Seafood Intoxication

Toxin-induced seafood poisoning is an illness that physicians are likely to see more as the world economy and travel increase. Although there are many different marine toxins, the ones most likely to be encountered are ciguatera, scombroid, tetrodotoxin, and shellfish poisoning. Diagnosis is generally based on symptoms and history of eating a particular type of seafood. Treatment is primarily supportive and in most cases there is no specific treatment. Prevention is the best way to avoid toxin-induced illness.

There are three types of illness that affect humans after seafood ingestion: allergic, infectious, and toxin-induced. This review will focus on toxin-induced seafood poisoning. Every year, approximately 30 cases of poisoning by marine toxins are reported in the United States (1). Because healthcare providers are not required to report these illnesses and because there are many milder cases that are not diagnosed, the actual number of cases of toxin-induced seafood poisoning is most likely much greater (1). There are hundreds of different marine toxins with different epidemiology and clinical manifestations. The following review will focus on the toxins that physicians are most likely to encounter (Table 1).

Ciguatera fish poisoning affects 10,000–50,000 individuals worldwide each year, although the number is most likely underreported (2). Most cases originate in the tropics and subtropics, between 35 degrees north latitude and 35 degrees south latitude. Ciguatera, along with scombroid, is the most common non-bacterial cause of foodborne illness associated with the ingestion of fish (3). Most of the cases in the U.S. have been reported in Florida and Hawaii, however, there have been reports in Texas, Louisiana, Washington, D.C., Massachusetts, and Maryland (2). There have been over 400 different fish species associated with ciguatera. The most common sources are reef dwelling tropical fish such as barracuda, moray eel, amberjack, certain types of grouper, mackerel, parrot fish and red snapper.

Several toxins are responsible for toxicity, of which ciguatoxin is best known. Ciguatoxin is a lipid soluble polyether compound that is thought to be synthesized...
by specific bacteria after phagocytosis by the dinoflagellate *Gambierdiscus toxicus* (4). The organism adheres to dead coral surfaces and bottom-associated algae. The toxin is then incorporated into the food chain as the dinoflagellates are eaten by fish. These fish are then eaten by larger marine carnivores, which are then eaten by humans (4). Large predatory fish concentrate the toxin in their organs and flesh, and are considered most risky to human health. Ciguatoxin is a heat stable, acid resistant neurotoxin. Ciguatera toxin-containing fish do not taste, smell, or appear unusual. These toxins appear to open voltage dependent sodium channels in cell membranes, triggering membrane depolarization (3). Maitotoxin, another ciguatera associated toxin, increases calcium ion influx through excitable membranes (5,6). Other toxins that have been described are scaritoxin, okadaic acid, and palytoxin.

Ciguatoxin usually causes symptoms within a few minutes to 30 hours after ingestion of the fish. Common symptoms include nausea, vomiting, diarrhea, cramps, sweating, headache, and muscle aches (1). Neurologic symptoms usually begin three to 72 hours after ingestion and can include parasthesias, painful teeth, and cold allodynia. Cold allodynia (reversal of temperature sensation) or dysesthesia associated with contact with cold water or objects is almost pathognomonic of ciguatera (3). Ciguatera poisoning is rarely fatal and symptoms usually clear in one to four weeks (1). It is estimated that 3%–20% have chronic effects of ciguatera poisoning which include fatigue, loss of energy, myalgias, and headaches and these may be exacerbated by drinking alcohol, caffeine or eating nuts or fish (3,5).

Diagnosis of ciguatera poisoning is based on presentation and history as lab tests are not currently available (2). Treatment consists of symptomatic and supportive therapy, intravenous rehydration, antiemetics, anti-diarrhea medications, atropine for possible bradycardia, and anti-depressants. Three to twenty percent have chronic effects from ciguatera poisoning such as fatigue and loss of energy and anti-depressants are thought to help. Intravenous mannitol was considered treatment of choice but a recent double-blind randomized trial comparing mannitol to normal saline found no difference in relieving symptoms at 24 hours and was associated with more side effects (7).

