Dangers in the Ocean: The Traveller and Marine Envenomation. I. Jellyfish

Peter J. Fenner
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Envenomation by marine creatures is more common than is often realized, and regularly accounts for both death and severe morbidity in humans. Worldwide marine envenomation morbidity and mortality result from two main animal groups: (1) jelly fish, and (2) "other" marine animals. Venomous jellyfish are discussed in part 1 of this article, with relevant information on their distribution and appearance, and on symptoms of envenomation; first aid and medical treatment are also suggested.

JELLYFISH

Three main classes of jellyfish pose a threat to humans:'

1. Scyphozoans (Class Scyphozoa)-the "true" jellyfish. Members of this group, which are common worldwide, have tentacles arising at regular intervals all around the bell (and often in other areas inside the bell), i.e., they are "radially" arranged.

2. Cubozoans (Class Cubozoa)-the "box" jellyfish. These are the most dangerous jellyfish and have caused hundreds, possibly thousands, of human deaths in tropical and subtropical waters worldwide. They have a box, or cube, shape with tentacles arising only from the corners. There are two subgroups, or Families:

   • Carybdeids (e.g., Irukandji), having just one tentacle (except in rare cases) arising from each lower corner of the bell. They have not caused a documented human fatality to date, although there is a possibility that death from heart failure after Irukandji envenomation may have occurred, but has been classified as a myocardial infarction, followed by heart failure.
   • Chirodropids, having more than one tentacle in each corner of the bell (Fig. 1, 2). Chirodropids regularly cause human deaths each year (Table 1; Fig. 3).

3. "Other jellyfish" (Class Hydrozoa). These are not actually jellyfish, although they resemble them, and are best dealt with as such. This group includes the siphonophore Physalia sp., commonly known as the "Portuguese man-o'-war" (Fig. 4, 5), and Gonionemus, a small hydrozoan, which causes sting problems in the Sea of Japan.

JELLYFISH ENVENOMATION

The tentacles of all jellyfish, and the bells of a few, have millions of small stinging cells, containing organelles called nematocysts. These microscopic structures have a small "trigger" on the outside of the organelle. When this trigger touches live tissue (e.g., its potential victim), it is stimulated by both tactile and chemical mechanisms. A coiled tube, present on the inside, then everts in milliseconds, puncturing the integument of the victim and penetrating just to the dermis. The tube is bathed in venom, so as it everts itself, venom is present on the outside of the tube. These everting thread tubes have been shown to directly penetrate small dermal capillaries, thus giving an intravascular injection of venom. The thread tubes also have a hollow lumen through which further venom is deposited in dermal tissues, where it is absorbed, probably by the lymphatic system, thus resulting in increased envenomation.

Jellyfish can be subdivided into three main groups, based on the symptoms they cause:

- Those causing human fatalities,
- Those causing severe envenomation with systemic effects, and
- Those causing nuisance stings.

Jellyfish Causing Human Fatalities

- Chirodropids (multi-tentacled box jellyfish) are the jellyfish causing most of the human fatalities. Fatal stings regularly occur worldwide in tropical and sub tropical waters (see Table 1).
- Portuguese man-o'-war *(Physalia physalis)* is a siphonophore colony that looks like a jellyfish, and is commonly regarded as one by the general public. It has caused three human fatalities in the SE corner of the United States (see Table 1).
- A large scyphozoan jellyfish, *Stomolophus nomurai* (sand jellyfish), has now caused eight recorded deaths in one area of the South China Sea around Qindao, China (see Table 1).

Jellyfish Causing Severe Envenomation with Systemic Effects

Several species of jellyfish cause severe morbidity, not necessarily resulting in death:

- Irukandji *(Carukia barnesi) is* a carybdeid, which causes severe systemic symptoms, called the Irukandji syndrome. Symptoms of severe hypertension, pulmonary oedema and heart failure may be life-threatening.'
- *Gonionemus is* a tiny hydrozoan that occurs almost worldwide, but has been reported to cause severe systemic symptoms similar to the Irukandji.
- Large carybdeids (box jellyfish) occur in most tropical or temperate seas, worldwide. In about 10% of cases they may cause a mild Irukandji-like syndrome.

