Poisoning, Envenomation, and Trauma from Marine Creatures

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In the course of their clinical work or during leisure activity, family physicians occasionally may encounter patients with injuries from marine creatures. Poisoning, envenomation, and direct trauma are all possible in the marine environment. Ciguatera poisoning can result from ingestion of predatory fish that have accumulated biotoxins. Symptoms can be gastrointestinal or neurologic, or mixed. Management is mostly symptomatic. Scombroid poisoning results from ingestion of fish in which histamine-like substances have developed because of improper refrigeration. Gastrointestinal and systemic symptoms occur. Treatment is based on antihistamines. Envenomations from jellyfish in U.S. waters and the Caribbean are painful but rarely deadly. Household vinegar deactivates the nematocysts, and manual removal of tentacles is important. Treatment is symptomatic. Heat immersion may help with the pain. Stingrays cause localized damage and a typically severe envenomation. The venom is deactivated by heat. The stingray spine, including the venom gland, typically is difficult to remove from the victim, and radiographs may be necessary to localize the spine or fragment. Surgical débridement occasionally is needed. Direct trauma can result from contact with marine creatures. Hemorrhage and tissue damage occasionally are severe. Infections with organisms unique to the marine environment are possible; antibiotic choices are based on location and type of injury. Shark attacks, although rare, require immediate attention. (Am Fam Physician 2004;69:885-90,893-4. Copyright© 2004 American Academy of Family Physicians.)

0 *A patient information handout on treating injuries from marine creatures is*

The United States has more than 80,000 miles of coastline and a population showing increasing interest in scuba diving, snorkeling, surfing, and other water sports. Thus, more persons in this country will be coming in contact with marine life, and the potential for illness and injury from marine creatures is likely to increase. Family physicians may be called on to treat patients who have suffered trauma, envenomation, or poisoning from marine creatures. Marine medicine is still relatively new, so treatment recommendations for these conditions are largely based on case reports and expert opinion, with few randomized controlled studies available to guide management. Misdiagnosis is common, especially if the contact took place while the patient was traveling overseas or if the patient has been poisoned by improperly refrigerated seafood. This article describes ailments and injuries occurring as a consequence of direct contact with marine creatures, and discusses prevention and management options.

TABLE 1
Fish Commonly Associated with Ciguatera Poisoning in the United States

Amberjack
Grouper
Snapper
Sturgeon
King mackerel
Barracuda
Moray eel (most toxic)

Information from reference 1.

See page 922 for definitions of level-of-evidence labels.

Poisoning

CIGUATERA

Ciguatera poisoning is caused by ingestion of reef fish (*Table 1*)[1] that have bioaccumulated sufficient amounts of the dinoflagellate *Gambierdiscus toxicus* through direct ingestion or ingestion of smaller reef fish. Although

Cold sensation reversal is considered pathognomonic for ciguatera poisoning.

limited to tropical regions, the dinoflagellate is heat- and lipid-soluble and can survive transport to other areas. The toxin becomes more concentrated as it is passed up the food chain.

Each year, ciguatera poisoning accounts for several thousand illnesses in Puerto Rico, the U.S. Virgin Islands, Hawaii, and Florida. Patients exhibit primarily gastrointestinal or neurologic symptoms, or a mixed pattern of symptoms. A cold sensation reversal, in which the patient perceives cold temperatures as hot sensations, and vice versa, occurs in 80 percent of patients and is considered pathognomonic for ciguatera poison (*Table 2*).[1,2]

The attack rate may be as high as 80 to 90 percent in persons who ingest affected fish, depending on the size of the fish and the toxin load. Symptoms also are related to the number of exposures, with patients typically having more severe symptoms with subsequent exposures. No immunity is acquired through exposure. Symptoms begin one to six hours after ingestion, although a delay of 12 to 24 hours is possible. The duration of symptoms is typically seven to 14 days, with symptoms occasionally persisting for months to years.[2]

