illnesses, the symptoms and severity of illnesses, and the small proportion of patients with other enteric pathogens isolated from stool specimens.

In summary, this study suggests that vibrio contaminated seafood is a cause of serious gastroenteritis in the Gulf of Mexico region and eating raw oysters is a leading seafood exposure of patients. Consumers should be made aware of the risk of vibrio gastroenteritis for healthy individuals who eat raw oysters. Studies should examine environmental conditions affecting vibrio counts on seafood and processing technologies to enhance the safety of raw oysters.

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Appendix. Seafood exposures and selected clinical features of 68 patients with gastroenteritis who had organisms in addition to vibrios isolated from stool specimens; the US Gulf of Mexico Regional Vibrio Surveillance System, 1988–97*

No. of patients	Seafood consumption†			Selected clinical features‡		
	Molluscan	Crustacean	Finfish	Bloody stools	Fever	Hospitalization
	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)	No. (%)
68	41 (60)	24 (35)	8 (12)	14 (27)	32 (59)	29 (43)

* Twenty-four patients had *Plesiomonas* sp. isolated from stool specimens, 16 *Campylobacter* sp., and 8 *Aeromonas* sp. Organisms isolated on three or fewer occasions were *Clostridium difficile*, *Edwardsiella tarda*, *Pasteurella multocida*, *Salmonella enterica*, *Shigella* species, *Staphylococcus aureus*, nematodes, and protozoal parasites.

† All patients were the denominator for percentages with each seafood exposure.

‡ Information on bloody stools was available for 51 patients, on fever for 54 patients, and on hospitalization for 67 patients.

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