### SCOMBROID

Scombroid poisoning causes nearly 5% of foodborne illnesses reported to the Center for Disease Control and Prevention and comprises approximately 37% of all seafood associated illness (2). Also referred to as histamine poisoning, it is due to the ingestion of fish

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**Table 1**

<table>
<thead>
<tr>
<th>Marine Toxins</th>
<th>Fish Affected</th>
<th>Location</th>
<th>Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ciguatera</td>
<td>Over 400 species—Moray eel, groupers, barracuda</td>
<td>Tropical, subtropical</td>
<td>Gastroenteritis Neurologic Bradycardia</td>
</tr>
<tr>
<td>Scombroid</td>
<td>Tuna, mackerel, amberjack</td>
<td>Coastal areas</td>
<td>Flushing, rash Palpitations, allergy-like Paralysis, respiratory failure</td>
</tr>
<tr>
<td>Tetrodotoxin</td>
<td>Pufferfish (fugu)</td>
<td>Japan common</td>
<td></td>
</tr>
</tbody>
</table>

**Shellfish Poisoning**

- **Paralytic (PSP)**
  - Clams, oysters, mussels
  - Temperate, tropical
  - Tingling, numbness neuromuscular, weakness

- **Neurotoxic (NSP)**
  - Shellfish
  - Gulf Coast
  - Temperate
  - Nausea, vomiting Diarrhea, Neurologic

- **Amnesic (ASP)**
  - Shellfish
  - Diarrhea
  - Vomiting, abdominal cramps

- **Diarrhetic (DSP)**
  - Shellfish
  - All areas (temperate, tropical)
  - Diarrhea
  - Vomiting, abdominal cramps
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FOODBORNE ILLNESS, SERIES #4

that contain high concentrations of histamine. It is caused by bacterial spoiling of certain fish such as tuna, mackerel, bonito, mahi-mahi, and bluefish. There are multiple case reports of poisoning occurring from eating tuna salad and tuna burgers (8,9,10).

Scombroid contamination is caused by bacterial overgrowth in improperly stored fish, usually at temperatures above 20 degrees Celsius for as little as two to three hours. These bacteria (most commonly Vibrio, Proteus, Klebsiella, Clostridium, E. coli, Salmonella, and Shigella) can decarboxylate endogenous histidine to form high levels of histamine and the toxic substance, saurine (3,5,11). These toxins are not broken down by cooking, freezing or subsequent refrigeration.

Symptoms usually appear minutes to a few hours after ingestion. These include tingling and burning sensation around the mouth, headache, facial flushing and sweating, rash and itching on the upper body, abdominal cramps, nausea and vomiting, diarrhea, and heart palpitations (9,12). Diagnosis is based on history and physical examination and can be confirmed by elevated serum or urine histidine levels (2). Bacterial decarboxylates endogenous histidine to histamine. Histamine is naturally present in muscle of dark meat fish. The decarboxylation produces high levels of histamine which causes the problems.

Treatments includes parental H₁ or H₂ blockers, oral activated charcoal, if the patient presents within one hour of ingestion as well as epinephrine and bronchodilators as needed (3). Scombroid poisoning usually resolves within 12 hours if untreated and has no longterm sequelae (5). Also, individuals who take isoniazid, which inhibits histamine metabolism, may be more vulnerable to poisoning (5).

TETRODOTOXIN

Tetrodotoxin is an inherent neurotoxin found in all puffer fish (balloon fish, swell fish, fugu fish, blowfish, toadfish, and globefish) (2). Also, a bite from the blue ringed octopus can result in the introduction of tetrodotoxin from the saliva (13). Most cases of poisoning occur in Japan or in Japanese communities where puffer fish are eaten as a delicacy (13).

The toxin blocks voltage gated sodium channels and exhibits effects on action potential generation and impulse conduction. Specifically, the toxin is a guanidinium toxin that prevents conduction in motor and sensory nerves by blocking sodium channels at the nodes of Ranvier (3). Within 10–15 minutes of ingestion, patients can experience numbness, tingling, visual disturbances and potentially fatal neuromuscular weakness. This toxin has been associated with many deaths, particularly in Japan. The mainstay of treatment is careful observation and serial neurological examination to determine more serious progression. After 24 hours, it is extremely unlikely that life-threatening effects will develop in patients who are not already severely poisoned (3).