Currently, recommended treatment for ciguatera poisoning is supportive (*Table 3*).[1] [Evidence level C, expert opinion/consensus guidelines] In most cases, provision of intravenous fluids to replace gastrointestinal losses is adequate. The use of atropine is indicated in patients with bradycardia, and temporary electrical pacing may be required in patients with refractory symptoms. Severe hypotension may require the use of pressors. Although mannitol (Osmitrol) often is cited as effective in reducing the duration of neurologic symptoms, the only double-blind trial failed to show any benefit.[3] [Evidence level A, randomized controlled trial (RCT)]

The ciguatera toxin is not deactivated by cooking, freezing, smoking, or salting. There are no outward signs of ciguatera—the affected fish look, taste, and smell normal. Although several commercial assays are available, they are not sensitive or specific enough

TABLE 2
Symptom Patterns Associated with Ciguatera Poisoning

Gastrointestinal*
Nausea or vomiting
Profuse, watery diarrhea
Abdominal pain
Neurologic†
Numbness
Paresthesias
Vertigo
Ataxia
Severe weakness or lethargy
Severe myalgia
Decreased vibration and pain sensations
Diffuse pain
Cold sensation reversal
Coma
Cardiovascular‡
Bradycardia
Hypotension

NOTE: *Generally, symptoms are noted within six to 12 hours after ingestion of tropical reef fish, but symptoms may begin within 15 minutes or be delayed as long as 24 hours after ingestion. Symptoms increase in frequency and severity over four to six hours.*

**—Often first to appear, lasting one to two days.*
†—Usually multiple, varied, and can be bizarre. Symptoms begin within a few hours or up to three days after the meal, and can last several months.
‡—Uncommon, but can be severe.

Information from references 1 and 2.

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to be relied on to prevent ciguatera poisoning. The only preventive measure is to avoid eating warm-water reef fish, especially those caught where ciguatera poisoning is known to occur, and large game fish from high in the food chain. If such fish are eaten, the risk of poisoning may be decreased by avoiding the consumption of internal organs and limiting the amount of initial ingestion. Although most cases of poisoning result from direct ingestion, in some cases ciguatera has been passed through sexual contact and breast milk.[1]

Supportive treatment and management of symptoms is the recommended treatment for ciguatera poisoning.

SCOMBROID

In the United States, scombroid poisoning is most common in Hawaii and California. Scombroid toxicity usually results from improper handling between the time the fish is caught and the time it is cooked. Improper preservation and refrigeration lead to production of histamine and histamine-like substances in the dark meat of certain fish such as tuna and mackerel.[4] The histamine reaction develops 20 to 30 minutes after ingestion. The symptoms—which include any or all of the following: flushing, nausea, vomiting, diarrhea, severe headache, palpitations, abdominal cramping, dizziness, dry mouth, urticaria, and conjunctival injection—typically last less than six to eight hours.[4]

For treatment, antihistamines (50 mg of diphenhydramine [Benadryl] or its equivalent) are delivered intravenously or intramuscularly in severe cases, and orally in milder cases. In severe cases, 300 mg of cimetidine (Tagamet) may be added for more complete histamine-receptor blockade. If ingestion was recent, induced emesis may be considered.[4] [Evidence level of evidence C, expert opinion/consensus guidelines] Patients should be instructed that they have not had an allergic reaction to fish, because the histamine is exogenous. Prevention is possible in regions where food storage and preparation are monitored through identification and removal of suspect fish.[4]

TABLE 3
Treatment of Ciguatera Poisoning

Agent	*Dosage*	*Indication*
Intravenous fluid	As clinically indicated	Volume replacement
Atropine	0.5 to 1.0 mg IV every three to five minutes to a maximum dose of 0.04 mg per kg per episode	Bradycardia
Pressors: dopamine (Intropin), dobutamine (Dobutrex), epinephrine	Titrated to clinical response	Hypotension
Antihistamines (no single agent preferred)	As clinically indicated	Pruritus
Mannitol (Osmitrol)	1 g per kg of 20 percent solution IV over several hours	Neurologic symptoms*
Amitriptyline (Elavil)	25 mg orally twice a day	Pruritus or dysesthesias

IV = intravenously.

**—Studied only in one double-blind clinical trial[3] and did not demonstrate benefit.*

Information from reference 1.