DESCRIPTION OF JELLYFISH

Chirodropids (multi-tentacled box jellyfish)

Distribution. Chirodropids are found on tropical coasts in the following oceans: the cast and west coasts of the Atlantic Ocean, the east coast and mid-ocean of the Indian Ocean, and the Indo West Pacific.

Season. Chirodropids occur in tropical waters in the summer months of either the Northern or Southern Hemispheres. Their season is longest closer to the equator; e.g., in Darwin, Australia, which is the area in Australia closest to the equator, fatalities have occurred in all months except July, but stings have been reported in every month of the year. Areas furthest from the equator have a correspondingly shorter jellyfish season-perhaps just a month or two in the height of summer in their distribution extremities (approximately the Tropic of Capricorn and the Tropic of Cancer).

Appearance. Chirodropids usually have a transparent bell, which may be up to 25-30 cm. in diameter in the mature adult (see Fig. 1, 2). They have four corners (hence "box" jellyfish), with up to 15 tentacles in each corner (up to 60 tentacles in total). These tentacles may extend up to 3 m, resulting theoretically in a total tentacle length of up to 180 m. As the shortest tentacle length causing fatality in a child has been just 1. 2 m, it earns its reputation as "the most deadly animal in the world!

Envenomation. Envenomation usually occurs in shallow water. Severe stings occur more often in women and young children, who are smaller and relatively hairless. Hair can prevent more intimate tentacle contact, and consequently prevents envenomation.

Chirodropids swim into shallow water when the wind is light and hot, and the water is calm. Unsuspecting victims frequently walk, or run, into tentacles trailing behind the jellyfish bell. The bell is difficult to see in the water, and the tentacles are almost invisible.

Pain is instant and savage; the victim will often scream with pain. Children often stand in the water, picking at the tentacles and getting stung on the hands and arms, increasing the envenomation, while adults frequently run out of the water and rub the tentacles. Most stings occur on the lower legs and body.

Adherent tentacles, like sticky threads, usually adhere to the victim: tentacle marks look like the victim has been whipped, or branded with irons.' If the victim lives, blistering and skin necrosis occur over the next few hours (Fig. 3); scarring often occurs, and lasts for life. Victims may rapidly stop breathing, sometimes within a few minutes of the initial envenomation, with death occurring rapidly unless prompt first aid and medical aid is available (Table 2, 3)

Human Fatality. Documented human fatalities from chirodropid jellyfish (see Table 1) include 66 deaths in tropical Australia, where fairly accurate records have been kept since 1884; one death in Texas, USA; and two deaths in Okinawa, the latest on 13 August 1997 (Cheryl Lewis, personal communication, August 1997).

Elsewhere in the world, accurate figures are not kept, and most reports of fatalities are heard "through the grapevine." Approximately 10 other deaths have been reported from around the Indo West Pacific, excluding the Philippines, but this information is probably only the tip of the iceberg, with many more probably occurring, but remaining unreported where the information is freely available.

Based on personal experience, the author, after a visit to the Philippines in 1984, calculated that between 20-50 human deaths occur each year from chirodropid stings." These figures have since been corroborated by Dr. Paul Cornelius, The Natural History Museum, London (personal communication, 1994) and by Prof. Thomas Heegar.

Irukandji (*Carukia barnesi)*

Distribution. The distribution of Irukandji in Australia, in tropical waters from Gladstone, north Queensland on the cast coast, northwards and westwards over Australia as far south as Exmouth, Western Australia.

Cleland and Southcott reported jellyfish similar in appearance in West Irian and Papua New Guinea (PNG) during World War II, which caused similar envenomation symptoms." Despite having an extensive database of worldwide stings, the author has no further reports of similar stings since then, although information on any envenomation from Papua New Guinea is particularly scarce and sketchy.

Season. Its season is the summer months, similar to the chirodropid season in Australia.

Appearance. Irukandji is a tiny transparent bell (< 2 cm diameter), with four small tentacles, one in each corner. It is a type of box jellyfish called a carybdeid.

