

Management of Marine Envenomation. Part 1: Jellyfish

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ABSTRACT

Envenomation from jellyfish and other marine animals causes human deaths and severe morbidity in both tropical Australia and many countries in the world having tropical, or sub-tropical waters. World distribution of venomous marine animals and the human mortality and morbidity they cause, are discussed; simple first aid and effective medical treatment is suggested. With travel becoming more popular than ever, General Practitioners and Travel Medicine consultants must routinely advise their patients when they are first consulted, on the hazards of marine envenomation, both in Australia and overseas.

INTRODUCTION

Worldwide marine envenomation may be divided into two main groups: -

- Jellyfish
- Other marine animals (covered in part 2)

Jellyfish may then be sub-divided into 3 main groups, those causing: -

- Human fatality, or potential fatality
- Severe envenomation with systemic effects
- Nuisance stings

A) Fatal / potentially-fatal stings

Fatal stings from multi-tentacled box-jellyfish (chirodropids) occur worldwide in tropical and sub-tropical waters (see Table 1). In Australia the chirodropid causing death is called *Chironex fleckeri* (referred to here as Chironex box-jellyfish). Other jellyfish have also caused deaths worldwide (see Table 2).

Table 1 - Human fatalities from chirodropid envenomation

Geographical locations – Human fatalities from chirodropid envenomation
Australia Brunei Indonesia (Kalimatan) Japan Labuan Malaysia (Penang & Langkawi Is. Papua New Guinea Philippines Sabah Sarawak Solomon (Bougainvillea) Is. United States of America (Texas)

Table 2 - Human fatalities from non-chirodropid envenomation

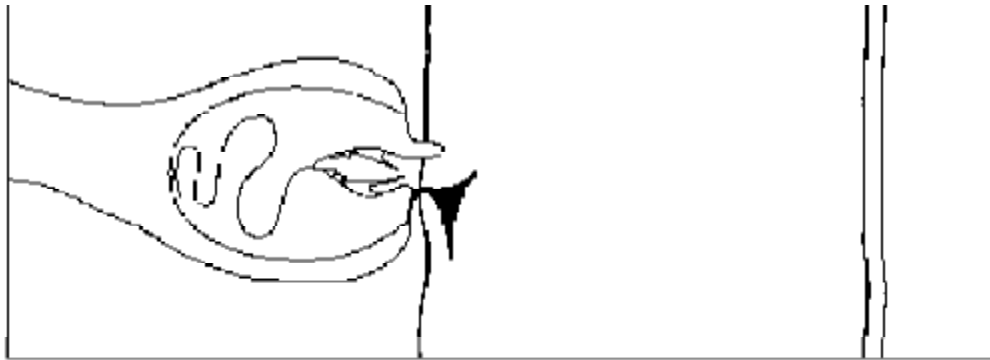
Geographical locations – Human fatalities from non-chirodropid envenomation
China (east coast) – <i>Stomolophus nomurai</i> (the sand jellyfish) United States of America – <i>Physalia physalis</i> (Portuguese man-o'-war)

Method of jellyfish envenomation

Envenomation is by nematocyst, the “stinging cell”. One of these is represented in Figure 1(a-d); millions of these nematocysts are present in the tentacles of a jellyfish.



Each nematocyst has a thread tube that is tightly coiled inside. On the outside is a lid with a “trigger” (1a).



When stimulated by both “taste” and touch of potential prey, the lid of the nematocyst opens (Figure 1b).

The thread tube then everts itself in milliseconds, driving through the skin of its hapless victim with tremendous force, comparable to a missile penetrating armour plating (Figure 1c).

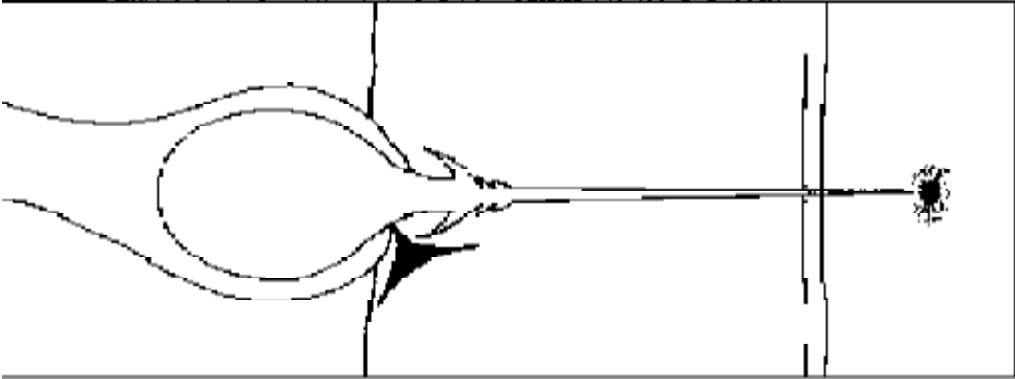
The thread-tube length is usually sufficient to reach the dermis in normal human skin where venom is deposited (Figure 1d). On eversion, venom is present on the outside of the thread tube. If it pierces a blood vessel, however small, venom can be introduced directly intravascularly, accounting for the rapid onset of symptoms within minutes, including unconsciousness and respiratory or cardiac arrest on the beach, in massive Chironex box-jellyfish envenomation.

