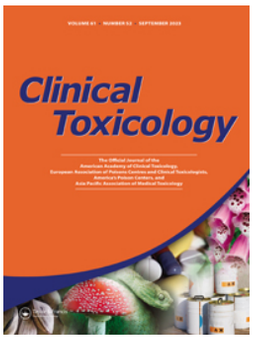

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SHORT COMMUNICATION

Clam calamity: five concurrent cases of neurotoxic shellfish poisoning with varying presentations following ingestion of clams from Gulf of Mexico water contaminated with *Karenia brevis* confirmed by serum brevetoxin assays

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ABSTRACT

Introduction: *Karinia brevis*, a marine dinoflagellate, is the causative organism for "red-tide" on the east coast of Florida. This microbe produces brevetoxins, which bioaccumulate in filter feeding bivalve shellfish. In humans, inhalational exposure is common, while ingestion of contaminated shellfish is more rare. Ingested brevetoxin causes gastrointestinal and neurological symptoms collectively known as neurotoxic shellfish poisoning.

Case cluster: A group of tourists collected clams from a beach during a red tide event. The clams were soaked in brine, microwaved, and consumed for lunch. The index patient experienced seizure-like activity postprandially prompting the cohort to present for medical attention. Five people presented to the emergency department with neurotoxic shellfish poisoning-related symptoms. All patients received supportive care only. Symptoms resolved within 24 hours. Serum brevetoxin concentrations were reported for four patients.

Discussion: Ingestion of brevetoxin is rare but may become more common as the frequency and severity of "red-tide" events increase. In our cluster, each person consumed a different number of clams and presented with classic and some "non-classic" symptoms. A trend toward more severe symptoms with a larger number of clams ingested was observed.

Conclusions: This case cluster describes the clinical course of individuals after consumption of brevetoxin contaminated shellfish.

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Brevetoxin; neurotoxic shellfish poisoning; Karenia brevis; harmful algal blooms; red tide

Introduction

Harmful algal blooms are a global intermittent, often seasonal, ecological hazard caused by the overgrowth of dinoflagellates in response to increased nutrient water contamination known as eutrophication. Commonly called "red tide", *Karenia brevis* produces heat-stable lipid-soluble polyethers (brevetoxins) that bioaccumulate in filter feeders such as clams, mussels, and oysters (bivalve shellfish) [1,2]. A total of 24 cases of brevetoxin poisoning were reported to the state of Florida between 2004–2009[1]. Hazards to humans include mucous membrane and respiratory irritation caused by beachside aerosolized brevetoxin and, rarely, consumption of contaminated shellfish.

Symptoms from ingestion include gastrointestinal distress and neurological abnormalities collectively known as neurotoxic shellfish poisoning. Classic symptoms include nausea, vomiting, diarrhea, as well as paresthesias and weakness [2,3]. Clinical experience with patients with symptomatic ingestions is limited due to noxious water conditions and posted warnings that typically deter humans from harvesting and consuming contaminated shellfish. We describe our experience of five patients who ingested brevetoxin-contaminated clams.

Case cluster

A group of tourists collected, prepared, and ate clams from a beach during a known a harmful algal bloom in July 2021. The clams were soaked in brine prior to being microwaved for 3 min, and subsequently added to a salad for lunch (Figure 1). Two hours later, one patient experienced seizure-like activity, prompting the group to present for medical attention. Five patients presented to the emergency department (ED) via emergency medical services.

Upon arrival, the index patient (Patient 1) was brought to a resuscitation bay and found to be awake, alert, and oriented and suffering diffuse severe muscle fatigue and fasciculations; unable to lift or hold extremities above the stretcher. The patient complained of "whole body numbness" as well as abdominal pain, which had started one hour after the meal, but had no other associated gastrointestinal symptoms. Initial vital signs were sinus tachycardia at 115 beats/-minute, blood pressure 117/96 mmHg, respiratory rate 14

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breaths/minute, oxygen saturation 99% on room air, and temperature of 37.2 °C. Laboratory values upon arrival were within normal limits aside from mild hypokalemia at 3.2 mmol/L. Initial electrocardiogram showed a narrow QRS complex (73 ms). The patient had no past medical history and took no home medications. Treatment consisted of one liter of intravenous crystalloid, intravenous lorazepam 1.5 mg, and intravenous potassium chloride 40 mEq. The patient was admitted to the medical intensive care unit for monitoring.

Figure 1. Clam meat prepared on salad consumed by patients.

Patients 2 through 5 were triaged to standard ED rooms. Chief complaints for these patients included similar "whole body numbness" but without accompanying weakness, and varying degrees of gastrointestinal distress (Table 1). Peripheral sensory examinations suggested sensory paresthesias, described as "whole body numbness", in each case. When asked to hold a can of refrigerated soda, none of the patients reported cold-temperature sensory reversal, burning, or tingling. None reported an exaggerated pain response to light touch. Past medical histories of patients 2 through 4 were unremarkable, while patient 5 had a history of breast cancer treated with anastrozole. Treatment for these patients included intravenous crystalloids and antiemetics. These patients were admitted to general medical ward. All patients were discharged within 24 h following complete resolution of symptoms.

