FIRST AID FOR HAZARDOUS MARINE LIFE INJURIES

STUDENT HANDBOOK

DAN® SOUTHERN AFRICA

FIRST AID FOR HAZARDOUS MARINE LIFE INJURIES STUDENT HANDBOOK

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1 First Aid for Hazardous Marine Life Injuries Course Overview

One reason many people learn to dive is to interact with and observe marine life; however, this is the same reason some are afraid to scuba dive. Fortunately, injuries caused by hazardous marine life are rare and usually the result of a diver's actions. Any time we enter the marine environment there is always the risk of being stung, bitten or lacerated by aquatic animals. These injuries are usually mild and require only simple interventions by first-aid providers. On rare occasions, more involved care is necessary.

The First Aid for Hazardous Marine Life Injuries course is an entry-level training programme that teaches participants how to identify potentially hazardous marine life, how to provide first aid when injuries occur and techniques for avoidance.

Successful completion of the First Aid for Hazardous Marine Life Injuries course includes demonstrating skill competency and passing a written knowledge assessment. Upon completion, you will receive a provider card indicating that you have been trained in basic first aid for hazardous marine life injuries.

First-Responder Roles and Responsibilities
First aid is the provision of initial care for an injury or illness. The three key aims of first aid are to (1) preserve life, (2) prevent the condition from worsening and (3) promote recovery. All skills performed in an emergency should be within the scope of one's training. Maintain skills and knowledge proficiency by reading current literature and participating in supervised practice sessions. Talk to your HMLI Instructor for options.

Reading this handbook without instruction and practice will not make someone competent to use first aid with regard to hazardous marine life injuries.

Prerequisites
There are no prerequisites for this course. However, the key foundation to the chain of survival is basic life support (BLS). Therefore, we highly recommend cardiopulmonary resuscitation (CPR) and first-aid training prior to participation. Ask your HMLI Instructor for more information about the Basic Life Support: CPR and First Aid programme.

Scuba Certification
Scuba diving certification is not a course prerequisite. This course teaches scuba divers and interested nondivers how to provide first aid for common marine life injuries. Interested and informed nondivers should be able to master the material.

Retraining
Emergency-response skills deteriorate with time. Retraining is required every two years to maintain DAN First Aid for Hazardous Marine Life Injuries provider certification. In addition, regular practice is encouraged, when possible, to retain skill proficiency. Your HMLI Instructor can provide information about these programmes.

Continuing Education
Other first-aid programmes that may be available through your HMLI instructor include Basic Life Support: CPR and First Aid, Emergency Oxygen for Scuba Diving Injuries, Neurological Assessment, and CPR: Health-Care Provider with First Aid. Two additional programmes that encompass content from multiple courses are Dive Emergency Management Provider and Diving First Aid for Professional Divers.

While certification in these programmes is not required for participation in the First Aid for Hazardous Marine Life Injuries course, it is strongly recommended that you obtain training in these essential life-saving skills.

How To Use This Handbook
Each chapter in this student handbook contains three distinct features
- The beginning of each chapter has a list of questions to assist with learning. This is the information you should look for as you read the material, complete the knowledge development sections and participate in class discussions
- Boxes with the word "Note" provide explanations that are important to understanding the material just presented
- Boxes titled "Advanced Concepts" contain additional information beyond what is required for this course. It is enrichment for students who want to know more

Terminology
The First Aid for Hazardous Marine Life Injuries student handbook introduces medical terms that may be unfamiliar to some readers. Familiarity with basic medical terminology will enhance the quality of communication with emergency and health-care workers, should it be required. A glossary of terms is provided in the back of this handbook.

Throughout this text, words marked with a superscript asterisk (e.g., toxinology*) will be covered in the glossary to facilitate learning. In addition, the medical description of some signs and symptoms has been provided along with their common descriptions within the text of this student handbook.

Unique to First Aid for Hazardous Marine Life Injuries, this handbook contains bonus content — information not required for course completion but provided for those who have an interest in marine biology. It is set apart from required text by framed boxes.

2 Introduction to Hazardous Marine Life Injuries

CHAPTER 2 OBJECTIVES

1. What are the three general categories of marine life injuries?
2. What is an envenomation?
3. What is the usual trigger for marine animal bites?
4. What is the primary cause of seafood poisoning?

Hazardous marine life injuries fall into one or more of the following three categories:

1. Envenomations
2. Traumatic injuries
3. Seafood poisonings

Appropriate first aid will depend on the type and source of injury.

Signs and symptoms will vary and are influenced by several factors, including the type of injury, differences in individual reaction, treatment provided and treatment delays. Additional factors may include the person's underlying health status, and the type, potency and quantity of injected or ingested venom/toxin or extent of tissue trauma.

Envenomations – Envenomation is the process by which venom or toxin is injected into another creature by means of a bite, puncture or sting. Fish (e.g., lionfish) use venom as a defense mechanism. Injuries result from direct contact with spines or fins. Such encounters often occur as a result of inadvertent contact while entering or exiting the water or when handling marine life. Envenomations are rare but can be life-threatening and may require rapid response by first-aid providers. Common signs of envenomation along with the appropriate first-aid procedures are described later in this book.

Traumatic injuries – Bites account for most of the trauma associated with marine life injuries. Fortunately, these occurrences are extremely rare and usually due to defensive reactions by the animal or from misidentification of a diver's body part (such as a finger) as a food source. Bites may occur when divers feed animals such as moray eels, barracudas and sharks. Bites are almost always accidental and rarely life-threatening.

Seafood poisonings – Food poisoning occurs as a result of ingestion of food or liquids contaminated with harmful bacteria, parasites, viruses or toxins.

Taxonomy

Taxonomy is the scientific system used to organise life and indicate natural relationships between different organisms. The table below provides examples of this system through the phylogenetic* organization of some common organisms.

The first column identifies the primary taxonomy categories. The remaining columns provide examples of how this system is applied for different organisms (human, E. *coli,* kidney bean, shiitake mushroom).

The final row, "scientific name," combines the genus and species and is inserted for clarity but might not be found in standard tables.

NOTE

When describing the larger group to which an organism belongs, we will often reference the order.

Table 1. Taxonomy or phylogenetic lineage of four common organisms

Taxonomy	Human	E. coli (bacteria)	Kidney bean	Shiitake mushroom
Domain	Eukaryota*	Prokaryote* (Bacteria)	Eukaryota*	Eukaryota*
Kingdom	Animalia	Monera	Plantae	Fungi
Phylum	Chordata*	Proteobacteria	Magnoliophyta	Basidiomycota
Subphylum	Vertebrata		Magnoliophytina	Agaricomycotina
Class	Mammalia	Gammaproteobacteria	Magnoliopsida	Agaricomycetes
Subclass	Eutheria		Magnoliidae	Agaricomycetidae
Order	Primates	Enterobacteriales	Fabales	Agaricales
Suborder	Haplorrhini		Fabineae	
Family	Hominidae	Enterobacteriaceae	Fabaceae	Marasmiaceae
Subfamily	Homininae		Faboideae	
Genus	*Homo*	*Escherichia*	*Pisum*	*Lentinula*
Species	*sapiens*	*coli*	*sativum*	*edodes*
Scientific name	*Homo sapiens*	*Escherichia coli*	*Pisum sativum*	*Lentinula edodes*

**See glossary.*

Table 2 shows the primary members of vertebrate and invertebrate families associated with human injury.

Table 2. Taxonomy of specific organisms covered in this text

Vertebrates	Invertebrates
Scorpionfish and stonefish Phylum: Chordata Class: Actinopterygii (ray-finned fish) Order: Scorpaeniformes Suborder: Scorpaenidae *Pterois* spp. *Scorpaena* spp. Suborder: Synanceiidae *Synaceja* spp. **Stingrays** Phylum: Chordata Class: Chondrichthyes Order: Myliobatiformes Family: Urotygonidae **Sea snakes** Phylum: Chordata Class: Reptilia Order: Squamata Suborder: Serpentes Family: Elapidae Subfamily: Hydrophiinae	**Cnidarians (jellyfish, corals and anemones)** Phylum: Cnidaria Class: Hydrozoa *Millepora* spp. (fire coral) *Physalia* spp. (Portuguese man-of-war) Class: Cubozoa (box jellyfish) *Chironex fleckerii* *Chiropsalmus* spp. *Carukia* and *Malo* spp. (Irukandji) Class: Scyphozoa (true jellyfish) Class: Anthozoa (anemones and corals) **Mollusks** Phylum: Mollusca Class: Gastropoda *Conus* spp. (cone snails) *Glaucus* spp. (blue ocean slug) Class: Cephalopoda (octopuses and squids) *Hapalochlaena* spp. (blue-ringed octopus) **Echinoderms (urchins, starfish and sea cucumbers)** Phylum: Echinodermata Class: Echinoidea (sea urchins) Class: Asteroidea (starfish) *Acanthaster planci* (crown-of-thorns) Class: Holothuroidea (sea cucumbers) **Sponges** Phylum: Porifera **Bristle worms** Phylum: Annelida

Standard Precautions

When treating any marine life injury, the safety of the first-aid provider is just as important. The use of protective barriers is essential to preventing injury to the rescuers while they are providing care. When removing stinging debris such as jellyfish tentacles or controlling external bleeding from an open wound, protective barriers are of particular importance.

Before providing care, don non-latex, medical-style gloves. If protective eyewear or masks are available, they should be used as well.

CHAPTER 2 REVIEW QUESTIONS

1. **The three general categories of marine life injuries include**
   a. envenomations
   b. traumatic injuries
   c. seafood poisoning
   d. all of the above

2. **Envenomation is a process facilitated by bites, punctures or stings**
   a. True
   b. False

3. **Marine animal bites are usually fatal**
   a. True
   b. False

4. **Seafood poisoning is the result of contaminated food or liquids**
   a. True
   b. False

5. **Standard precautions include the use of**
   a. non-latex, medical-style gloves
   b. surgical-style masks
   c. protective eyewear
   d. all of the above

Answers to review questions are on Page 78.

3 Envenomations and Toxins

CHAPTER 3 OBJECTIVES

1. By what mechanisms do envenomations occur?
2. Why do most envenomations occur?
3. What factors may impact the victims' response to envenomations?
4. What are the first-aid steps for venomous fish injuries?
5. For which three injuries is the pressure immobilisation technique recommended?
6. What are the general first-aid guidelines for jellyfish stings?
7. What are the general first-aid guidelines for treating injuries resulting from contact with marine life?

Recognition of Venomous Marine Life and Treatment of Injuries

The mechanisms of marine envenomations include stings, spines, bites and barbs. Most of these injuries result from the animal's defensive actions or accidental contact. Our physical reactions to these encounters are dependent upon several factors, including venom potency, volume injected and the area involved. Underlying factors such as the individual's health status, sensitivity to venom and delays to first aid and treatment all impact the extent of victim response.

Envenomations may also cause allergic reactions and, in severe cases, an exaggerated reaction may cause airway narrowing. First-responder responsibilities always include basic life support, which may be as simple as maintenance of an open airway or include provision of CPR. The signs and appropriate first-aid procedures for severe allergic reactions are described later in this handbook.

Regardless of the type of venomous marine animal injury, appropriate first aid is intended to minimise the effects of injury.

NOTE

All wounds acquired in or subjected to a marine environment carry the risk of infection with the bacteria that causes tetanus. The Centers for Disease Control and Prevention (CDC) recommends tetanus boosters every 10 years (subsequent to completing the initial series). Repeat boosters are advised when high-risk wounds occur more than five years since your last tetanus booster. Deep puncture wounds are a risk factor for tetanus infection and should always receive thorough cleaning and medical evaluation, which may include a tetanus booster (Td or Tdap).*

PART 1: VERTEBRATES

Vertebrate animals are characterised by the presence of backbones and spinal columns. Members include fish, amphibians, reptiles, birds and mammals. Envenomations from fish species include localised trauma in the form of puncture wounds and lacerations.

While the extent and nature of each injury is unique and will vary depending on the animal, the essential approach to first aid is consistent. General signs and symptoms plus generic first aid follows. Treatment specific to a particular animal is listed with its description below.

Lionfish, scorpionfish, stonefish

Phylum: Chordata
Class: Actinopterygii
Order: Scorpaeniformes
Suborder: Scorpaenoidei

These fish have characteristic physical attributes and for this course are separated into two different groups. One is very extravagant and represented by well-known organisms such as lionfish or zebrafish. The other is well-camouflaged (or mimetic, indicating attempts to mimic their surroundings). This group includes stonefish, scorpionfish and leaf fish.

Members of this order are found in oceans all over the globe. Typically nocturnal, these fish are voracious predators. Generally docile, they allow curious divers to closely approach, which enhances the risk for accidental contact. Venom is rapidly injected through needle-like spines located along the dorsal, pectoral, pelvic and anal fins.

Puncture wounds can be painful, with rapid oedema and subcutaneous bleeding. Pain can last for several hours, oedema typically resolves in two to three days and the tissue discolourations can last up to four or five days.

Rare but serious signs include cyanosis*, bradycardia (slow heart rates), hypotension* and respiratory failure. In extreme cases, compartment syndrome and tissue necrosis may occur.

NOTE

Skeletal muscle is wrapped in a tough, fibrous sheath called fascia, which forms a muscle compartment. As fascial tissue doesn't readily stretch, tissue trauma or envenomation that causes bleeding or oedema within the compartment may result in elevated compartment pressures. Compartment syndrome describes a situation in which pressures within a muscle compartment have elevated enough to compress nerves and blood vessels. If pressures rise enough to choke off blood flow both in and out of the area, tissue death from lack of oxygenation within the compartment can occur. Compartment syndrome most often involves the forearm and lower leg.

Summary: Lionfish, stonefish, scorpionfish and other Scorpaena

- Envenomation results from direct contact/puncture
- Mimetic species tend to cause more serious reactions
- Oedema can rapidly become significant
- Pain may be severe
- Deep puncture wounds can become infected
  - Tetanus can result from these wounds
- First aid involves cleaning the wound, controlling pain and applying topical antibiotics

Stingrays

Phylum: Chordata
Class: Chondrichthyes
Order: Myliobatiformes
Suborder: Myliobatoidei

Stingrays are usually shy fish and are closely related to sharks. They do not typically represent a risk to divers unless threatened, startled or stepped on.