Further venom extruded through the end of the hollow thread tube is deposited in the dermis and collected by lymph vessels (Figure 1d).

Figure 1c



Figure 1d



***Chironex fleckeri* (Chironex Box-Jellyfish)**

Chirodropid distribution in Australia

Chironex box-jellyfish occur in tropical Australian waters from just south of Gladstone, Queensland on the east coast, across the north of Australia as far south as Exmouth, Western Australia (see Map, Figure 2). They occur in summer months.

Human fatality in Australia from *Chironex*

Sixty six deaths have occurred from 1884 (first records kept) to date. Awareness and prevention of envenomation policies, issued in conjunction with Surf Life Saving Queensland, have reduced human morbidity and human fatalities from Chironex box-jellyfish from 1-2 per year, to approximately 1 fatality every two years. Deaths usually occur in children, often in Aborigines.

Season

Longest closer to the equator - in Darwin fatalities have occurred in all months except July, but stings have been reported in every month of the year. Areas furthest from the equator (e.g. Gladstone) have a shorter jellyfish season - December through to February/March. Local experts in Surf Life Saving Clubs must be consulted before swimming in these areas.

Chironex box-jellyfish appearance

Transparent bell, a few centimetres diameter in juveniles, up to 25-30cm diameter in the mature adult (Figure 3). It has 4 corners (hence "box" jellyfish); up to 15 tentacles/corner, which may extend to 3 metres - theoretically total of 180 metres. The least tentacle length for a child fatality was 1.2 meters – hence "the most deadly animal in the world!"

Chironex envenomation

Usually occurs in very shallow water, especially in women and young children, who are relatively hairless. Chironex come into very shallow water when the wind is light and hot (usually northerly), and the water is calm. Unsuspecting victims frequently walk, or run, into tentacles trailing behind the jellyfish bell, as they are very difficult to see in the water. 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; 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, are usually adhering 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; scarring often occurs, and lasts for life.

Victims may rapidly stop breathing, sometimes within a few minutes of the initial envenomation, and death occurs shortly after, unless prompt first aid and medical aid is available.

Chirodropid world distribution

Chirodropid (multi-tentacled box-jellyfish) seems to be similar in appearance and clinical envenomation effects, wherever they are present in any tropical ocean. The Countries with human fatalities are shown in Table 2. General Practitioners should be aware of these locations as their patients may be traveling to these areas, and such an encounter might well spoil their holiday!

B) Jellyfish causing severe morbidity

Species of jellyfish causing severe morbidity are: -

- Irukandji (*Carukia barnesi*) - being the most severe
- The multi-tentacled *Physalia* (Pacific man-o'-war – a smaller type of Portuguese man-'o'-war), which causes severe skin pain, and systemic symptoms similar to, but much more mild than the Irukandji
- The "Morbakka". In about 10% of cases this may cause a mild Irukandji-like syndrome (see below).

Irukandji (*Carukia barnesi*)

Distribution of Irukandji in Australia

Similar to that of *Chironex* - extending from waters near Gladstone, north Queensland on the east coast, across the north of Australia as far south as Exmouth, Western Australia.

Season

Similar to *Chironex* box jellyfish

Irukandji appearance

A tiny transparent bell (<2cm diameter), with 4 small tentacles, one in each corner (Figure 5). It is a type of box jellyfish called a carybdeid (hence the need for specificity, and not just "stingers", or "box jellyfish", which may refer to any similar jellyfish).

Irukandji envenomation

It starts with a skin sting, which may be so mild as to be hardly felt, or may be somewhat uncomfortable.

However, some 5-40minutes later (usually 30 minutes) the severe systemic symptoms called the 'Irukandji syndrome' start, usually with severe 'boring' pain in the sacral area

Other symptoms quickly develop and include muscle pains or 'cramps', moving rapidly into all 4 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. These include: sweating - localised or generalised, often profuse and drenching; localised or generalised piloerection; anxiety and 'wretchedness' - the victim feels 'absolutely dreadful' and often have 'a feeling of impending doom' (a thought 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 280/150mm Hg in previously-normotensive victims may occur. Later complications may be acute pulmonary oedema, usually some 15-18 hours post-envenomation (occasionally less) secondary toxic global cardiac dilatation with left ventricular dysfunction proven by echocardiography.