SHELLFISH POISONING

In the United States, toxic shellfish poisoning accounts for approximately 1.1% of foodborne illness or 7.4% of marine toxicity (3). Paralytic, neurotoxic, amnesic, and diarrhetic are the four major toxic shellfish poisonings.

PARALYTIC SHELLFISH POISONING (PSP)

Paralytic Shellfish Poisoning (PSP) is a life threatening illness caused by more than 20 different structurally related saxitoxins with varying toxicities produced mainly by the Alexandrium species of dinoflagellates (2). It occurs in temperate climates and is linked to algal blooms called “red tides.” In the U.S., it occurs primarily along the northeast and northwest coasts (5).

These toxins are taken up by mollusks such as mussels, clams, and oysters and ingested by humans (5). These toxins, structurally similar to tetrodotoxin, block TTX-sensitive sodium channels, disrupting nerve conduction and result in paralysis and sensory nerve abnormalities (3). Clinical effects develop over 30 minutes to three hours. Paresthesias are usually the first effect that is noted, with tingling and numbness of the tongue and lips, then spreading to the face, neck, fingers, and toes. Patients often will describe a feeling of “floating” or disequilibrium (3). In severe cases, muscle paralysis and respiratory failure occur in two to 25 hours (1). With supportive treatment, patients usually recover within two to three days. The best method to prevent PSP is to avoid eating shellfish during red tide toxicity.

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alerts, many of which are made by federal and state governments (2). In the U.S., high-risk harvest areas are closed when toxin levels surpass 80 mcg/g (2).

**NEUROTOXIC SHELLFISH POISONING (NSP)**

Neurotoxic Shellfish Poisoning (NSP) occurs in the U.S., especially following algal blooms along the Gulf Coast in Florida and Texas (2). It is caused by a dinoflagellate with a toxin that occasionally accumulates in oysters, clams, and mussels. Symptoms begin one to three hours after eating the contaminated shellfish and include numbness, tingling in the mouth, arms and legs, incoordination and gastrointestinal upset (1). Treatment is supportive and complete recovery usually occurs in 48 hours.

**AMNESIC SHELLFISH POISONING (ASP)**

Amnesic Shellfish Poisoning (ASP) is a rare syndrome caused by a heat stable toxin called domoic acid, which is produced by single-celled, algae-like organism called diatoms (5). It acts as a powerful neurotransmitter and can cause death of neurons in the amygdala and hippocampus (5). Symptoms usually begin with diarrhea and abdominal cramps, but in severe poisoning patients become dizzy, ataxic, and experience cognitive difficulties. Treatment is symptomatic, but the loss of short-term memory, confusion and occurrence of seizures may be permanent (13). Canadian authorities monitor mussels and clams for domoic acid and close shellfish beds when levels exceed 20 mcg/g (2).

**DIARRHEATIC SHELLFISH POISONING (DSP)**

Diarrhetic Shellfish Poisoning (DSP) is characterized by a severe gastroenteritis and is not associated with nerve effects. Three classes of toxins, derived from a dinoflagellate species, have been identified and include okadaic acid and dinophysistoxins, pectenotoxins, and yessotoxins. These toxins were found to be widely distributed in Japan, coastal regions of Western Europe, South America, and New Zealand (3). Symptoms include chills, nausea and vomiting, diarrhea, and abdominal cramps. Symptoms usually occur within two hours of ingestion and resolve within two days.

**PREVENTION**

In addition to the measures outlined earlier, the Centers for Disease Control website, www.cdc.gov offers some specific tips:

1. Keep fresh tuna, mackerel, grouper, and mahi-mahi refrigerated to prevent development of histamine. Remember these toxins are not destroyed by cooking.
2. Do not eat barracuda, especially those from the Caribbean.
3. Check with local health officials before collecting shellfish, and look for Health Department advisories about algal blooms, dinoflagellate growth or “red tide” conditions that may be posted at fishing supply stores.
4. Do not eat finfish or shellfish sold as bait. These products do not meet the same food safety regulations as seafood for human consumption.

**References**