Stingrays feed on sandy seabeds and are responsible for approximately 1 500 accidents per year in the United States. Most injuries occur in shallow water, due to foot traffic where stingrays reside. Fatalities due to stingrays are infrequent and occurrences are not consistently tracked.

Stingrays are armed with a serrated, bony barb at the end of their tail. When threatened or stepped on, stingrays will strike, and the barb can easily penetrate or cause deep and painful lacerations. A typical wetsuit offers limited protection. These types of wounds carry a particularly high risk of serious infection.

Venom glands are located at the base of the barb. The venom is a variable mixture of substances, none of which are specific to the animal, therefore the creation of a specific antivenom is not possible. The initial concern with stingray injuries is the trauma and pain from the barb puncture wound. The risks of infection is a serious concern that requires monitoring of the injury.

Summary: Stingrays

- Injuries are rarely fatal
- Pain is scorching in nature and can be out of proportion to the injury
- Wounds can become infected easily
  - Tetanus and other forms of soft-tissue infections can result from these wounds
- First aid involves controlling bleeding, cleaning the wound and controlling pain
- Definitive medical care may include surgical wound debridement, antibiotics and tetanus vaccination

Treating venomous fish injuries

Signs and symptoms

- Puncture or laceration
- Blisters around the puncture site
- Patches of purple or black skin colouration
- Intense pain
- Swelling
  - Can lead to compartment syndrome
- Other:
  - Nausea
  - Vomiting
  - Shock (rare)
  - Respiratory arrest (rare)
  - Cardiac arrest (rare)

First aid (lionfish/stonefish and stingrays)

- Wash the area thoroughly with soap and fresh water (tap water is fine)
- Remove foreign material
- Control bleeding (if present)
- Pain control: Immerse the affected area in nonscalding fresh water (upper limit 45°C) for 30 to 90 minutes (repeat as needed).
- Apply topical antibiotic ointment or cream, if available
- Apply bandaging as necessary
- If necessary, administer pain-control medications
- Seek professional medical evaluation as medical management may include sedatives, tetanus vaccination and antibiotics. Advanced life support may be required in rare instances

NOTE

The use of heat to the affected area is effective for pain control and can be repeated as needed. Cold packs can also be used, and may provide relief and reduce or minimise swelling.

ADVANCED CONCEPTS

Thermolysis describes the use of heat (often by immersion of the affected area in hot water) to break down substances (*thermo* meaning heat, and *lysis* meaning breakdown or destruction). For venoms comprised primarily of proteins, this may denature them and reduce their potency.

Protein denaturation*, however, may not be necessarily limited to venom and may also injure healthy tissue in the affected area. Each case is unique and requires some estimation of the depth to which the venom was injected. If the inoculation occurs in deep tissues, heat at the surface of the skin will rapidly diffuse and deeper tissues will not acquire the temperatures necessary to denature foreign proteins. In addition, vasodilatation caused by exposure to elevated temperatures may expedite the onset of absorption and the onset of systemic effects. Thermolysis is not recommended in first-aid circumstances since temperatures high enough to denature venom proteins can also cause severe burns. If attempted, minimise the risk of local tissue damage by testing the water on yourself first. Use the hottest temperatures you can tolerate while avoiding scalding. Do not rely on the victim's assessment, as intense pain may impair his/her ability to discriminate between "hot but tolerable," "too hot" and "much too hot."

Sea snakes

Phylum: Chordata
Class: Reptilia
Order: Squamata
Suborder: Serpentes

Sea snakes are highly venomous, air-breathing animals that are well adapted to marine life, and are related to land species such as cobras and coral snakes. They have a paddle-shaped tail and the adult sea snake can reach 90-110 cm in length. They are adept and graceful swimmers and have been known to reach depths of up to 40 m or more. Their habitat includes the Indian and Pacific oceans.

These animals are rarely a threat to divers or swimmers. They are often curious, and may approach divers in a fast and deliberate manner that can be construed as aggressive. The best way to handle these situations is to remain calm and swim in a different direction. Armed with small fangs (2-3 mm), most of their bites do not result in envenomation.

Multiple bites with tiny jagged lacerations are suggestive of venom inoculation. Sea snakes can produce an average of 10-15 mg of venom — a sobering thought, when 1.5 mg is enough to kill an average adult human.

Sea snake venom rarely contains large quantities of tissue-toxic compounds, therefore bites will rarely cause localised pain. However, their venom does contain neurotoxic components, which can cause paralysis. Venom may have muscle-specific toxic effects that can result in a condition known as rhabdomyolysis*. This is a serious condition that can cause loss of kidney function and require medical intervention. Symptoms usually appear within two hours after the bite; more serious poisonings may present sooner. A bite victim should be kept under observation in a medical facility. If a bite victim remains symptom free for more than eight hours, envenomation is unlikely, but continued medical supervision may still be warranted.

Fatalities associated with snake bites are unknown among divers, but fatal bites have occurred among Southeast Asian fishermen while attempting to disentangle sea snakes from fishing nets.

Very few sea snake species spontaneously venture onto land. When they do, they are typically clumsy and move slowly. Despite this, they should be treated with respect and left alone.

Treating sea snake envenomations

Signs and symptoms

- Small lacerations or punctures
- Bleeding
- Painless bite site
- Retained material in the wound

Early neurological warning signs

- Difficulty swallowing (dysphagia*)
- Drooping of the upper eyelid (ptosis)
- Dilatation of the pupils (mydriasis*)
- Double vision (diplopia*)
- Difficult or painful speech (dysphonia*)
- Tongue twitching (lingual fasciculations*)

First aid

Initial treatment is symptomatic, and the first-aid responder must focus on three primary tasks:

- Pressure immobilisation technique is recommended for affected limbs. Limiting all movement as much as possible is also advised
- Keep victim hydrated
- Transport victim to a hospital capable of advanced life support and possibly antivenom administration

Summary: Sea snakes

- Prevent bites by avoidance – don't antagonise the animal
- Bites can be painless and difficult to detect
- Most bites do not result in envenomation
- Neurotoxic venom may cause:
  - difficulty speaking and swallowing
  - weakness
  - progressive flaccid paralysis
  - respiratory distress/arrest
  - cardiac arrest due to respiratory depression
  - death
- First aid includes pressure immobilisation of wounded limbs, limiting movement of the injured diver and hydration
- Seek medical attention if bitten (antivenom may be available)

ADVANCED CONCEPTS

Antivenom* (or **antivenin** or **antivenene**) is a serum product cultivated from animal blood and given therapeutically to neutralise the effects of venomous bites and stings. Antivenom is generally specific to particular venom and works by introducing venom-specific antibodies that help to minimise venom activity.

- For optimal effectiveness, antivenom should be injected within four to eight hours following a bite or sting
- Since antivenom is cultivated from the blood of animals, it is important to know a person's allergy history. Allergic reactions to antivenom are not uncommon (serum sickness) and may be mitigated by the use of antihistamines

PRESSURE IMMOBILISATION TECHNIQUE

The pressure immobilisation technique should be used only as an interim aid while getting the injured individual into advanced medical care. It is not universally effective but has been reported to delay systemic envenomation.

An elastic bandage (vs. roller/crepe gauze) is recommended but should not be applied too tightly. Peripheral pulses and circulation should be checked to ensure adequacy. A suggested technique for wrapping pressure is similar to the pressure used to wrap a sprain.

Once applied, the bandage and splint should not be removed until the injured person is in definitive medical care. Antivenom must be immediately available when the bandage is released to prevent increased risk from a systemic venom bolus.

The immobilisation component of the technique does not apply to just the injured limb. The injured person should stay as still as possible because movement of other limbs will contribute to venom circulation.

If an injury indicates the need for this technique, constant monitoring of breathing and circulation should also be implemented.

ADVANCED CONCEPTS

Sea snakes and other marine creatures have highly toxic venom to overcome the difficulties they face securing prey. Fish are cold-blooded animals with a slow circulatory system to disseminate venom. When these animals strike, they need a highly effective poison to subdue their prey.

ADVANCED CONCEPTS

Acute renal (kidney) failure may occur secondary to rhabdomyolysis (muscle protein breakdown). To minimise this effect, active hydration (ideally with IV fluids) and immobilisation (to minimize muscular activity) are the cornerstones of first aid and medical management.

BONUS CONTENT

Snake Morphology: What do their shape and physical features tell us?

Venomous vs. non-venomous: There are a few physical characteristics that enable differentiation between most venomous and non-venomous snakes, whether terrestrial or marine. It is important to emphasise that these features should be used only as a general guideline and that handling or approaching snakes should be done only by or under the direction of herpetology experts.

Head-neck-body: Most venomous snakes have a clearly defined neck that differentiates the head from the body. In contrast, non-venomous snakes, such as colubrids, do not. The heads of many venomous snakes are triangular, while the heads of non-venomous snakes tend to be more spoon-shaped.

Elliptical pupils: Most venomous snakes have elliptical pupils, while non-venomous snakes have round pupils.

Loreal pit: Venomous snakes have loreal pits, while non-venomous snakes do not. The loreal pit is a depression between the nostril and the eye. It is a highly effective sensory organ that enables certain snakes to perceive the body heat that radiates from its prey.

Ridged or keeled scales: Most venomous snakes have keeled scales that give them a rough-to-the-touch appearance. In contrast, non-venomous snakes typically have a smooth appearance with flat and often shiny scales.

Body-tail: With some venomous snakes it is possible to identify where the body and its internal organs end, and the purely muscular tail begins. This feature may not be obvious or possible to see when the animal is coiled or hidden.

NOTE
There is one important exception to these general rules. Elapids (cobras, coral snakes and sea snakes) have all the same features as, and therefore resemble, harmless non-venomous snakes.

Head Shape and Fang Location
Whether terrestrial or marine, snakes are characterised not only by name and family but also by skull shape and location of their teeth and fangs (or absence thereof). All snakes will fit into one of four different groups.

Aglyphous (prefix *a-* meaning "lack of" and *glyph* meaning "fangs"). These snakes do not have fangs; they have jaws full of teeth that are similar in shape and size, and are not connected to poison glands. Two-thirds of all snakes belong to this group. Most aglyphous snakes are non-venomous. Pythons are aglyphous.

Opisthoglyphous (prefix *opistho-* meaning "back"). Opisthoglyphous snakes are found in the family Colubridae. Their classification stems from the "back-of-the-mouth" location of their fangs. These specialised teeth have an open groove that allows venom to flow down the backside of the tooth into the bite. Due to the location of these fangs, it is relatively hard for these snakes to open their mouths wide enough for their fangs to be a threat to humans. Most of these snakes typically feed on amphibians and small rodents as well as other snakes (ophiophagous). While some human deaths have been documented, these snakes typically pose little risk to humans.

Proteroglyphous (prefix *pro-* or *protero-* meaning "forward"). This form of dentition is unique to elapids, the most toxic of all snakes. These snakes have a shorter upper jaw with few teeth except for a large fang on each side, which points downward and curves around the venom channel, forming a true hollow needle. Because of the location of these fangs and their relative shortness (only a few millimeters), these snakes have to momentarily hang onto their prey to inject venom.

Solenoglyphous (prefix *soleno-* meaning "pipe" or "channel"). This form of dentition is unique to vipers such as rattlesnakes and other members of the Crotalinae subfamily. This group of snakes has the most advanced venom-delivery mechanism. The upper jaw supports a hollow fang on each side, which can be as long as half the length of the animal's head. Fangs are retractile, folding backward, and these animals can open their mouths to almost 180 degrees, which means that when they attack, their fangs can thrust forward toward their prey. Though the venom of these animals poses a different type of toxicity than that of proteroglyphs, the effectiveness of the venom-delivery mechanism enables them to inject large quantities very quickly.

CHAPTER 3 ENVENOMATIONS AND TOXINS
PART 1: VERTEBRATES REVIEW QUESTIONS

1. **Envenomations may occur in all of the following ways except:**
   a. bites
   b. stings
   c. ingestion
   d. punctures
   e. barbs

2. **Envenomations occur only during accidental contact**
   a. True
   b. False

3. **The health status of the injured person, sensitivity to the venom and delays in receiving first aid impact the victim's response to the injury**
   a. True
   b. False

4. **First-aid steps for treating venomous fish injuries include all of the following except**
   a. wash area
   b. remove foreign material
   c. control bleeding
   d. induce vomiting
   e. control pain

5. **Pressure immobilisation is recommended for which vertebrate injury?**
   a. Stingrays
   b. Nurse sharks
   c. Sea snake
   d. Goliath grouper

Answers to review questions are on Page 78.

PART 2: INVERTEBRATES

Invertebrates are animals without backbones and comprise more than 98% of earth's animal species. Injuries arising from contact include envenomation and localised tissue trauma (cuts and scrapes). The mechanisms of envenomation are stings and punctures.