Envenomation. Envenomation starts with a skin sting, which may be so mild as to be hardly felt, or may be somewhat uncomfortable. However, some 5-40 minutes later (usually 30 minutes) the severe systemic symptoms start: these are called the ‘Irukandji syndrome.’

The first symptom is usually a severe 'boring' pain in the sacral area. Other symptoms quickly develop and include muscle pains or ‘cramps,’ moving rapidly into all four limbs and the abdominal and chest wall muscles. The pain is described as severe, unbearable and coming on in ‘waves’(similar to labour pains), although never fading completely. Chest pain or 'tightness' occurs from spasm of the intercostal muscles and probable cardiac muscle pain.

Many of the signs and symptoms associated with the Irukandji syndrome resemble those of an adrenal medullary tumour (phaeochromocytoma), with excessive release of catecholamines into the bloodstream.

Symptoms include the following: sweating - localized or generalized, often profuse and drenching; localized or generalized piloerection; anxiety and 'wretchedness'-the victim feels 'absolutely dreadful and often has 'a feeling of impending doom' (a feeling often shared by the treating first aider!); restlessness, moving continuously; severe frontal or global headache, which may be incapacitating; nausea- often with severe, intractable vomiting; increased respiratory rate-often of a 'sighing nature'; tremor; pallor, or peripheral cyanosis; oliguria due to reduced renal perfusion and fluid loss from the sweating and/or vomiting; tachycardia-often irregular with ventricular extra-systoles; hypertension, with levels as high as 280/150 mm. Hg in previously normotensive victims. Recommended hospital treatment is described in Table 5.

Later complications may be acute pulmonary oedema, usually some 15-18 hours post-envenomation (occasionally less), and secondary toxic global cardiac dilatation with left ventricular dysfunction, proven by echocardiography.

Portuguese Man-o-War (*Physalia physalis*)

Distribution. Distribution of the multi-tentacled Portuguese man-o'-war is worldwide in temperate and tropical zones. Stings appear to be more severe in warmer waters.

Appearance. The Portuguese man-o'-war has a clearly visible blue float up to 25 cm in length (see Fig. 4). It sits on the surface of the water with long blue tentacles hanging in the water. These are highly retractable and may extend up to 30 m in length! The smaller version of the same species in the Pacific is often referred to as the Pacific man-o'-war, and the smaller cousin, the single-tentacled species *(Physalia utriculus),* which is the most common species in Australia, is usually known as the bluebottle.

Envenomation. The smaller bluebottle causes uncomfortable skin pain. However, both the Pacific and Portuguese man-o'-war cause very painful skin stings (see Fig. 5), although not as severe as that of *Chironex* box jellyfish (see Fig. 3). *Physalia physalis* causes painful breathing, even leading to hypoxia, as well as nausea, muscle cramps and anxiety-similar to the initial effects of the Irukandji, therefore referred to as an "Irukandji-like" syndrome (see Table 5 for hospital treatment).

There have now been three deaths recorded from the Portuguese man-o'-war in south eastern United States (see Table 1).

Physalia sp. was also thought to be responsible for a severe envenomation resulting in brachial artery spasm after a second sting, 2 weeks after the initial sting, at Mangalore in the Indian Ocean m the summer of 1983 .14 The cause was attributed to hypersensitivity. Serious envenomation from an Indian Ocean (Goa) jellyfish was reported, in which a Physalia sp. was suspected, on the basis of serologic titers, of producing localized necrosis, vasospasm. and gangrene, although the identity of the jelly fish was not confirmed.

It has since been reported that a little-known jellyfish called *Sanderia* present in the Indian Ocean can also cause severe symptoms, and may have been responsible for these unusual stings of chirodropid jellyfish. In approximately 10% of cases,

Gonionemus sp.

Distribution. Distribution of *Gonionemus* sp. is worldwide; however, *Gonionemus* has been reported as causing severe envenomation effects only in the Sea of Japan around Vladivostock (previously USSR), and the northwest shores of Honshu Island, Japan.

Season. Serious stings from *Gonionemus* tend to occur in the hot summer month of August in the Northern Hemisphere in the Sea of Japan.

Appearance. *Gonionemus* is a small jellyfish in the class Hydrozoa, measuring 5-15 mm in diameter, with many tentacles attached to the entire edge of the bell. A symmetrical, right-angled cross is visible in the transparent bell.