Nematocysts can cause stings even when detached from the jellyfish.

Envenomation

Many marine creatures are venomous, and beachgoers experience envenomation regularly. Jellyfish and related creatures (Cnidaria), sea urchins (Echinodermata), and stingrays (Chondrichthyes) are some of the more easily identified marine creatures involved with envenomations.

JELLYFISH

These invertebrates have stinging cells, called nematocysts, that continue to function when separated from the organism. For example, jellyfish nematocysts can sting if the tentacle is separated from the body and after the jellyfish is dead. The venom is antigenic and can cause a dermatonecrotic, hemolytic, cardiopathic, or neurotoxic reaction. The severity of the reaction depends on several variables, including the number of nematocysts that discharge, the toxicity of the coelenterate involved, and the unique antigenic response of the patient.

Although fatal anaphylaxis occurs occasionally in the United States and the Caribbean, the primary concern from these stings is pain, which is almost always self-limiting (*Table 4*).[5,6] The symptoms may last two to three days. Certain Pacific jellyfish are much more dangerous, but they are limited to the waters around Australia.[5]

Treatment of jellyfish stings in the United States and the Caribbean is concerned mostly with limiting pain and neurologic symptoms. The following general guideline can be applied. The patient should remove any visible tentacles carefully, using gloves or forceps if available to prevent further stings. If a towel is used for protection, any nematocysts adhering to the towel will discharge. Household vinegar can block discharge of the remaining nematocysts on the skin and should be applied liberally. If vinegar is not available, salt water can be used to wash off the nematocysts. Other solutions such as urine or fresh water and rubbing with sand should be avoided.[5]

If the patient presents to the physician's office, household vinegar (5 percent acetic acid) should be applied for 30 minutes or until the pain subsides, followed by removal of the nematocysts, using gloves or forceps. Another method of removing the nematocysts is to apply shaving cream or a baking soda slurry to the area and then scrape off the nematocysts with a razor.[5] [Evidence level B, double-blinded randomized trial]

Application of cold in the form of an ice pack or hot-water immersion have variously been shown to relieve pain, but because of the self-limited nature of the discomfort, it is hard to gauge an optimal therapy. Hot or cold therapy probably is acceptable until the patient is comfortable. Meat tenderizer has been found to be ineffective.[6-8] [Reference 8—Evidence level A, RCT] Although not supported by evidence, local anesthetics, antihistamines, and steroids have been used to control prolonged symptoms. Antibiotics generally are not necessary.

TABLE 4
Symptoms of Cnidaria Envenomation in the United States and Caribbean

Local pain
Paresthesias
Nausea
Headache
Chills
Cardiovascular collapse

NOTE: *Listed in order from most common to least common.*

Information from references 5 and 6.

ECHINODERMS

The echinoderm family includes sea urchins. Urchins have toxin-coated spines that

TABLE 5
Antibiotic Treatment of Infections Associated with Marine Trauma

Outpatient management
Ciprofloxacin (Cipro)
Trimethoprim-sulfamethoxazole (Bactrim, Septra)
Doxycycline (Vibramycin)
Inpatient management
Third-generation cephalosporin (cefoperazone [Cefobid], ceftazidime [Ceptaz, Fortaz], ceftizoxime [Cefizox], ceftriaxone [Rocephin])
Ciprofloxacin
Gentamicin (Garamycin)
Trimethoprim-sulfamethoxazole
Cefuroxime (Zinacef, Ceftin)

NOTE: *Common organisms associated with marine trauma include Staphylococcus and Streptococcus species,* Vibrio vulnificus,* *and* Mycobacterium marinum.*

**—Unique to marine environments.*

Information from reference 5.

break off, leaving calcareous material in the wound that potentially can cause infection. Symptoms include local pain, burning, and discoloration. The discoloration is thought to be a temporary tattooing of the skin resulting from dye in the spines. Absence of a spine in the skin is indicated if the discoloration spontaneously resolves within 48 hours.