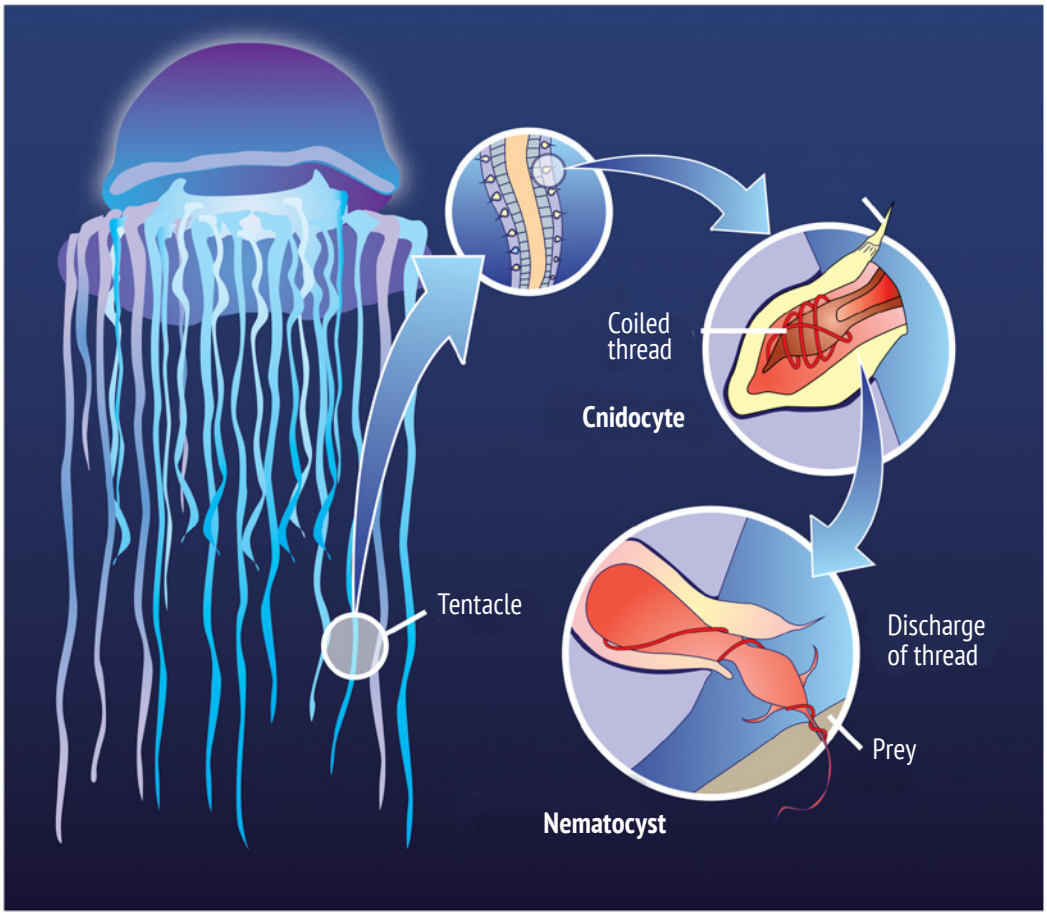
As with venomous-vertebrate animals, individual invertebrate animal groups have unique features that impact signs and symptoms, as well as first aid.

CNIDARIANS
Jellyfish, corals, anemones and hydroids

Phylum: Cnidaria

Cnidarians (nematocyst-carrying species) are responsible for more envenomations than any other marine phylum. These organisms contain tentacles with numerous stinging cells, called nematocysts. These ingenious harpoon-like devices excel at venom delivery.

There are thousands of cnidarians, but only a fraction pose potential harm to humans. In general, first-aid treatment remains the same for all organisms. However, some species may require additional interventions. Be aware that treatment protocols vary in different parts of the world (see Note box for Portuguese man-of-war on Page 22).



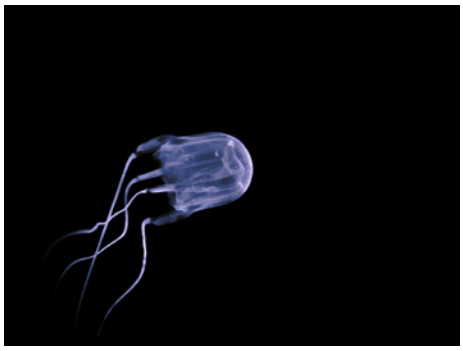
Jellyfish

Phylum: Cnidaria
Subphylum: Medusozoa

Of all the cnidarians, jellyfish cause the most frequent and severe human injuries. Injuries result from direct contact and are usually localised to the affected area. Though these encounters may be painful, most are not life-threatening and only result in mild to moderate skin irritations. Stings can be avoided by proper exposure protection.

Box jellyfish

Phylum: Cnidaria
Class: Cubozoa
Order: Chirodropida
Family: Chirodropidae



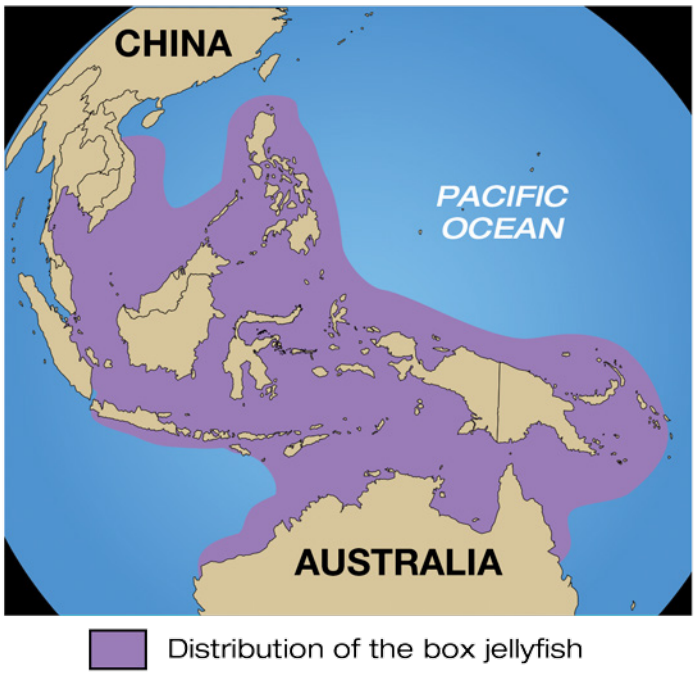
Box jellyfish, also known as "sea wasps," are considered the most venomous of all creatures and are responsible for more human fatalities than any other marine organism. According to health authorities in Queensland, Australia, where the highest number of cases are recorded, box jellyfish have been responsible for at least 63 recorded deaths in Australian waters since 1884.

Rapid toxin absorption impacts the cardiovascular system and can lead to death from cardiac arrest in as little as three minutes – scarcely enough time for any rescue response. Prevention is therefore a key measure. Even a lightweight dive skin can provide adequate protection.

NOTE
There is a specific antivenom (bovine origin) for box jellyfish.*

Signs and symptoms

- Immediate, extreme pain
- Significant, localised welts and discolouration of skin
- Rapid progression of symptoms
  - May lead to death within minutes



Distribution of the box jellyfish

Irukandji jellyfish

Phylum: Cnidaria
Class: Cubozoa
Order: Carybdeia
Family: Carybdeidae

Irukandji syndrome is a condition caused by tiny box jellyfish, *Carukia barnesi* and *Malo kingi.* Fortunately, fatalities are rare, but stings are nonetheless extremely painful and can cause systemic symptoms that should prompt immediate medical attention.

First described in northern Australia, reports of Irukandji-like syndromes have also come from Hawaii, Florida, French West Indies, the Caribbean, Timor-Leste and Papua New Guinea.

Irukandji syndrome occurs within 5-45 minutes after contact.

Signs and symptoms

- Moderate pain initially
  - Progresses to extreme pain throughout the body
- Excruciating muscle cramps
- Restlessness
- Severe hypertension
- Anxiety and a feeling of impending doom
- Rarely fatal

Life-threatening manifestations such as fluid on the lungs (pulmonary oedema), hypertension or heart failure may also occur and can be fatal if not treated.

Portuguese man-of-war

Phylum: Cnidaria
Class: Hydrozoa
Order: Siphonophora
Family: Physaliidae

Portuguese man-of-war are floating cnidarians that use their sail-like gas bladder to catch wind currents that propel these animals along the surface of the open ocean. The gas bladder, known as a pnematophore, is filled with atmospheric gases and may contain up to 90% carbon dioxide (CO_2).

There are two species: the larger Atlantic or Portuguese man-of-war and its smaller Indo-Pacific relative known as the bluebottle. The Atlantic species is found from south Brazil through to the Gulf of Mexico and all along the eastern United States. Further east, they are found around South Africa and as far north as the Mediterranean and Scotland. While the Pacific species are typically found in Australia, the Indian Ocean and New Zealand, they have also been reported in the Hawaiian Islands.

Because of their propensity to cause systemic symptoms, these two species are considered among the most dangerous cnidarians. Their venom contains a powerful neurotoxin that can paralyse small fish and other prey.

Symptoms can persist up to 48 hours. Severe systemic symptoms are rare but may require advanced life support, including mechanical ventilation and advanced cardiac life support.

The first responder must consider evacuation to a higher level of care if symptoms worsen or the overall condition deteriorates.

Signs and symptoms

- Localised pain
- Localised redness
- Pain with breathing
- Back pain and abdominal cramps
- Anxiety

NOTE

The American Heart Association (AHA) recommends vinegar as an effective measure to prevent unfired nematocysts from discharging on all cnidarians. However, in the case of Physalia spp. *(Pacific Portuguese man-of-war or bluebottle) the Australian Resuscitation Council (ARC) strongly discourages the use of vinegar for these species because some studies report that vinegar stimulates massive nematocyst discharge. These conflicting approaches may cause some to delay treatment. The most recent AHA guidelines are based on the best available experimental evidence and recommend the use of vinegar in all cases of jellyfish stings. If these recommendations change or undergo refinement, this text will be updated.*

BONUS CONTENT

Despite its appearance, the Portuguese man-of-war technically is not a jellyfish, it's a siphonophore. These differ from jellyfish in the sense that they are not actually single organisms but a colony of specialised polyps or zooids. One type of polyp fills itself with gas and forms the pneumatophore; three others respectively take up the roles of defense (dactylozooid), reproduction (gonozooid) and feeding (gastrozooid). Their tentacles, covered with stinging dactylozooids, can reach up to 50 m in length.

BONUS CONTENT

There are two species of nudibranchs (gastropods or sea slugs) that are known to feed on Portuguese man-o-war. These sea slugs not only devour the tentacles, but they also somehow manage to use the man-of-war's venom in their own defense. The venom is collected in specialised sacs (cnidosacs) at the tip of their thin "feather-like fingers" (branchia), which enables them to potentially produce a sting equally powerful to the man-of-war upon which it feeds.

Fire coral

Phylum: Cnidaria
Class: Hydrozoa
Order: Capitata
Family: Milleporidae

Fire coral (*Millepora* spp.) are also stinging cnidarians and present as branching yellow-green or brown, limestone-like formations in tropical and subtropical seas. These formations have tiny pores through which cnidocytes protrude. Due to the jagged nature of these formations, envenomation is often associated with local tissue trauma, which may require aggressive and thorough irrigation, and bleeding control. Wound edges can become necrotic.

Anemones, hydroids and other corals

Phylum: Cnidaria
Class: Anthozoa

While related to jellyfish and equipped with cnidocysts (stinging cells), these organisms are typically harmless to humans. In some particularly sensitive individuals, contact may produce a mild skin irritation (dermatitis). Treatment is geared toward symptomatic relief.

Hard corals typically do not represent a threat. The biggest hazard is mechanical injury such as cuts and scrapes. These injuries are at risk for infection.

Soft corals, sea feathers and **gorgonians** are non-venomous and any contact that results in injury should require only thorough cleaning with soap and fresh water, and symptomatic treatment. If necessary, remove any foreign material.

NOTE

The routine use of home remedies, such as meat tenderiser or urine, for marine life injuries is not recommended. These techniques have limited efficacy and may cause additional tissue irritation.

Treating Cnidarian Injuries

(Jellyfish, corals, anemones and hydroids)

Signs and symptoms

- Pain (may be excruciating with some species)
- Intense burning and itching
  - Fire-coral injuries may be associated with abrasions or lacerations, which may enable additional toxin entry and also increase the risk for infections
- Localised swelling
- Nausea, vomiting, dizziness
- Blister formation (may be delayed for days with some species)
- Shock (rare)

First aid

The following describes a general first-aid approach for species of different classes of cnidarians. Since nematocysts are microscopic structures that are mechanically activated, it is extremely important to avoid further envenomation while performing first aid.

- **Inactivation.** Irrigate the area with generous amounts of household vinegar (or 4-6% acetic acid solution). This does not reverse the effects of venom or control pain, but it helps prevent the discharge of unfired nematocysts
- **Removal.** Visible tentacles or filaments should be carefully removed with the aid of fine tweezers or protective barriers. Gloves, women's stockings or any other thin material can provide enough mechanical protection to prevent rescuers' envenomation during tentacle removal.
- **Wash/irrigate.** After liberal use of household white vinegar and removal of tentacles or filaments, wash the area with seawater or saline solution. Avoid rubbing or use of fresh water as these can stimulate nematocyst discharge
- **Symptomatic treatment and control of bleeding.** Treatment usually consists of painkillers, anti-inflammatory medications and topical anesthetics. Local application of heat or cold can provide additional pain reduction. Reports indicate that the application of heat to the affected area may provide more effective pain relief than the use of cold, but cold packs should not be refused or avoided on this basis

Summary: Cnidarians

(Jellyfish, corals, anemones and hydroids)

- Avoid contact (physical distance, neutral buoyancy, exposure protection)
- Thoroughly rinse wound with vinegar
  - Avoid the use of fresh water
- Remove foreign material – use barriers or tweezers
- Wash affected area with salt water or saline
- Control bleeding if present
- Immerse in hot water for pain control (ice packs can also be used)
- Medical attention and tetanus booster may be necessary

MOLLUSKS
Cone snails and blue-ringed octopus

Of the nearly 85 000 recognised species of mollusks, only two are potentially harmful to humans: Cone snails and blue-ringed octopus.

Cone snails

Phylum: Mollusca
Class: Gastropoda
(Unranked): different clades*
Family: Conidae

There are about 600 different species of cone snails. The shells of these mollusks are characteristically conical (cone shaped) and all of them are poisonous. Cone snails have a tiny harpoon-like structure that delivers potent neurotoxic venom. Injury occurs when handling these animals and should therefore be avoided.

ADVANCED CONCEPTS

Slow-moving but voracious night predators, cone snails require fast-acting venom to paralyse their prey. Several toxic compounds, collectively called conotoxins, form the unique characteristics of cone-snail venom. These toxins are composed of small peptides and carbohydrates whose primary target is the nervous system.

Initial signs and symptoms of envenomation vary widely. Stings from some species may initially be no worse than a bee sting, while others may cause severe systemic effects.

Local effects

- Immediate pain (mild to moderate)
- Mild oedema and/or erythema (usually resolves within a few hours)
- Numbness/sensation changes (may persist for weeks)

ADVANCED CONCEPTS

Venom toxicity appears directly related to an animal's dietary habits and inversely proportional to their abundance. There are three primary dietary categories: **fish eaters,** less abundant (10%) and very venomous; **shellfish eaters,** more abundant (30%) but less venomous; and **worm eaters,** very abundant (60%) and the least venomous. The relative toxicity of venom makes sense, as fish are harder to subdue than worms.