Envenomation. Three forms of intoxication of jellyfish stings make them a potential danger: Those described are: - painful, respiratory and mixed.

In the painful form (approximately 37%), the symptoms are severe muscle joint, chest and loin pains, which persist for 2-3 days. There is general muscle fasciculation.

In the respiratory form (44%), patients develop allergic rhinitis, lacrimation, hoarseness, cough and dyspnoea. These symptoms persist from several hours to 2 days. In the mixed form (19%), in addition to severe joint and muscular pains, cough, bronchospasm, throat irritation, rhinitis and lacrimation, some patients have a tachycardia (up to 100 beats per minute), and mild hypertension (up to 150/100 = Hg).

Severe stings documented by physicians are accompanied by psychic dysfunction. Neuropsychiatric symptoms, depression and hallucinations are also possible.

In Japan, the stings mainly occur underneath bathing costumes. A similar syndrome has been reported in northern Japan after the victim ate raw seaweed. As Gonionemus lives in this seaweed, it is presumed the syndrome results from its ingestion.

Large Carybdeids (*Tamoya* and *Carybdea* sp.)

Distribution. Distribution of large carybdeids (box jellyfish) appears to be all temperate, subtropical and tropical oceans, although they are much more common in the latter.

Season. They may be present any time of the year, but are more common at the beginning and end of summer.

Appearance. The large carybdeids are large box-shaped jellyfish with just a single large tentacle in each corner. The bell may be from 4-18 cm in height, with the four tentacles up to a meter long in the larger specimens. Travellers should be aware that this jellyfish has stinging cells on the bell, which may also cause stings.

Envenomation. The organisms cause skin pain, from “burning” to a very painful sting, although not as severe as that of chirodropid jellyfish. In approximately 10% of cases, it may cause a similar syndrome to the Irukandji, but not as severe, known as an Irukandji – like syndrome.

Jellyfish Causing Nuisance Stings.

Nuisance stings from jellyfish occur all around the world. Fortunately, it is unnecessary to identify these stings as the symptoms are skin pain only in the stung region, and the only treatment necessary is the use of cold packs to relieve the pain. Should there be systemic symptoms, which rarely occur, they can be treated on an ‘ad hoc’ basis (see Tables 2-5)

AVOIDING JELLYFISH STINGS

Awareness

Travellers should be aware of several factors which may make jellyfish stings a potential danger.

- time of the year (summer)
- geographical location (tropical and subtropical waters)
- weather (hot, still weather with light northerly winds).

If these conditions exist, travellers should at all times be using patrolled beaches (surf lifesaver on duty).

Prevention

Travellers need to do the following:

- Obey warning signs (advising of dangerous jellyfish)
- Wear protective clothing (pantyhose, lycra "stinger suits")
- Swim on patrolled beaches
- Swim in stinger-resistant nets, if available (there are now 17 in north Queensland).

TREATMENT OF JELLYFISH STINGS

Table 1

First Aid Treatment of Chirodropid Envenomation

1. Retrieve the victim from the water and restrain, if necessary.
2. If bystanders are available, immediately send them for ambulance/medical help.
3. Check the victim's Airway, Breathing and Circulation (ABC). Treat with Expired Air Resuscitation (EAR), or Cardiopulmonary Resuscitation (CPR), if necessary.
4. If others are available, or if resuscitation is not needed, pour vinegar over the stung area for a minimum of 30 seconds to inactivate remaining stinging cells on any adherent tentacles left on the skin.
5. AFTER vinegar application, apply compression bandages directly over major stings. Major stings are those
   a) covering an area more than half of one limb
   b) causing impairment of consciousness
   c) causing impairment of breathing
   d) causing impairment of circulation.
   If vinegar is unavailable, the rescuer should pull tentacles off using their fingers bandages.
6. Cold packs may be used (15 minutes and repeated when necessary) to help case the skin pain in conscious victims. In severe envenomation, use oxygen if available. Inhaled analgesia (i.e., entonox or methoxyflurane) can be administered for unremitting pain in conscious, breathing, cooperative patients. Its use should be discontinued if the patient's condition worsens.
8. In Australia, if available, use *CSL Chironex* antivenom. For all major cases. Three ampoules each containing 20,000 units may be given intramuscularly, above the bandages, by a trained health professional on the beach. Medical personnel may give one ampoule intravenously.