Theoretically, hot water disables the toxin, although there is no evidence that this treatment is effective in humans. If a spine is present and easily accessible, it should be removed with fingers or forceps. If it is close to a joint or a neurovascular structure, it should be removed surgically. If the patient is not symptomatic, retained pieces of spine likely will absorb into the skin.[5]

STINGRAYS

Although many fish are venomous, stingrays are the most clinically important, accounting for an estimated 1,500 (mostly minor) injuries in the United States annually. These creatures partially bury themselves in the sandy bottom of the ocean shallows, where water enthusiasts may accidentally step on them.

Stingrays have a spine at the base of their tail that contains a venom gland. The spine, including the venom gland, may be broken off in the attack and may remain in the wound.

Stingray venom includes vasoconstrictors that can cause poor wound healing and tissue necrosis.

The venom has vasoconstrictive properties that can lead to cyanosis and necrosis, with poor wound healing and infection. Symptoms include immediate and intense pain, salivation, nausea, vomiting, diarrhea, muscle cramps, dyspnea, seizures, headaches, and cardiac arrhythmias. Fatalities are rare and usually a consequence of exsanguination at the scene or penetration of a vital organ.

Home care should include rinsing the area thoroughly with fresh water, if available (salt water may be used if necessary) and removing any foreign body. If the damage is minimal, the patient may soak the wound in warm water at home. The patient should watch for signs of infection and seek care for excessive bleeding, a retained foreign body, or infection.[5,9] [Reference 9—Evidence level C, expert opinion/consensus guidelines] Medical treatment includes achieving hemostasis followed by submersion of the affected region in hot, but not scalding, water (42° to 45°C [108° to 113°F]) for 30 to 90 minutes or until the pain resolves. Typically, spines and stingers are radiopaque, so radiography or ultrasonography may be used to locate any remaining pieces.

The wound should be thoroughly cleansed, and delayed closure should be allowed. Tetanus immunization status should be reviewed and updated as appropriate. Surgical exploration may be necessary to remove residual foreign bodies. Prophylactic antibiotics (*Table 5*)[5] are typically not necessary unless there is a residual foreign body or the patient is immunosuppressed.[9]

Trauma

Abrasions, bites, and lacerations are usually the result of a marine creature's instinct to protect itself against a perceived danger. The most commonly involved creatures are octopi,

TABLE 6
Management of Marine Injuries: General Principles

Remove the patient from the water.
Ensure airway control.
Control bleeding.
Do not remove wet suit if the patient is wearing one.
Attempt to identify creature involved in injury.
Transport the patient to a hospital.
Irrigate the wound with normal saline.
Surgically débride the wound, as appropriate.
If sutures must be placed, they must be loose to allow drainage. Primary suturing should be avoided in puncture wounds, crush injuries, and wounds in the distal extremities.
Start appropriate antibiotic therapy, if indicated.

Information from references 5 and 9.

sharks, moray eels, and barracuda. The trauma alone creates problems for patients, but the injury can be complicated by envenomation. It often is difficult to identify the marine creature involved in the attack. Treatment is symptomatic; local cleansing and topical dressing usually are adequate. If the wound becomes infected, antibiotics that cover common organisms should be selected (*Table 5*).[5]

Although sharks receive much publicity, about 50 shark attacks occur worldwide annually, and these result in fewer than 10 deaths.[10] Most of these attacks are in South African waters. Typically, these attacks involve tiger, great white, gray reef, and bull sharks. Attacks generally occur in shallow water within 100 feet of shore during the evening hours when sharks tend to feed. Common sense dictates avoiding areas of water where aggressive shark feeding has been noted.

Symptoms of shark attack range from abrasions to death from hemorrhage. Abrasions and lacerations occur when sharks brush against or aggressively investigate humans. Soft tissue and neurovascular damage, and fractures result from attacks. Most attacks result in minor injuries that require general wound care and, sometimes, simple suturing. The morbidity increases when wounds are greater than 20 cm or when more than one myofascial compartment is lost.

General principles of first aid in marine creature injuries are listed in *Table 6*[5,9] and should be followed in any and all marine injuries. Although it would seem self-evident, practices such as urinating on the injury, applying oil or gasoline to the injury, or applying any strong oxidizing agents, such as bases or acids, should be counseled against in patient education about self-care.

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