Blue-ringed octopus

Phylum: Mollusca
Class: Cephalopoda
Order: Octopoda
Family: Octopodidae

The blue-ringed octopus is the only cephalopod that poses a real medical threat to humans. These small animals rarely exceed 20 cm in diameter and are commonly found in warm tide pools from Japan to Australia.

At rest, they are patterned with distinctive brown bands on the body and tentacles. Their iridescent blue rings are expressed when the animal is disturbed or on the prowl. Its small size and distinct markings enable easy identification. Envenomation happens when the animal is handled.

BONUS CONTENT

Like all other cephalopods, the mouth of the blue-ringed octopus is armed with a strong beak in the centre of its body, right at the confluence of all its tentacles. This sharp beak resembles that of parrots. The bite is usually painless and leaves two small V-shaped puncture wounds oriented in opposite directions. The toxins, created by bacteria within its saliva, are extremely potent and may induce generalised weakness that can lead to paralysis and death. A single 25 g specimen possesses enough venom to paralyse at least 10 regular adults.

Initial signs and symptoms

- Painless or difficult to find bite site
- Confusion
- Progressive weakness
- Nausea and vomiting

Symptoms usually resolve within 24 hours and may be associated with generalised itching (*pruritus*), wheals/hives (*urticaria*) and joint swelling. Symptoms can progress quickly, so immediate medical evaluation and support is strongly advised. Victims who live through the first 24 hours generally go on to make a complete recovery.

Treating mollusk injuries

(Cone snails and blue-ringed octopus)

Signs and symptoms

- Blurred or double vision
- Difficulty speaking or swallowing (dysphagia*)
- Slurred speech, vocal hoarseness
- Numbness and fullness around the mouth, neck and throat (especially with blue-ringed octopus)
- Progressive weakness
- Paralysis
- Death (from respiratory depression due to paralysis)

First aid

- Clean wound thoroughly with soap and fresh water
- Remove any foreign material
- Pressure immobilisation technique is recommended for affected limbs. Limiting all movement as much as possible is also advised
- Immediately transport victim to a medical facility for monitoring and advanced medical support
  - Do not wait for muscular paralysis to develop. Respiratory depression may require advanced medical support, including mechanical ventilation
- Monitor breathing and airway

Keep patients with systemic symptoms under careful observation in a medical setting and monitor for signs of respiratory depression for at least 6-8 hours.

Tetanus coverage is always recommended and antibiotic therapy may be necessary. Monitor for infection. There is no available antivenom.

Immersion in hot water may provide some relief but may also enhance venom distribution due to vasodilatation.

Summary: Mollusks

(Cone snails and blue-ringed octopus)

- Avoid contact. Do not handle live specimens
- Clean the affected area with soap and water
- Monitor breathing and airway
- Seek local emergency medical services immediately and monitor the injured person
- **Cone snails:** To control pain, immerse affected area in hot water

ADVANCED CONCEPTS

Blue-ringed octopus venom was once known as maculotoxin but was later found to be identical to tetrodotoxin (TTX), a toxin found in Tetrodontids (pufferfish, triggerfish, porcupinefish, etc.), some cone snails and amphibian reptiles such as certain newts and dart frogs. TTX is considered more toxic than cyanide (read more about TTX under "Seafood Poisonings" on Page 42). The venom also contains an enzyme that dissolves certain molecular structures in connective tissues, which increases its permeability, and speeds venom dispersion and delivery.

Even in serious envenomations, the bite site might be hard to detect. Victims often do not realise they have been bitten until respiratory depression and paralysis set in. Symptom onset typically occurs within 10 minutes following a bite.

ECHINODERMS
Sea stars, sea urchins and sea cucumbers

The phylum Echinodermata (Greek for "spiny skin") is comprised of about 7 000 species. While most echinoderms are poisonous, only a few members are capable of causing venomous injuries to humans.

BONUS CONTENT

Echinoderms show a huge variety of shapes, sizes and colours, and all share certain common anatomical and structural features. One of them is five-spoke or pentaradial symmetry, easily identifiable in sea stars, sea-urchin skeletons and sand dollars. There are exceptions to the five-spoke symmetry, with up to 14 arms in some varieties, such as the crown-of-thorns *(Acanthaster planci)*.

Echinoderms are the only animals that possess a vascular system that uses water. This system consists of five radial canals, and it facilitates respiration, nutrition and even locomotion by connecting hundreds of pairs of tubular feet (called pedicellariae). These extremely versatile "feet" are independently mobile and by means of synchronised movements they can transport the animal around the sea bed. Synchronic traction can also be strong enough for gripping and these pedicellariae have sensory perception function as well.

Crown-of-thorns sea stars

Phylum: Echinodermata
Class: Asteroidea
Order: Valvatida
Family: Acanthasteridae

Crown-of-thorns sea stars have a unique appearance and voracious appetite. Injuries occur as a result of contact with its spines. These species have a wide habitat and are found from the Red Sea to the Great Barrier Reef in Australia and even further west to the western tropical Americas. They are known for achieving plague-like population proportions and can cause severe bleaching to tropical reef ecosystems.

ADVANCED CONCEPTS

Seasonal overpopulations of crown-of-thorns sea stars may cause massive coral bleaching. In some areas, scuba divers have deliberately dismembered them in an attempt to curtail reef destruction, only to find that each damaged limb has the capacity to fully regenerate the whole organism. Such efforts therefore only serve to increase the population and the risk of injuries to the involved divers, as well as further reef destruction.

Sea urchins

Phylum: Echinodermata
Class: Echinoidea

The primary hazard associated with sea urchins is contact with the spines. Although not necessarily venomous, sea urchins have sharp spines that easily penetrate skin, wetsuits and shoes, and are brittle enough to quickly break off once embedded. The brittle nature of these spines can also make removal difficult, as they tend to break off or disintegrate with traction. Although puncture wounds won't necessarily become infected, they may stimulate a foreign-body reaction. Spine injuries that involve joints may require surgery.

Prevention is key. Physical contact with sea urchins should always be avoided unless you have the knowledge, equipment or experience to handle them safely.

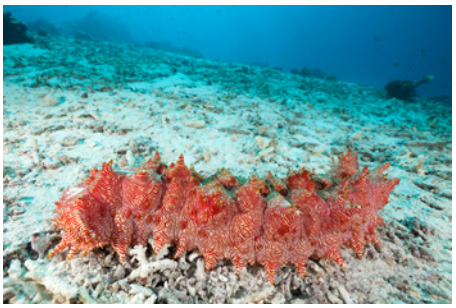
If the species responsible for the injury is venomous, wounds quickly become intensely painful, erythematous and swollen. Systemic symptoms are rare, and usually mild and self-limited.

ADVANCED CONCEPTS

The flower urchin *(Toxopneustes pileolus)* is the only urchin in which short spines are not the problem, but its pedicellaria are (see Bonus Content on Page 28). If you see them in the Pacific or Western Americas, enjoy them but do not touch!

Sea cucumbers

Phylum: Echinodermata
Class: Holothuroidea



These seabed scavengers are found in every ocean. Their characteristic shape resembles that of a cucumber or large caterpillar, and their texture, size and colour vary significantly.

Injuries associated with these animals may occur upon ingestion of certain species or from contact with holothurin – a toxic chemical released by sea cucumbers to deter potential predators.

Holothurin is water-soluble and heat stable. Contact with this toxin can cause mild to moderate skin irritation. Anecdotal reports mention cases of swimmers who complained of conjunctivitis (eye irritation) or even became blind after swimming where fishermen cleaned their catch prior to consumption. Fisherman themselves have developed skin rashes after cleaning high volumes of these animals.

BONUS CONTENT

When threatened, some sea cucumbers can expel their stomach contents or their whole stomach to provide an alternative meal to potential predators and give the slow sea cucumber time to escape.

Treating Echinoderm Injuries

(Sea stars, sea urchins and sea cucumbers)

Signs and symptoms

- Sharp, stinging pain
- Local swelling
- Redness (erythema)
- Tissue damage and/or spines protruding from skin

In severe cases there have been reports of muscle weakness, nausea, vomiting and paresthesias.

First aid

- Thoroughly wash the area with soap and fresh water (tap water is fine)
- Remove foreign material
  - Seek medical attention if spines have entered joints
- Monitor for signs of infection (see additional information in Chapter 4)
- Tetanus coverage is recommended

The use of topical antibiotics or corticosteroids may help reduce discomfort and minimise the risk of infection. In areas where deep skin penetrations have occurred or joints are involved, seek immediate medical attention.

Summary: Echinoderms

(Sea stars, sea urchins and sea cucumbers)

- Avoid contact
- Clean the affected area with soap and water
- Seek medical attention if spines are deeply embedded or have entered joint spaces
- Tetanus coverage is recommended
- Monitor for signs of infection

OTHER PHYLUMS
Sponges and bristle worms

Irritations are the most common marine life injury and are also the easiest to avoid. These are rarely life-threatening, and usually just require a thorough cleaning and close observation to prevent infection.

Common causes of these injuries include contact with rough surfaces such as coral, barnacles and rocks, sponges and various marine organisms. If the irritation, cut or abrasion shows signs of infection, seek medical attention.

Sponges

Phylum: Porifera

Sponges are one of the most primitive organisms. Of the approximately 10 000 known species, only 150 live in fresh water. Sometimes described as "living hotels," these sessile* organisms provide shelter for a large array of small creatures.

Aside from a few species that contain harmful toxins (noted on the next page), contact dermatitis is the most characteristic presentation. Skin lesions may take two to three weeks to resolve.

Corticosteroids, antihistamines and antibiotics will not necessarily alter the course of acute injuries but may be used in an attempt to treat delayed reactions or persistent skin irritation.

NOTE

There are 13 species of sponges reported as harmful to humans. Species include the Caribbean and Pacific fire sponges, the poison-bun sponge in the tropical West Atlantic and the red-beard sponge found along the eastern United States.

Envenomations can occur even after the sponge has been removed from the sea, provided it remains moist. Dry sponges are apparently harmless, but reports indicate that rehydration can reactivate toxins.

Bristle worms

Superphylum: Lophotrochozoa
Phylum: Annelida
Class: Polychaeta

Bristle worms are found in every ocean – from cold abyssal plains, to the extreme heat of hydrothermal vents, to tropical tide pools. Injuries typically result from accidental contact or deliberate handling. Such contact can result when the worm's bristles, located along the sides of the animal, embed in the contact skin.

Symptoms usually last for several hours but may take several days to completely resolve.

Treating sponge and bristle worm envenomations

Signs and symptoms

- Sharp, stinging pain
- Localised redness, skin irritation
- Bleeding associated with cuts/scrapes
- Mild to severe itching
- Oedema
- Burning and numbness
- Blisters

First aid

- Clean the affected area with soap and fresh water
- Remove any foreign material
  - Cellophane tape may aid in bristle removal
- Leave blisters intact if present
  - Keep the area clean, dry and aerated until the blisters dry out and eventually peel off
- If eye contact occurs, flush with copious quantities of fresh water and seek medical attention
- Monitor for signs of infection
- Steroid ointments may prove useful in reducing skin irritation

Summary: Sponges and bristle worms

- Avoid contact (physical distance, neutral buoyancy, exposure protection)
- Thoroughly wash affected area with soap and fresh water
- Control any bleeding that may be present
- Monitor for infection

CHAPTER 3 ENVENOMATIONS AND TOXINS PART 2: INVERTEBRATES REVIEW QUESTIONS

1. **The correct order for first aid for jellyfish stings is**
   a. inactivation, removal, washing/irrigation of the injury site, treatment of the symptoms
   b. washing/irrigation of the injury site, treatment of symptoms, inactivation, removal
   c. removal, washing/irrigation of their injury site, inactivation, treatment of the symptoms

2. **Pressure immobilisation is recommended for which invertebrate marine life injuries?**
   a. Anemones and blue-ringed octopus
   b. Cone snail and blue-ringed octopus
   c. Bristle worms and sea cucumbers
   d. Fire coral and sponges

3. **First aid for contact injuries includes**
   a. controlling bleeding
   b. washing area thoroughly
   c. removing any foreign material
   d. leaving blisters intact
   e. all of the above

Answers to review questions are on Page 78.

4 Traumatic Injuries

CHAPTER 4 OBJECTIVES

1. For what three reasons do marine animal bites occur?
2. Why are marine animal bites of particular concern?
3. What is the primary method to control most external bleeding?
4. When should a tourniquet be used?
5. How long should a tourniquet be left in place?
6. What are the signs and symptoms of infection?

Physical trauma denotes a wound or injury caused by some external force or agent. Trauma associated with marine life injuries results primarily from bites and scrapes.

Bites

Most human-associated marine animal bites result from the following circumstances:
- The animal feels threatened
- The human is mistakenly identified as prey
- Humans are engaged in spearfishing or feeding

All bites have a high risk of infection and should receive prompt cleaning. Marine animals known to bite include sharks, barracuda, moray eels and triggerfish. Injury severity depends on many factors including bite location, size of animal, extent of blood loss and treatment delays. First-aid efforts should focus on controlling bleeding and reducing risk of infection.

Control of External Bleeding

The body has two mechanisms for limiting blood loss. The first is vasoconstriction (narrowing of blood vessels), which occurs in response to injury and helps to reduce blood loss. The second mechanism is platelet activation which initiates blood clotting. For minor bleeding, this process works extremely well and with little support will stop blood loss. When bleeding is more severe, additional intervention may be needed.

Direct Pressure

- Direct pressure over a bleeding site is usually sufficient to control most bleeding. This is accomplished by using an absorbent pad or dressing and gloved hands. If the bleeding continues and seeps through the pad, add additional absorbent material on top of the original pad. Do not remove the original pad. Dressing removal may remove clotting blood and disrupt the clotting process. Continue to hold direct pressure until the bleeding stops.
- Secure the pad with a clean or sterile bandage. The bandage should be big enough to cover the pad, extending past the edge (2.5-5 cm if possible). Wrap the bandage from the distal side (farthest from the heart) of the wound site toward the heart.
- The bandage should help maintain direct pressure but not prevent circulation. You can check circulation by squeezing the nail beds and looking for the pink colour under the nails to return quickly after pressure is released. It should return to its normal pink colour in 2-3 seconds. In cold conditions, colour refill may take slightly longer. If colour does not return in a timely manner, loosen the bandage and rewrap.