Serum and urine from four patients were collected the morning after presentation and sent for quantitative brevetoxin assay. The Department of Health and Human Services reported values 38 days after procurement for all four of the serum samples (Table 1). The analytical method used was an enzyme-linked immunoassay (ELISA) [4]. The assay targets brevetoxin 3 with a quantitative detection limit of 0.04 μg/L [4]. Urine brevetoxin assays were not reported.

Discussion

No clam remnants were available for direct brevetoxin analysis, however local biomonitoring data by the Florida Fish

Table 1. Patient characteristics and symptoms after ingestion of brevetoxin-contaminated clams.

	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5
Patient characteristics					
Sex	F	M	M	F	M
Age (y)	23	60	30	66	24
Weight (kg)	51.3	58	55	57.1	47
Ingestion/brevetoxin characteristics					
Number of clams consumed	10	10 to 12	12	5 to 6	10
Serum brevetoxin concentration (μg/L)	11.8	12.4	10.8	10	N/A
Gastrointestinal symptoms					
Abdominal pain	(+)	(-)	(-)	(+)	(+)
Nausea	(-)	(-)	(+)	(+)	(+)
Vomiting	(-)	(-)	(+++)	(-)	(++)
Diarhhea	(-)	(-)	(+)	(+)	(-)
Neurological symptoms					
Numbness	(+)	(+)	(+)	(+)	(+)
Duration of numbness (h)	8	>12	>12	8	24
Cardioavascular findings					
Heart rate (beats per min)/QT duration (ms)	111/338	71/364	100/349	94/384	69/371
QRS duration (ms)	73	79	89	81	87
Other reported symptoms					
Other reported symptoms	Reported seizure-like activity prior to presentation, severe musclar weakness/fasciculations, anxiety	(-)	Mid-sternal chest pain with deep breathing	(-)	(-)

N/A: Not available, +: present, -: absent.

and Wildlife Conservation Commission near the beach where the clams were harvested corroborated the highest reported range of *K. brevis* (>1,000,000 *K. brevis* cells/L seawater) [5].

Each patient reported eating a different number of clams (total weight of clam flesh consumed per person unquantifiable) and presented with a variety of gastrointestinal and neurologic symptoms. This case cluster illustrates that individuals eating brevetoxin-contaminated clams from the same source may manifest variable effects of neurotoxic shellfish poisoning. Also, the number of clams ingested roughly correlated with severity of symptoms. Reported serum brevetoxin concentrations ranged from 10 to 12.4 μg/L. By comparison, coastline residents with incidental inhalational exposure had serum brevetoxin concentrations of up to 0.421 μg/L [4]. No fatalities were reported.

The patients in this cluster presented with findings consistent with classically described neurotoxic shellfish poisoning. However, the group also had some atypical features. Patient 1 reportedly seizure-like activity but was not postictal per the emergency medical services report or upon presentation. Patient 2 denied gastrointestinal symptoms yet had the highest reported serum brevetoxin concentration. Patient 3 reported mid-sternal chest pain with deep breathing, which is not a commonly reported symptom of neurotoxic shellfish poisoning.

Clinicians that practice in areas prone to harmful algal blooms are often aware of local hazards due to noxious conditions and published biomonitoring alerts [6]. Neurotoxic shellfish poisoning can occur remotely if contaminated shellfish is harvested and transported elsewhere [3]. Concomitant presentations shortly after consumption of a common shellfish can provide the key diagnostic clue. Toxicological considerations for patient taken ill shortly after seafood consumption includes: neurotoxic shellfish poisoning (brevetoxin), amnestic shellfish poisoning (domoic acid), diarrheal shellfish poisoning (okadaic acid), paralytic shellfish poisoning (saxitoxin), ciguatera fish poisoning (ciguatoxin), tetrodotoxic fish poisoning (tetrodotoxin), and palytoxin poisoning (palytoxin) [7]. Knowing the geographic region, severity and onset of symptoms, and food type can help narrow the differential diagnosis.

Patients with neurotoxic shellfish poisoning can present with a variety of gastrointestinal and neurological symptoms within minutes to hours. Resolution of symptoms can be expected within 12–24 h without sequelae. Brevetoxin concentrations, while confirmatory, are of no practical clinical use.

While a naturally occurring phenomena, harmful algal blooms are increasing in frequency and duration caused by climate changes and increased nutrient runoff in population centers [8]. It is expected that more patients will seek medical care for exposures to brevetoxin in areas prone to these harmful algal blooms.

Conclusions

This case cluster illustrates that individuals consuming brevetoxin-afflicted shellfish from the same source can present with variable gastrointestinal and neurological effects. Supportive care lasting up to one day is expected to be adequate care.

Disclosure statement

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