Table 2
Medical Treatment of Chirodropid Stings

1. If necessary, continue resuscitation with endotracheal intubation and 100% oxygen (if appropriate), monitoring the oxygen haemoglobin saturation and electrocardiography.
2. Insert an intravenous line; monitor urine and cardiac output.
3. In major chirodropid stings, administer a minimum of 1 ampoule of diluted antivenom (20,000 units) IV If the clinical response is inadequate, three (or more) ampoules may be given IV, according to clinical response.
4. Inotropes such as adrenaline or dopamine should be considered for persisting hypotension; however, calcium should not be given.
5. Intermittent positive pressure ventilation with 100% oxygen will also assist in control of pulmonary oedema.
   Note: Cardiopulmonary resuscitation with oxygen (preferably 100%) should be continued and not abandoned until more antivenom (at least 6 ampoules total dose, if available) and inotropes have been administered.
6. Intravenously administered analgesia may be necessary (1 mg/kg of pethidine up to 50 mg adult dose initially).
   For pain not relieved by cold packs and narcotic analgesia, in chirodropid stings, consider administration of 1 ampoule of antivenom IV as in #3.
7. Intravenous antivenom (administered as in #3) may confer cosmetic benefits in stings involving cosmetically sensitive areas (e.g., face or neck) especially in females.

Table 3
First Aid Treatment of Non-chirodropid Envenomation

1. If fresh, adherent tentacles are present on the skin, they should be flushed off with seawater. If this is unavailable, tentacles can be picked off the skin with the fingers (only a harmless prickling of the fingers will be felt).
2. Ice in a polyethylene bag, wrapped in a cloth, or cold packs are applied to the stung area and left in place for 5-15 minutes. This will relieve most skin pain.
3. The ice or cold packs can be reapplied if the skin pain is unrelieved, or returns.
4. Unresolved pain or any further systemic symptoms are immediately referred to medical care.
5. Inhaled analgesia (such as entonox or penthrane) may be available from the local ambulance for more severe pain, but further medical aid should be sought.

Table 4
Primary Hospital Treatment of Irukandji, and Irukandji-like Syndrome*

- Analgesia: IV morphine infusion with boluses 5-10 mg (adult); pethidine 50 mg IV 3 hrly prn
- Catecholamine-like effects: phentolamine 5-10 mg boluses (adult) +/- infusion
- Chest pain: IV GTN (50 mg in 500 ml 5% dextrose) commencing at 3 ml/hour
- Pulse occimetry: administer oxygen to keep haemoglobin oxygen saturation > 93%
- Cheek BP regularly (automatic machine - dynamap, if possible)
- Monitor ECG
- Chest X-ray if respiratory rate increases, or O2 sats reduced
- Blood for cardiac enzymes: CK, CK:MB, catecholamines (if possible)
- Admit to high dependency ward
- Echocardiogram within first 24 hours
- If heart failure: refer to Physician for high flow oxygen, CPAP, increase GTN, frusamide, CVP line, inotropes

No first aid treatment is available for Irukandji syndrome, although one method is being tested at present.

CONCLUSION

Envenomation by venomous jellyfish can be a fatal event. Morbidity is even more common and the victim may suffer severe systemic reactions. With the increasing numbers of travellers worldwide, especially to the more remote areas, travel medicine experts and general practitioners must warn their patients of these dangers, in addition to providing the more common forms of advice.

Although marine envenomation may be caused by a number of jellyfish species, in addition to immediate resuscitation, three main treatments cover first aid management of the stings of all jellyfish species:

1) Cold packs to stop skin pain of jellyfish stings
2) Vinegar, to prevent further stinging from chirodropid (box jellyfish) stings
3) Compression/immobilization to reduce the spread of venom from bites depositing large amounts of venom in one spot.

Although medical treatment is more extensive and variable, prompt first aid by those first on the scene will usually be life saving.

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