Tourniquets

If direct pressure fails to control massive bleeding, the next step may be to use a tourniquet if the injury is on an extremity. Tourniquets are a primary intervention when the bleeding is a massive arterial (spurting) bleed and is life-threatening.

A tourniquet is a wide band placed tightly enough around an arm or leg to stop blood flow. It must be applied with sufficient force to stop arterial bleeding, not just venous bleeding. Arteries are deeper in the body and therefore require forceful pressure to stop arterial flow. This is accomplished with the use of a windlass device (part of a commercial tourniquet or makeshift in an improvised tourniquet). Double check the effectiveness of a tourniquet by assessing distal pulses, which should not be present if the tourniquet is applied tightly enough.

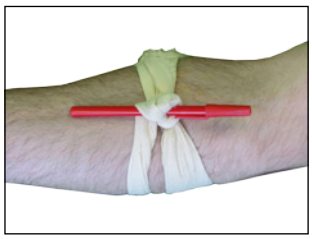
A tourniquet should be:

- used only when direct pressure is not effective
- wide (at least 5 cm wide if an improvised tourniquet is used)
- well-padded (6-8 layers of a bandaging material)
- placed 2.5-5 cm proximal to the wound

A tourniquet should NOT be:

- placed directly over knees, elbows or other joints. If there isn't room to place a tourniquet between a wound and a joint, place the tourniquet 2.5-5 cm proximal to the joint
- made of wire or rope. A narrow, excessively tight or insufficiently padded band may cause local damage to tissues in minutes

Applying a tourniquet



Before applying a tourniquet, inspect the wound to ensure direct pressure was being applied directly to the site of the bleeding. If not, attempt direct pressure once more.

Place a commercial tourniquet as noted above and secure it in place. Twist the windlass until bleeding stops and secure it with the mechanism on the tourniquet.

Wrap an improvised tourniquet proximal to the wound, as noted above, several times. Secure in place with an overhand knot. Place a stick or similar object on top of the knot, and tie a second overhand knot over it. Twist this "handle" just until the bleeding stops. Secure the handle in place by wrapping with a second bandage.

Using a marker, write on the patient's forehead "T" or "TK" (for "tourniquet") and the time the tourniquet was placed. This ensures subsequent caregivers are aware the tourniquet is there and how long it has been on. The tourniquet should not be removed until advanced medical care is available.

NOTE

- *Death of tissue below the tourniquet is possible after two or more hours*
- *Tourniquets may cause pain in the extremity*

Haemostatic Dressings

A final option for controlling bleeding that is not responding to a tourniquet or is located in an area where a tourniquet cannot be used is a dressing impregnated with haemostatic agents.

Remove any other dressing materials so the agents can have direct contact with the bleeding site. Cover the entire bleeding surface with the haemostatic dressing, and continue direct pressure. Apply additional layers of haemostatic dressings if necessary. Hold dressings in place with a pressure bandage.

Advise medical personnel that a haemostatic agent was used to assist with control of bleeding. Retention of the dressing's packaging material may be helpful to emergency personnel. Haemostatic dressings should not be left in place more than 24 hours.

First aid: Direct pressure

- Wash the wound thoroughly with soap and water (tap water is fine) as soon after the injury as possible
- Apply dressing and direct pressure to wound
  - Add additional dressings as necessary
- Bandage the dressing(s) in place
  - Extend the bandage 2.5-5 cm beyond the edge of the dressing, if possible
- Check extremity circulation (capillary refill) to ensure bandage is not too tight
- Seek medical evaluation. A tetanus booster may be required
- Monitor for signs of infection

First aid: Tourniquets

- Place the tourniquet 2.5-5 cm above (proximal to) the wound
- Improvised tourniquets require 6-8 layers of bandaging materials
- Tie an overhand knot
- Place a stick or similar object over the knot, and secure it with another overhand knot
- Twist the stick until bleeding stops, and secure it in place with an additional bandage
- Mark the victim's forehead with a "T" or "TK" and the time the tourniquet was placed
- Leave the tourniquet in place until the victim is under medical care

First aid: Haemostatic dressings

- Apply dressing directly to bleeding site, and apply direct pressure to the wound
  - Add additional dressings as necessary
- Bandage the dressing(s) in place
  - Extend the bandage 2.5-5 cm beyond the edge of the dressing, if possible
- Do not leave the dressing in place more than 24 hours
- Seek medical care

Wound Infections

The skin is our primary and most effective defense against infection. When this protective layer is breached, the introduction of bacteria, fungi, viruses and other organisms into tissue layers beneath the skin is enabled. The source of injury is important, as organic material comes with higher risks of wound infection and delayed healing.

Thoroughly cleaning wounds with soap and fresh water soon after injury is a simple yet effective way to minimise infection risk. Delayed cleaning may enable micro-organisms to replicate beneath the skin, resulting in infection. The presence of bacteria within a wound does not necessarily constitute infection; instead, this is often referred to as contamination. When bacterial populations thrive and become large enough or interrupt healing or cause further tissue damage, then an infection has occurred.

Signs of infection appear within hours, days or even several weeks following injury. Inflammation is one of the cardinal signs of any infection, and the components that are typically present can be easily recalled with the acronym **PRISH.**

Pain
Redness
Immobilisation (loss of function)
Swelling
Heat (elevated warmth of the infected area)

Other signs of infection include:
- Pus and yellowish discharge
- Foul smell
- Swollen lymph nodes
- Fever
- Chills
- Non-healing wounds

Marine-acquired wounds, particularly in people with compromised immune systems (e.g., people with diabetes, cancer or AIDS), may require more aggressive treatment. If a marine-acquired wound is beyond your skills to manage or shows any signs of worsening, seek medical attention.

BONUS CONTENT

Moray eels

Eels are generally passive marine creatures that often tolerate curious divers getting quite close but will defend their lairs against encroachment. Teasing or coaxing an eel from its home for a photo or to capture a lobster invites a bite. The teeth of an eel are angled backward to prevent escape of their prey.

Triggerfish

Triggerfish have been called one of the most aggressive ocean fish, attacking for no apparent reason. Due to their relatively small size, bites are usually more of a nuisance than a threat.

Octopus

Injuries from octopus bites result from handling. The beak at the confluence of the tentacles results in a double V-shaped pattern with the "Vs" in opposite directions. Octopus bites are associated with pain and mild to moderate swelling.

Stingrays

Stingrays use the barb in their tail in defense of perceived threats. The puncture wounds and lacerations may result in bleeding and infection.

Coral scrapes and cuts

Surf and surge in shallow water or poor buoyancy control over reefs can result in scrapes and cuts of various degrees. Since bacteria and numerous tiny larvae live on these underwater formations, wound contamination should be assumed. Skin irritations are a frequent occurrence.

Some infections resulting from coral-inflicted injuries can be quite serious. Taking precautionary steps to clean and debride a coral wound should be a priority once out of the marine environment.

CHAPTER 4 REVIEW QUESTIONS

1. **Marine animals bite when**
   a. they feel threatened
   b. humans are mistaken for food
   c. humans engage in spearfishing or feeding
   d. all of the above

2. **Infection is of particular concern with marine animal bites**
   a. True
   b. False

3. **Which of the following is the first line of action to control external bleeding?**
   a. direct pressure
   b. tourniquets
   c. haemostatic dressings

4. **A tourniquet should be placed**
   a. if the wound exhibits massive arterial bleeding
   b. if bleeding is not stopped by direct pressure over the wound
   c. 2.5-5 cm above the wound
   d. all of the above

5. **A tourniquet should be removed after two hours regardless of continued bleeding**
   a. True
   b. False

6. **Signs and symptoms of infection include**
   a. pus, redness, sweating, heat
   b. purple wound borders, red dots on skin, irritability, sensitivity, high temperature
   c. pain, redness, immobility, swelling, heat

Answers to review questions are on Page 78.

5 Seafood Poisonings

CHAPTER 5 OBJECTIVES

1. What is the primary cause of seafood poisoning?
2. What kinds of contaminates trigger seafood poisoning?
3. What are the three well-established types of seafood poisoning?
4. How can the risk of seafood poisoning be minimised?

Most human gastrointestinal* complications that occur as a result of eating seafood are largely due to improper storage of caught fish. Poorly preserved seafood commonly alerts us of spoilage with a "fishy" odour resulting from the breakdown of certain fatty acids. However, odour alone does not determine whether food is safe to eat and is not associated with a particular toxicity.

There are several marine species, primarily in the tropics, that store specific toxins in their skin, muscles, viscera and/or gonads. Seafood poisoning occurs when ingested food or water is contaminated with certain types of bacteria, parasites, viruses or toxins.

NOTE

Of particular importance, most of these toxins are heat stable, which means cooking does not reduce their toxicity.

ADVANCED CONCEPTS

The technical term for food poisonings resulting from ingestion of fish is ichthyosarcotoxism (pronounced ik´thé-ó-sar´-kó-tók´sizm), meaning "poisoning from eating fish meat" (Greek *ichthys* = fish and *sarx* = meat or muscle). Though the term includes the Greek for "flesh" or "muscle," it should be noted that this is a general term that includes, but does not discriminate among, poisonings resulting from ingestion of muscle tissue, viscera, skin or other organs and/or secretions. Paralytic shellfish poisoning (PSP) and other seafood poisonings resulting from ingestion of any seafood other than fish are therefore, by definition, not an ichthyosarcotoxism.

The three primary foodborne syndromes covered here are:
- Ciguatera
- Tetrodotoxin poisoning (or tetrodotoxism)
- Scombroid fish poisoning (also known as histaminoid syndrome)

Since there are few, if any, first-aid procedures for these conditions, the emphasis is on prevention.

Ciguatera

Ciguatera can be a serious, but rarely fatal, self-limited disease that primarily affects the gastrointestinal and neurological systems (sometimes the heart), and is caused by ingestion of various species of tropical reef fish.

Cause

Certain dinoflagellate* (planktonic* protozoans*) are thought to be responsible for producing ciguatoxins. These microscopic organisms live on algae and dead coral surfaces, and are eaten by small reef fish. Their toxins are then transmitted from fish to fish through the food chain in a process of bioaccumulation*.

The process of ciguatoxin bioaccumulation starts when small marine herbivores feed on macroalgae on which dinoflagellates live. As small herbivores are eaten by larger predators and these are then eaten by even larger predators, the toxin accumulates in the tissues of top predators such as barracudas, groupers and moray eels. Human poisoning occurs when any of the fish involved in this chain are consumed, but particularly when the fish consumed is a large reef predator.

Toxicity depends on exposure and dose, with more severe cases occurring in individuals who have suffered previous exposure.

Onset usually occurs within two to six hours after ingestion.

Common gastrointestinal signs and symptoms

- Abdominal pain and gastroenteritis
- Nausea, vomiting
- Diarrhoea

These initial symptoms typically resolve without intervention within a few hours.

Common neurological signs and symptoms

- Numbness and tingling
- Lack of muscle co-ordination (ataxia*)
- Vertigo

Symptoms may include skin itching, which can persist for weeks and worsen by activities that increase skin temperature, such as exercise and alcohol consumption.

Musculoskeletal symptoms

- Joint pains
- Muscle pains and weakness

Decompression sickness (DCS) should be considered as a differential diagnosis in individuals with a recent history of scuba diving.

Other signs and symptoms

One of the most well-identified symptoms is the patient's inability to distinguish hot versus cold temperature. This is known as temperature reversal.

More than 175 symptomatic manifestations have been described for ciguatera, which can make diagnosis difficult. Some 80% of patients show varying degrees of neurological impairment in addition to gastroenteritis.

Fish species commonly associated with ciguatera

- Barracuda
- Snapper
- Moray eel
- Amberjack
- Grouper
- Parrotfish
- Triggerfish

Ciguatera toxins rarely contaminate pelagic fish such as tuna, marlins, dolphin fish or other ray-finned fish. While the whole fish will contain toxins, the highest concentrations are typically found in the liver, intestines and gonads. Ciguatoxin can be found throughout the world in the tropical reef belt between 35°N and 35°S latitude.

NOTE

Affected meat does not have a characteristic appearance, smell or strange taste. Ciguatoxins are also heat stable, which means they are not affected by freezing, cooking or drying and are impervious to gastric (digestive) juices.

ADVANCED CONCEPTS

Levels as low as 0.1 ppb (parts per billion; 1 drop every 1 billion drops of water) in consumed flesh can result in clinical poisoning. These low levels pose a major obstacle for the development of a simple detection method.

First aid

- Treatment is aimed at symptom control
- Correct possible dehydration
- Support compromised heart or pulmonary function

If ciguatera is suspected, seek medical evaluation. There is no effective treatment or specific antidote for ciguatera poisoning. The best course of action is prevention through education and avoidance of seafood in endemic or suspected areas.

Summary: Ciguatera

- Ciguatera is caused by a neurotoxin produced by microscopic organisms that contaminate reef fish
- The bigger the fish, the more toxic the meat. Predators (such as barracudas, eels, groupers, etc.) contain more toxins due to bioaccumulation
- Symptoms are primarily neurological (could mimic DCS) but rarely fatal
- Fish appears, smells and tastes normal (no fishy odour)
- Cooking does not alter toxin potency
- Avoid eating large reef predators

BONUS CONTENT

The name ciguatera refers to a disease caused by the Spanish name *cigua* (for sea snail), associated with a less common, but similar, syndrome in the Caribbean's Spanish Antilles.

Historical perspective: There are reports from the times of Alexander the Great about prohibitions against feeding fish to soldiers to avoid ciguatera. Reports during the T'ang dynasty (618-907 AD) in China also indicate an awareness of this syndrome. The first known, written report is from 1789 from Captain William Bligh. He describes symptoms consistent with ciguatera after eating mahi-mahi, although this is an uncommon source. Captain James Cook, in 1774, on his expedition to the South Pacific aboard the Resolution, described the poisoning in many of his crew members after eating fish from the islands near Vanuatu in the South Pacific.

Gambierdiscus toxicus is named after the location where it was discovered, the Gambier Islands in French Polynesia, a place where virtually all reef fish contained the toxin. Later research showed that other dinoflagellates could also play a contributing role in ciguatera, but ***G. toxicus*** appears to be the most toxic.

Four types of ciguatoxin have been identified. Ciguatoxins seem to lower the threshold for opening voltage-gated sodium channels in synapses in the nervous system, which results in depolarisation of excitable cells. Ciguatoxin has also demonstrated anticholinesterase activity. Of note, the toxin remains unaltered within bodily fluids, and its toxicity can be transmitted both by vertical transmission (mother to baby) as well as through breast milk and semen. Because it does not cross the blood-brain barrier* (BBB), ciguatoxins affect only the peripheral nervous system, not the central nervous system.

Tetrodotoxin Poisoning (or Tetrodotoxism)

Tetrodotoxin (TTX) is a strong neuromuscular blocking agent (blocks the transmission of impulses from nerves to muscles) that produces one of the most serious forms of poisoning. TTX is water soluble and heat stable (which means it is not broken down by the application of heat or by cooking).

Poisoning results from consumption of certain fish and invertebrates, most notably pufferfish, porcupinefish, ocean sunfish and triggerfish. Of note, TTX is not confined to marine environments. Poison dart frogs, and some newts and worms may also contain this deadly substance.

TTX is usually found in the liver, intestines, gonads and skin of these animals, and fatalities have been reported in as little as 15 minutes following ingestion.

Symptom onset ranges between 30 minutes to a few hours following ingestion.

Initial symptoms
- Numbness of the lips and tongue
- A sense of lightness or floating
- Moderate gastrointestinal symptoms
  - Upper abdominal pain
  - Nausea
  - Vomiting
  - Diahrroea

Second-stage symptoms
- Increasing paralysis
  - May initially manifest as difficulty walking

Final-stage symptoms
- Complete muscular paralysis (to include smooth visceral muscle)
  - Survivors describe having full consciousness but with the complete inability to move and absence of all neurological reflexes — a description that matches stories told about Haitian zombies

First aid
- Management (both field and definitive medical) is symptomatic and supportive
  - Symptoms can progress quickly; therefore activate EMS immediately upon symptom presentation
- Mechanical ventilation may be necessary due to the patient's inability to breathe on his or her own

The goal is prevention through education. Avoid eating these species in any form or preparation. If TTX poisoning is suspected, seek medical evaluation.

Summary: TTX poisoning
- TTX poisoning is caused by a neurotoxin produced by certain fish and invertebrates (e.g., pufferfish, triggerfish, mola mola, Japanese fugu) from the order Tetrodontiformes
- It causes systemic paralysis, which can lead to death
- Cooking does not alter toxin potency
- Avoid eating these fish in any form or preparation

Symptoms of TTX poisoning can progress rapidly. Activate EMS as soon as symptoms present.

BONUS CONTENT

Tetrodotoxin ingestion has a unique place within certain cultures.

In Japan, "fugu" is considered a delicacy and can be found in strictly controlled restaurants where specially trained and licensed chefs carefully prepare the fish for consumption. The Japanese consider the expert chefs artists when they prepare sashimi well enough to leave just enough toxin to cause slight tingling sensations in the mouth. Drinking a mixture of fugu gonads with sake is a longstanding right-of-passage or sign of manhood for some Japanese. This practice is considered the Japanese counterpart of Russian roulette, as it is impossible to know the degree of toxicity or the possibility of a serious intoxication without a thorough analysis. Even under strict state control and strict licensure requirements, fugu is the leading cause of death from food poisoning in Japan.

TTX has been implicated as the possible causative agent of the Haitian voodoo "zombie potions," as it is said it can cause a state of suspended animation.

Scombroid Fish Poisoning (or Histaminoid* Syndrome)

Scombroid is caused by ingestion of fish containing high levels of histamine*. Often confused with seafood allergy, the source of the "allergy chemical" histamine comes from the fish itself rather than from the person.

Histamine release within the fish is associated with inadequate refrigeration immediately following capture. Sun exposure or poor refrigeration enables bacterial invasion from intestinal bacteria. Once these bacteria invade the fish's flesh, they convert histidine (an amino-acid precursor harmless in our digestive systems) into histamine — the chemical responsible for allergic signs and symptoms.

Potential sources belong to the family Scombroidae, which includes tuna, bonito or mackerel, mahi-mahi, and others such as anchovies, sardines and herrings. Scombroid poisoning accounts for 5% of food poisoning reported to the Centers for Disease Control and Prevention (CDC) in the United States.

NOTE

A key contributing factor to the prevalence of this condition is the absence of an associated flavor or taste. Some report a slight metallic or peppery taste, but otherwise the fish look, smell and taste normal.

Manifestations of scombroid are usually self-limited and resolve in about eight to 12 hours. Significant discomfort and serious manifestations are possible.

Symptom onset
- Rapid; commonly seen 10 to 30 minutes after ingestion

Symptoms
- Flushing
  - Manifests in the face, neck and upper chest
- Itchiness
- Eye irritation

Severe symptoms in rare cases
- Headaches
- Chills
- Vomiting
- Diahhroea
- Abdominal cramps
- Bronchospasm
- Hypotension

First aid
- Symptomatic treatment
  - Antihistamines such as diphenhydramine (e.g., Benadryl) and other medications in this class are commonly used for symptom control
  - In cases of severe bronchospasm or hypotension, epinephrine may be indicated but it is rarely required
- Since histamine is not being released as a result of an allergic reaction, corticosteroids are ineffective

Prevention

The disease is entirely preventable by immediately storing fresh fish in coolers or ice containers and away from direct sunlight. The CDC recommends temperatures below 4.4°C at all points during the fish supply chain.

Summary: Scombroid fish poisoning

- It is caused by eating species of scombroids (tuna, mackerel, mahi-mahi, jacks) that have not been properly refrigerated after being caught
- Bacteria break down a component of the meat that releases histamine*. Ingestion of large quantities of histamine-contaminated meat triggers an allergic-like reaction
- It can be easily confused with and misdiagnosed as seafood allergy
- Fish appearance, smell and taste are normal, perhaps with a slight peppery or metallic taste, but not unpleasant or foul
- Cooking does not alter histamine and will therefore not prevent symptom occurrence
- Avoid eating fish if unsure it was properly stored immediately after being caught. Storage temperatures should always be kept below 4.4°C immediately after being caught and until preparation

NOTE

Each of the seafood poisonings described have two consistent features:
1. They are NOT affected by cooking or method of food preparation.
2. Seafood containing these toxins tastes, smells and looks normal.

CHAPTER 5 REVIEW QUESTIONS

1. **Contaminated seafood may taste and smell normal**
   a. True
   b. False

2. **Seafood poisoning is triggered by**
   a. bacteria
   b. parasites
   c. viruses
   d. toxins
   e. all of the above

3. **The three primary seafood poisonings discussed here do not include**
   a. ciguatera
   b. scombroid
   c. shellfish poisoning
   d. tetrodotoxin

4. **The most effective way to prevent seafood poisoning is to**
   a. only eat fish you have caught and cleaned yourself
   b. store fish properly
   c. cook fish thoroughly
   d. eat fish that has a slightly fishy smell

Answers to review questions are on Page 78.

6 Life-Threatening Complications

CHAPTER 6 OBJECTIVES

1. What are the signs and symptoms of an allergic reaction?
2. What steps should be taken if an allergic reaction occurs?
3. What are the signs and symptoms of cardiogenic shock?
4. What steps should be taken if cardiogenic shock occurs?
5. What are the signs and symptoms of hypovolemic shock?
6. What steps should be taken in the case of severe bleeding?

Anaphylactic Shock

Anaphylactic shock is a severe allergic reaction that may occur subsequent to envenomations. Life-threatening manifestations involve airway narrowing, which requires rapid activation of emergency medical services. As a first responder, you can help by supporting an open airway and assisting the victim with administering allergy medications.

Most allergic reactions are fortunately less severe and are characterised by local skin reactions. Once assured the victim is breathing normally, thoroughly clean and rinse the affected area. In some cases allergy medications may be useful, but it requires familiarisation or medical guidance.

Signs and symptoms (mild/moderate)

- Generalised itching (pruritis*)
- Localised redness, swelling, raised rash that may change with time (urticaria/hives)
- Bloodshot, puffy eyes
- Facial swelling (eyes, lips)
- Localised or diffuse swelling (edema)

Signs and symptoms (severe)

- Airway narrowing
- Respiratory distress
- Cardiac arrest

First aid

- This is a medical emergency – alert local emergency medical services immediately (call 10177). Do not call DAN
- Assist the injured person with administration of allergy medications if prescribed for him personally. First-line medications include antihistamines. If airway narrowing or difficulty breathing is present, consider use of an epinephrine auto-injector if one is prescribed for the injured person
- Monitor airway and breathing
- Avoid giving anything by mouth

Cardiogenic Shock

Cardiogenic shock refers to a reduction in the heart's ability to circulate blood to the brain and vital organs. Causes include heart attack (myocardial infarction), unstable arrhythmias and envenomations, especially from box jellyfish (of note, stonefish venom may also have vasoactive* effects that cause hypotension, and may result in decreased blood flow to the brain and other vital organs).

Signs and symptoms

- Hypotension (low blood pressure)
- Pale, cool, clammy skin
- Cold hands and feet
- Severe shortness of breath
- Weak pulse
- Altered mental status
- Reduced urinary output
- Nausea and vomiting
- Unconsciousness
- Cardiac arrest
- Chest pain (can radiate to the arms, shoulder, neck or back)

First aid

- This is a medical emergency – alert local emergency medical services immediately (call 10177). Do not call DAN
- Have the person lie down on his back or in a position of comfort. Take necessary steps to maintain a normal body temperature
- Check for signs of circulation; if absent, begin CPR
- Keep the person warm and comfortable
- Avoid giving anything by mouth

Hypovolemic Shock

Hypovolemic shock results from a sudden decrease in circulating blood volume that results in a deficiency of blood supply to vital organs. Blood loss is secondary to internal or external bleeding. In the marine environment, the most likely cause is large animal bites (sharks, seals, eels), but acute blood loss can also occur due to non-traumatic events such as intestinal disease.

To control external bleeding, use universal precautions and apply direct pressure. Universal precautions include barrier devices such as non-latex medical gloves plus protective eyewear or a surgical-style mask if there is blood being sprayed.

Signs and symptoms

- Anxiety or agitation
- Pale, cool, clammy skin
- Confusion
- Generalised weakness
- Rapid breathing
- Decreased urine output
- Unconsciousness

First aid

- This is a medical emergency — alert local emergency medical services immediately (call 10177). Do not call DAN
- Attempt to stop all external bleeding with appropriate measures, as discussed in the last chapter
- Have the person lie down on his back or in a position of comfort. Take necessary steps to maintain a normal body temperature
- Check for signs of circulation; if absent, begin CPR
- Keep the person warm and comfortable
- Avoid giving anything by mouth

CHAPTER 6 REVIEW QUESTIONS

1. **The signs and symptoms of an allergic reaction include**
   a. itching
   b. redness
   c. swelling
   d. all of the above

2. **In the event of an allergic reaction, the rescuer should**
   a. assist the injured person with any medications prescribed for him
   b. monitor airway and breathing
   c. immediately begin CPR
   d. all of the above
   e. a and b only

3. **Cardiogenic shock refers to**
   a. a decrease in blood volume
   b. the heart's inability to circulate blood
   c. an allergic reaction
   d. all of the above
   e. none of the above

4. **The primary course of action for cardiogenic shock is to**
   a. immediately call EMS and be prepared to begin CPR
   b. provide fluids to restore blood volume
   c. both a and b
   d. neither a nor b

5. **Hypovolemic shock results in**
   a. cool, clammy skin
   b. confusion
   c. weakness
   d. all of the above

6. **Respond to hypovolemic shock by**
   a. contacting EMS
   b. controlling any external bleeding
   c. providing fluids to replenish blood volume
   d. all of the above
   e. a and b only

Answers to review questions are on Page 78.

7 Avoiding Hazardous Marine Life Injuries

CHAPTER 7 OBJECTIVES

1. What are the likely causes of injuries by marine life?
2. What dive practices can reduce the risk of injuries by marine life?

While hazardous marine life injuries can be life-threatening, most occur accidentally. Divers with poor buoyancy control or those swimming in rough water may accidentally grab fire coral or bump into a stonefish. Both of these situations are avoidable through skill development and situational awareness.

If an animal acts aggressively, it is likely a defensive reaction from a perceived threat. Examples include putting your hand into a lobster hole, only to find that it is also home to a moray eel or stepping on a stingray while putting your fins on in shallow water.

The best way to avoid hazardous marine life injuries during scuba diving activities is to ***practice perfect buoyancy control.*** This helps avoid the sea bottom and accidental contact with coral and other animals.

In addition, follow these tips to reduce your risk of hazardous marine life injuries:

- Plan your dive, and know what hazardous marine life is present
- Pack a first aid kit. Be sure that the components have not expired (see Appendix 1 for examples of DAN First Aid kits)
- Wear appropriate exposure protection including hood, gloves and boots. While gloves protect you from potential injury, they may also increase the likelihood of touching the reef, leading to some dive operators banning the use of gloves. However, gloves should be worn when wreck diving, diving in strong currents or when needed for thermal protection
- Shuffle your feet and wear thick-soled boots when entering the water in sandy or muddy bottoms
- Streamline your body and equipment to avoid fatigue

- Improve awareness of your surroundings. Develop a sense of where you are in the water column and if you're busy looking at marine life or taking pictures, be sure to also note your position and proximity to marine life
- When taking pictures underwater, avoid using the reef for stabilisation
- Be passive in your interactions with marine life. Avoid feeding and petting animals as this may lead to accidental injury
- Avoid picking up shells. Some hazardous marine animals live inside shells and may defend their territory
- Avoid carrying speared fish when diving in areas populated by sharks and other predatory marine life
- Look up and around as you slowly ascend. Keep a careful eye out if you're in jellyfish-inhabited areas. Avoid holding onto the ascent/descent line without gloves; jellyfish and other stinging organisms may live or get caught on the line
- Avoid fish that are known to be potentially poisonous

The hard truth is that the most hazardous marine life you are likely to encounter is yourself or your buddy. Far more injuries and fatalities happen to divers due to lack of training, skills or experience than are caused by marine life.

CHAPTER 7 REVIEW QUESTIONS

1. **Marine life injuries can occur as a result of**
   a. accidental touching
   b. poor situational awareness
   c. perceived threats to the marine life
   d. all of the above

2. **Dive practices that can help minimise the risk of marine life injuries include**
   a. practicing good buoyancy control
   b. maintaining good situational awareness
   c. avoiding handling or feeding marine life
   d. streamlining yourself and your equipment
   e. all of the above

Answers to review questions are on Page 78.

8 Skills Development

CHAPTER 8 OBJECTIVES

1. **Scene Safety Assessment**
   - List the steps in performing a scene safety assessment
   - Perform a scene safety assessment in a scenario
   - Use appropriate first-aid barrier devices in a scenario
   - Demonstrate a caring attitude toward a simulated diver who has become ill or injured
2. **Donning and Doffing Gloves**
   - Don gloves without tearing or compromising the glove integrity
   - Demonstrate removal of gloves without contaminating exposed skin
3. **Initial Assessment with Basic Life Support**
   - Establish responsiveness of a simulated injured/ill diver
   - Demonstrate current sequence of providing care with proper ventilations and compression rates
4. **Shock Management**
   - Demonstrate the proper technique for managing shock by placing the victim on his back or in a position of comfort and taking steps to maintain normal body temperature in a scenario
5. **Injury Management**
   - Demonstrate the proper technique in a scenario for managing
     - spiny envenomations
     - stinging envenomations
     - contact injuries
6. **Pressure Immobilisation Technique**
   - Demonstrate the proper technique for applying a pressure immobilisation bandage
7. **Traumatic Injuries (Control of External Bleeding)**
   - Demonstrate applying direct pressure to control bleeding on a simulated patient
   - Demonstrate bandaging to secure a dressing in place once bleeding has stopped on a simulated patient
8. **Applying a Tourniquet**
   - Demonstrate applying a tourniquet to control bleeding on a simulated patient
9. **Severe Allergic Reactions**
   - Demonstrate the proper technique for assisting with an epinephrine auto-injector in a scenario
10. **Emergency Assistance Plan**
    - List the components of an emergency assistance plan
    - Develop an emergency assistance plan for the local diving area

Scene Safety Assessment

Objectives

- *List the steps in performing a scene safety assessment*
- *Perform a scene safety assessment in a scenario*
- *Use appropriate first-aid barrier devices in a scenario*
- *Demonstrate a caring attitude toward a simulated diver who has become ill or injured*

Follow these steps to perform a scene safety assessment.

Skill Description:

S A F E

S – Stop

- Stop
- Think
- Act

A – Assess the scene.

- Is the scene safe?
- Is it safe to approach the injured diver?
- Are any other hazards present?
- Are any additional risks present?

F – Find and secure the first aid kit, oxygen unit and AED

- First aid kits contain critical supplies such as barrier devices

E – Ensure exposure protection

- Use barriers such as gloves and mouth-to-mask barrier devices

Remeber S-A-F-E

S Stop
- Stop
- Think
- Act

A Access the scene
- Scene Safe?
- Safe to approach?
- Any hazards?
- Additional risks

F Find and secure the 1st aid kit (and oxygen and AED unit)
- First aid kits contain critical supplies such as barriers

E Exposure protection
- Use barriers such as gloves and mouth-to-mask barrier device
- Don gloves and inspect them for damage

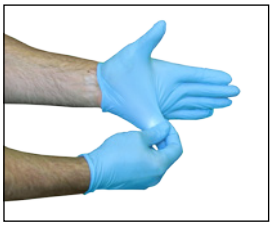
Donning and Doffing Gloves After Use

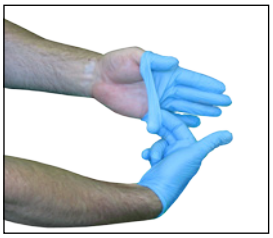
Objectives

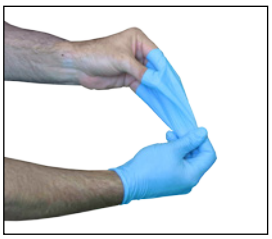
- *Demonstrate donning of gloves without tearing or compromising glove integrity*
- *Demonstrate removal of gloves without contaminating exposed skin*

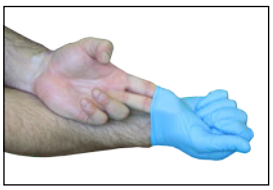
Skill Description:

- Before donning gloves, remove rings or jewellery that may tear the gloves during use
- To doff gloves, grasp the first glove at the outside of the wrist and pull the glove toward the fingers of that hand
- Turn the glove inside out
- Use your protected hand to crumple the glove into a ball (making a fist with the gloved hand)
- When the removed glove is in the palm of the still-protected hand (fist), place an "unprotected" finger inside the second glove (between wrist and glove) and pull the glove toward the fingers as before
- This glove will also turn inside out and the first glove will be inside the second
- Avoid touching the outside of the glove with your unprotected hand as you remove it
- Place the gloves in a hazardous waste bag to avoid others having contact with the gloves
  - This bag can also be used for the disposal of all other infected materials after use









Initial Assessment with Basic Life Support

Objectives

- *Establish responsiveness of a simulated injured/ill diver*
- *Demonstrate current sequence of providing care with proper ventilations and compression rates*

Remember S-A-F-E.

Assess responsiveness.

- State your name, training and desire to help
- Ask permission to help
- If unresponsive
  - Tap on the shoulder
  - Shout, "Are you OK?"
  - If there is no response, call for help, and activate emergency medical services (EMS)

Assess breathing.

- While you assess responsiveness, determine if the diver is breathing normally

CPR

- If he is unresponsive and not breathing normally, initiate CPR, beginning with 30 compressions. If an AED unit is available, deploy it
- If the diver is breathing normally and you suspect a diving emergency, initiate oxygen first aid and put your emergency action plan into motion

CPR is not generally taught as part of this course, although your instructor may offer it as an additional module. Discuss other training opportunities with your HMLI Instructor.

Shock Management

Objective

- *Demonstrate the proper technique for managing shock by placing the victim on his back or in a position of comfort and taking steps to maintain normal body temperature in a scenario*

1. Assess scene safety.
2. Support the airway and breathing if indicated.
3. Activate EMS.
4. Control external bleeding if present.
5. Provide comfort and reassurance.
6. Place the victim on his back or in a position of comfort.
7. Protect the victim from cold or heat; maintain normal body temperature.
8. Monitor the level of responsiveness

NOTE

- *Use extreme caution if providing fluids to someone in suspected shock. If in doubt, refrain from providing oral fluids, and activate EMS*
- *Do not force a person (especially with a heart or breathing problem) to lie down. Place him in the most comfortable (sitting) position*

Injury Management

Objective

- Demonstrate the proper technique in a scenario for managing
  - spiny envenomations
  - stinging envenomations
  - contact injuries

Wound management should occur only after life-threatening conditions have been addressed. Cleaning wounds may promote healing and prevent infection.

Spiny envenomations (lionfish, stonefish, stingrays, sea stars, crown-of-thorns)

1. Wash area thoroughly with soap and fresh water.
2. Control bleeding if present.
3. Remove visible pieces of spine or other foreign material with tweezers or forceps.
4. Control pain.

- Administer oral analgesics
- Immerse affected areas in hot water (45°C maximum) for 30-90 minutes. Do not burn the skin

5. Apply topical antibiotic ointment/cream.
6. Bandage if necessary.
7. Seek evaluation by a medical professional (for tetanus vaccination or antibiotics).
8. Monitor for allergic reaction and/or infection.

IMPORTANT NOTE

If a stingray spine is lodged in the victim, it should be left in place (if possible) and secured from motion until the victim is brought to a medical facility.

IMPORTANT NOTE

Spines lodged deeply in soft tissues or in joints may require additional treatment by a healthcare professional.

Stinging envenomations (jellyfish, coral, hydroid, anemones)

1. Irrigate with household vinegar or other mild acetic acid for 30 seconds. This neutralises any unfired stinging cells still on the skin.
2. Remove the tentacles with forceps (tweezers) as necessary.
3. Irrigate with saline solution or seawater. Do not rub.
4. Control pain.

- Oral analgesics (aspirin, Tylenol, Advil, etc.)
- Anti-inflammatory agents (hydrocortisone)
- Topical anesthetic agents (lidocaine)
- Immerse affected area in hot water (45°C maximum) for 30-90 minutes
- Cold packs may also be effective

5. Monitor for allergic reaction and/or infection.

Contact injuries (sponges, corals, bristle worms)

1. Clean area with soap and fresh water.
2. Remove foreign material.

- Cellophane tape maybe helpful to remove bristles
- Irrigate with syringe and catheter using clean water or saline solution to provide a steady stream of water that is forceful enough to dislodge debris and bacteria

3. Remove any remaining visible debris with tweezers or forceps.
4. Control bleeding if present.
5. Apply steroid ointment if available.
6. Cover with sterile dressing and bandage.
7. If eye contact occurs, flush with fresh water.
8. Monitor for signs of allergic reaction or infection.

Pressure Immobilisation Technique

Objective

- *Demonstrate the proper technique for applying a pressure immobilisation bandage*

For wounds from sea snakes, cone snails and blue-ringed octopus:

1. Thoroughly clean wound with soap and water.
2. Remove foreign material if present.
3. Place dressing or small pad over the bite or wound. Bandage in place.
4. Apply an elastic bandage firmly over the site, starting at least 15 cm above the bite and continue wrapping to at least 15 cm on the far side of the wound (if there is insufficient space to wrap 15 cm above or below the bite, wrap as far as possible).
5. Check for adequate circulation to the fingers or toes of the injured extremity.
6. Normal feeling, colour and palpable pulse should be present.
7. Splint the extremity to limit movement.
8. Use a sling when the wound involves the upper extremity.
9. Do not delay transport to nearest medical facility (for antivenom administration, tetanus vaccination, monitoring, IV hydration and respiratory support).
10. Do not remove bandage until at a medical facility.

IMPORTANT NOTE

The pressure immobilisation technique may delay absorption of venom from a bite or sting site into the general circulation. Marine animal injuries that may benefit from the use of pressure immobilisation technique include wounds from blue-ringed octopus, sea snakes and cone-shell snails.

Traumatic Injuries (Control of External Bleeding)

Objectives

- *Demonstrate applying direct pressure to control bleeding on a simulated patient*
- *Demonstrate bandaging to secure a dressing in place once bleeding has stopped on a simulated patient*

To control bleeding:

- If possible, wash area with soap and water as soon as possible
- Cover the wound completely with a sterile or clean dressing, and apply pressure until the bleeding stops. Use additional layers of dressing if the dressing becomes soaked. Do not remove any layers of dressing materials as it may disrupt the clotting mechanism of the body
- Once bleeding has stopped, use conforming bandage, roller gauze or tape to secure the dressing, and make sure there aren't any loose edges
- Remove all jewellery or constricting clothing on the injured appendage
- Be careful not to interfere with circulation
  - Check capillary refill on appendage nail beds to ensure adequate circulation
  - Ask the patient if any tingling or numbness is present
  - Adjust bandage if necessary to ensure circulation
- Monitor the pulse and motor function distal to the bandage before and after bandage application
  - Continue to monitor for signs of infection

NOTE

- *Bandage small wounds several inches on either side to ensure coverage and even pressure distribution*
- *To bandage across a joint, maintain the area in a comfortable position but try to keep the joint immobilised to minimise further discomfort or bandage displacement*

Applying a Tourniquet

Objective

- *Demonstrate applying a tourniquet to control bleeding on a simulated patient*

To apply a tourniquet

- Inspect the wound to ensure direct pressure was being applied directly to the site of the bleeding. If not, attempt direct pressure once more
- Place the tourniquet 2.5-5 cm proximal to the wound
- Secure the tourniquet
- Turn the windlass device to stop bleeding. Verify absence of pulse in the distal portion of the extremity
- Secure the windlass
- Simulate noting on the victim's forehead use of a tourniquet and time of placement
- Leave a tourniquet used in an actual injury in place until under medical care

NOTE

When performing this skill as part of skill practice for course requirements, the tourniquet should be released immediately after verifying absence of the distal pulse.

Severe Allergic Reaction

Objective

- *Demonstrate the proper technique for assisting with an epinephrine auto-injector in a scenario*

1. Ensure airway and breathing.
2. Assist in the delivery of allergy medications carried by the injured diver, such as antihistamines or an EpiPen® or Twinject® (epinephrine). Such medication should be administered only if it is prescribed for the individual having the reaction.
3. Activate EMS.

Emergency Assistance Plan

Objectives

- *List the components of an emergency assistance plan*
- *Develop an emergency assistance plan for the local diving area*

The following information is critical in managing scuba diving injuries and illnesses.

Diver information

Name: _____ Age: _____

DAN Member # _____

Address: _____

_____

Emergency contact phone: _____

Current complaint: _____

_____

Significant past medical history (medications, allergies, previous injuries, etc.):

_____

Dive Profile	Depth	Time	Safety Stops/Deco	Surface Interval
Dive #1				
Dive #2				
Dive #3				
Dive #4				
Dive #5				

Exit water time: _____ AM/PM Breathing gas: air/nitrox/mix _____%

Emergency assistance plan

Emergency contact information: _____

Emergency medical assistance: _____

Nearest medical facility directions: _____

_____

Phone: _____

Diving medical consultation information: _____

Divers Alert Network (DAN-SA): **0800 020 111 (local) or +27 828 10 60 10 (int.)**

** This number may be called collect in an emergency.*

Other important information: _____

Phone: _____

Notes: _____

_____

_____

9 Summary

Diving provides many opportunities to observe and interact with the creatures of the sea. Most of these encounters result in experiences that are truly memorable. However, in rare circumstances, certain interactions with marine life can become hazardous.

During this course you have learned how to identify potentially hazardous marine life and the signs of injuries caused by common marine creatures.

You have reviewed basic life support procedures and how to provide first aid to injured divers.

Finally, you have also learned the steps you can take to minimise your risk of injury from hazardous marine life.

In the unlikely event that you do become injured or believe that you have decompression illness, activate emergency medical services and/or transport to the nearest medical facility. Contact DAN at **0800 020 111 (local) or +27 828 10 60 10 (int.)** after activating local EMS.

This course has introduced you to the fundamentals of managing hazardous marine life injuries. We recommend continuation of your marine environment education by taking courses in marine ecology, animal behavior and general biology. Explore the Internet to locate more information on issues involving marine life and the environment.

The more you know about the marine environment and its animals, the greater your chances are for safe and memorable dives.

Appendix 1

FIRST AID KITS

Another essential item for dive-accident management is a first aid kit that should be appropriate for its intended use and the location of diving activity. Many kits are commercially available or you can assemble one yourself. In choosing or assembling a first aid kit, consider the types of marine life in the diving environment and any special first-aid requirements that may be warranted.

The following items should be included, at a minimum, in a standard first aid kit:

- protective case (waterproof if used in wet environments)
- resuscitation barrier device (face shield or mask)
- non-latex examination gloves
- cleansing wipes
- sterile saline for wound irrigation
- bandages
- sterile dressings (various sizes)
- sterile gauze
- sterile eye pads
- adhesive tape
- scissors (strong enough to cut away clothes)
- triangular bandage
- safety pins
- tweezers
- adhesive dressings (several sizes)

Optional, but recommended:

- wound-closure strips (Steri-Strips)
- isothermal blanket
- irrigation syringe
- infectious waste bag
- penlight
- splint to immobilise fractures
- thermometer
- NuMask® or oronasal resuscitation mask
- disposable razor
- first aid manual
- cold and hot compresses
- a list with emergency numbers
- Tourniquet or materials to improvise a tourniquet
- Hot and/or cold packs

Medications and ointments may also be helpful but may require input from your doctor to ensure appropriate use. While we have provided suggestions for some common over-the-counter medication, first-aid providers are not legally authorised to dispense medications or share their own prescriptions.

Recommended medications include:

- antiseptic solution
- eyewash
- hydrocortisone ointment
- antihistamine tablets
- antibiotic ointment
- pain reliever

Remember to check components regularly. Replace any items that have expired or have been used. Check both the first aid kits and oxygen units before each outing, and replenish after every use.

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Glossary

abrasion – a superficial excoriation, with loss of substance in the form of small shreds.

acute – symptoms or signs that begin and worsen quickly; an acute disease is a disease with a rapid onset (as in acute infection) and/or a short course *(as opposed to a chronic course)*.

antivenom, **antivenin** or **antivenene** – a biological product used in the treatment of venomous bites or stings. Antivenoms are created by injecting small amounts of the targeted venom into an animal (typically horses, sheep, goats or rabbits), with the intention of the subject animal developing antibodies against the venom's active molecule. The plasma of the animals, containing the antibodies, can then be harvested from the animal's blood and used to treat the envenomation.

aphonia – voice loss, inability to phonate sounds

ataxia *(or ataxy)* – loss of co-ordination; inability to co-ordinate voluntary muscle movements; unsteady movements and staggering gait.

bioaccumulation – the accumulation of substances in nature, in organisms or the environment.

blood-brain barrier (BBB) – a separation of circulating blood and cerebrospinal fluid in the central nervous system. It occurs along all capillaries and consists of tight junctions around the capillaries that don't exist in normal circulation.

Chordata – a major phylum in the kingdom Animalia characterised by the presence of a spinal cord. Phylogenetically, this phylum includes all vertebrates and some closely related invertebrates.

chronic – disease or signs and symptoms that are long-lasting or recurring.

clades – a group of organisms that are classified together as descendants of a common ancestor.

cyanosis – bluish colour of the skin due to insufficient oxygen in the blood.

debridement – surgical removal of foreign bodies and dead tissue from a wound.

denaturation – a structural change in macromolecules (e.g., proteins) caused by extreme conditions such as heat or external stress (e.g., strong acid or base) or a biological solvent (e.g., alcohol or chloroform).

diaphoresis – excessive perspiration; profuse sweating.

dinoflagellates – microscopic unicellular organisms that share characteristics of both plants and animals and therefore do not fit into either kingdom; typically present in plankton, microscopic algae and microscopic bioluminescent organisms.

diplopia – double vision; disorder of the vision in which one object is seen as two.

dysesthesia – a condition in which a sense, especially touch, is distorted.

dysphagia – difficulty swallowing.

dysphonia – difficulty in phonation, or painful speech; typically a hoarse or weak voice; not to be confused with *aphonia* (inability to phonate sounds).

dyspnea – difficult, painful breathing or shortness of breath.

edema – swelling caused by excess fluid in body tissues.

erythema – redness of the skin.

Eukaryota – from the Greek *eu* ("good" or "true") and *karyon* ("nut" or "kernel," which refers to the cell nucleus), meaning their cells have a true nucleus. Eukaryotes represent a complex form of biological evolution.

fasciculations – a small and very localised involuntary sequence of muscle twitches; rapid muscle contractions and relaxations; not to be confused with seizures or grand mal.

gastrointestinal – refers to the stomach and intestines.

grand mal – tonic-clonic seizures; a type of generalised seizure that affects the entire brain and causes massive muscular spasmic convulsions (See *seizures*).

hemolytic – that causes hemolysis, dissolution of red blood cells.

histamine – an organic nitrogen compound which is released during allergic reactions that triggers an inflammatory response. It also regulates other physiological responses and acts as a neurotransmitter.

histaminoid – similar to histamine.

hypotension – excessively low arterial blood pressure; causes include blood loss, infection, poisoning, heart failure, neurological injury, endocrine disorders and medications.

inflammation – redness, swelling, pain or a feeling of heat in an area of the body; a protective reaction to injury, disease or irritation of the tissues.

laceration – a protective reaction to injury, disease or irritation of the tissues; a jagged wound or cut.

lingual – relating to or resembling the tongue.

localised – restricted to the site of origin, without evidence of spread.

maxilla – the principal bone of the upper jaw (The bone of the lower jaw is the mandible).

mimicry/mimetic – protective resemblance; the resemblance that certain animals and plants exhibit to other animals and plants or to the natural objects among which they live; a characteristic that serves as their chief means of protection against enemies; imitation; mimesis; mimetism.

morphology – science of the form and structure of organisms (plants, animals and other forms of life).

mydriasis – a long-continued or excessive dilation of the pupil of the eye.

necrosis – tissue death, which typically turns black.

necrotic – death of cells or tissue as a result of injury or disease.

neuromuscular – the synapse or junction of the axon of a neuron and the motor end plate of a muscle; in vertebrates, the signal passes through the a neurotransmitter called acetylcholine.

paralysis – loss of ability to move all or part of the body.

paresthesia – an abnormal sensation, such as burning, prickling, formication, etc; usually referred to as the feeling of "pins and needles".

pelagic – any water in the sea that is not close to the bottom or near to the shore is in the pelagic zone; from the Greek *pélagos,* which means "open sea".

planktonic – a group of microscopic floating organisms

pneumatophore – one of the polyps of *Physalia* spp., which forms a gas-filled bladder that enables the organism to float along the ocean surface; also known as the marissa or sail

prokaryote – from the Greek *pro* (meaning "before") and *karyon* ("nut" or "kernel"), meaning these cells have no real nucleus. They represent a more primordial form of life, less evolved than nucleated cells (eukaryotes).

protozoan – a large group of single-celled, usually microscopic, nucleated organisms

pruritus – an intense chronic itching sensation that can have various causes (allergies, infection, lymphoma, jaundice, etc.); poison ivy causes pruritus

rhabdomyolysis – disintegration of skeletal muscle

seizure – a convulsion; a sudden, involuntary movement of the muscles; typical of epileptic disorders

sessile – resting directly upon the main stem or branch, without a petiole or footstalk (as a sessile leaf or blossom)

sign – an entity that indicates another entity; in medicine, an indication of the existence of something; any objective evidence of a disease perceptible to the examiner (as opposed to a *symptom*)

symptom – an often subjective indication that a person has a condition or disease (examples of symptoms are headache, fever, fatigue, nausea, vomiting and pain)

systemic – affecting the entire body

Td, Tdap – refers to different combination vaccines that provide immunisation against tetanus. Tdap includes immunological coverage against three infectious diseases: tetanus (T), diphtheria (D) and pertussis – whooping cough (P). Td lacks the pertussis component.

thermostable – the quality of a substance to resist irreversible change in its chemical or physical structure at a high relative temperature

toxicology – a branch of biology and medicine concerned with the study of the adverse effects of chemicals on living organisms; study of the signs, symptoms, mechanisms of action and treatments of poisonings

toxinology – the specialised area of science that deals specifically with animal, plant and microbial toxins; a branch of biology and medicine concerned with the study of the adverse effects of natural toxins or chemicals on living organisms

vasoactive – exerting an effect on blood vessels

REVIEW ANSWERS

Chapter 2, Page 7
1. D
2. A
3. B
4. A
5. D

Chapter 3: Part 1, Page 18
1. C
2. B
3. A
4. D
5. C

Chapter 3: Part 2, Page 34
1. A
2. B
3. D

Chapter 4, Page 41
1. D
2. A
3. A
4. D
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6. C

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2. D
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4. B

Chapter 6, Page 55
1. D
2. E
3. B
4. A
5. D
6. E

Chapter 7, Page 58
1. D
2. E

NOTES:

Divers Alert Network Southern Africa

Divers Alert Network Southern Africa (DAN-SA) is an international, nonprofit organisation dedicated to improving dive safety through research, education, medical information, evacuation support, products and services.

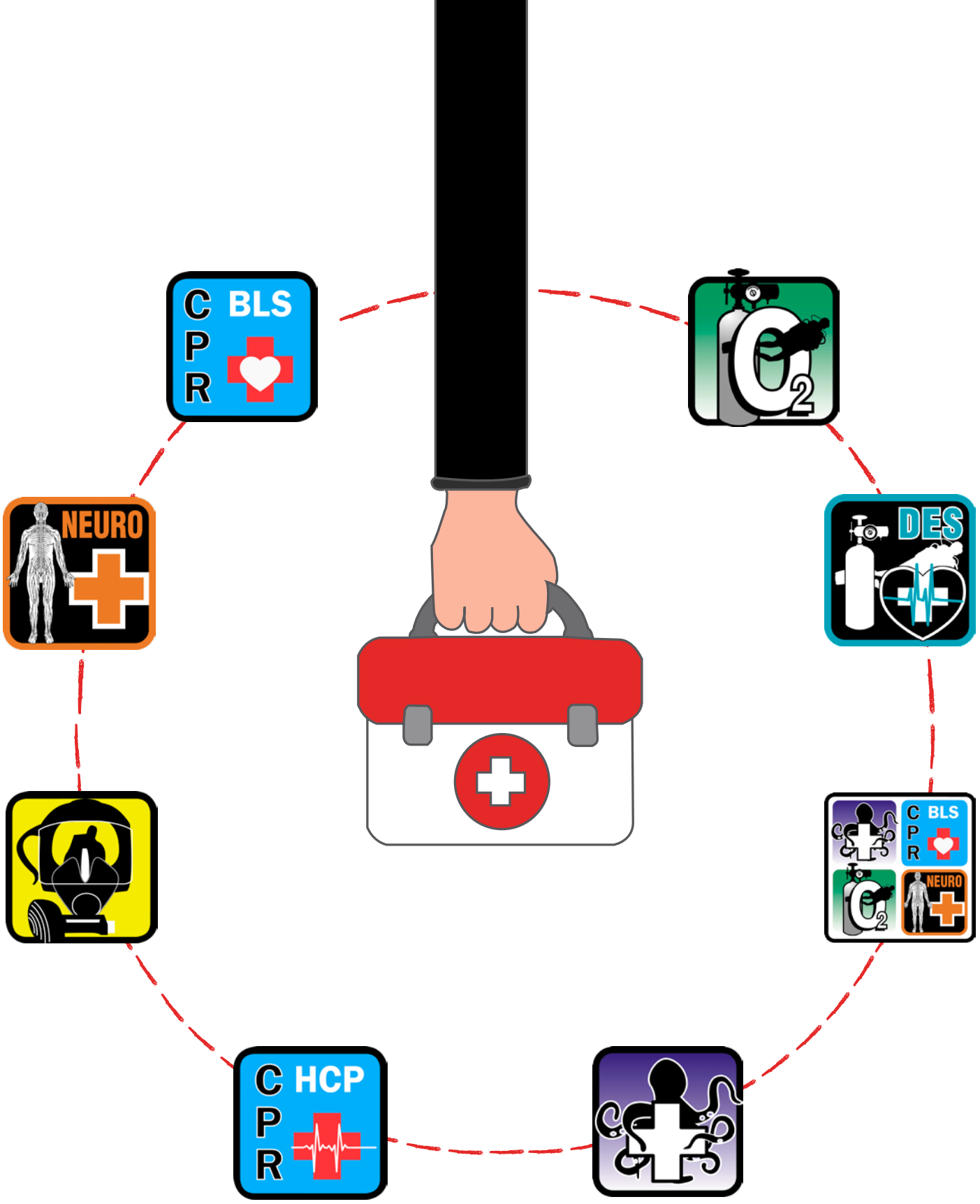
Among the services DAN-SA provides to the diving public is the DAN Emergency Hotline (0800 020 111 (local) or +27 828 10 60 10 (int.)). This hotline is available 24 hours a day, seven days a week for anyone who suspects a diving injury, requires assistance or needs to activate **your DAN evacuation benefits** (an exclusive benefit of DAN membership). Callers are connected directly with a member of DAN's Medical Services department, who can facilitate medical consultation with dive medicine specialists and co-ordinate evacuation to ensure appropriate care.

DAN-SA's non-emergency safety resources include the DAN Medical Information Line DAN-SA (0800 020 111 (local) or +27 828 10 60 10 (int.)), the online Health & Diving libary (http://dansa.org/dan-resources.htm) and ***Alert Diver*** magazine, the DAN Shop, the DAN-SA Podcast, a blog and more.

Membership dues and dive cover support DAN's nonprofit efforts. DAN members enjoy benefits such as access to the DAN Dive Accident Cover, medical evacuation support, access to the electronic Alert Diver magazine, safety guides and more.

Your participation in this DAN training course demonstrates your commitment to dive safety. Continue your education and your commitment by supporting **the industry's only organisation dedicated solely to improving dive safety.** Join DAN today.

To learn more about DAN and the multitude of resources it provides, or to become a member, please visit dansa.org.



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