Pacific man-o'-war (*Physalia physalis*)

Distribution

Distribution of the multi-tentacled Pacific man-o'-war appears to be south from Cooktown, around the southern part of Australia to north of Perth in Western Australia. They are present from September through to June, although more commonly in December and January.

Appearance

Similar to the Bluebottle (the single-tentacled variety) and its larger cousin, the Portuguese man-o'-war, it has a clearly visible blue float that sits on the surface, with long blue tentacles trailing in the water.

Envenomation

Unlike the smaller bluebottle with its uncomfortable skin pain, the Pacific man-o'-war causes a very painful skin sting, although not as severe as that of *Chironex* box jellyfish. It causes a similar, but less-severe syndrome similar to the initial effects of the Irukandji, but not as severe – an “Irukandji-like” syndrome.

Morbakka (*Tamoya* species)

Distribution

Distribution of the large carybdeid (a box-shaped jellyfish having just one tentacle in each corner appears to be south from Cooktown, usually as far south as Moreton Bay (“Moreton Bay Stinger”; “Fire jelly”). Occasionally specimens may reach as far south as Sydney Harbour. They also occur on the coast of Western Australia and in the Northern Territory. They may be present anytime of the year but are more common at the beginning and end of summer.

Appearance

A large box-shaped jellyfish with just a single large tentacle in each corner. The bell may be from 4-18cms in height, with the four tentacles up to a metre long in the larger specimens. BEWARE – this jellyfish has stinging cells on the bell and it too may cause stings.

Envenomation

Causes skin pain, from “burning” to a very painful sting, although not as severe as that of *Chironex* box jellyfish. In approximately 10% of cases it may cause a similar syndrome to the Irukandji, but not as severe – an Irukandji-like syndrome.

C) Nuisance stings

Occur all round Australia, but cause most problems on the east coast of Australia where up to 10,000 stings occur each year from “bluebottles”, “hair jellyfish” and other, similar “nuisance” stings. Large numbers of these stings also occur on the west Coast of Australia, but numbers have not been determined.

Fortunately it is unnecessary to identify these stings as the symptoms are of skin pain only in the stung region, and the only treatment necessary is the use of cold packs to relieve the pain. Rarely, should there be systemic symptoms, they can be treated on an `ad hoc' basis as below.

- Avoiding stings
- Awareness
- There is a need for people to be aware of the: -
 - Time of the year (summer)
 - Geographical location (tropical and sub-tropical waters)
 - Weather (hot, still weather with light northerly winds)
 - Whereabouts of patrolled beaches (surf lifesaver on duty)
- Prevention
 - 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

Is best described under the following tables:

Table 3

First aid of Chironex box-jellyfish stings (and all world chirodropids)

First Aid Treatment of <u>Chirodropid envenomation</u>
<ol style="list-style-type: none">1. Retrieve the victim from the water and restrain them, if necessary.2. If others are available, immediately send them for ambulance / medical help (emphasise the sting is from a Box jellyfish as the Ambulance may have antivenom available).3. Check the victims Airway, Breathing and Circulation (ABC). Treat with Expired Air Resuscitation (EAR), or Cardio-Pulmonary 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, i.e. Those:<ol style="list-style-type: none">a) Covering an area more than half of one limbb) Causing impairment of consciousnessc) Causing impairment of breathingd) Causing impairment of circulationIf vinegar is unavailable, the rescuer should pull tentacles off using their fingers (only a faint, harmless pricking will be felt) - before applying the compression bandages6. If available, use CSL <i>Chironex</i> antivenom for all major cases (see above). Three ampoules each containing 20, 000 units may be given intramuscularly, above the bandages, by a trained health professional on the beach. One ampoule intravenously may be given by medical personnel.7. Cold packs may be used (15 minutes and repeated when necessary) to help ease the skin pain in conscious victims.8. In severe envenomation use oxygen if available; Inhaled analgesia (i.e. entonox or penthrane) can be administered for unremitting pain in conscious, breathing, cooperative patients; its use should be discontinued if the patient's condition worsens.

Table 4

Medical Treatment of Chironex and other Chirodropid Stings

Medical Treatment of Chironex and other Chirodropid Stings
<ol style="list-style-type: none">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) intravenously. If the clinical response is inadequate, 3 (or more) ampoules may be given intravenously, according to clinical response.4. Inotropes such as adrenalin 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. <p>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 consideration of inotropes has been tried.</p> <ol style="list-style-type: none">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 intravenously as above.7. Intravenous antivenom (administered as above) may provide cosmetic benefits in stings involving cosmetically sensitive areas (eg. face or neck, especially in females).

Table 5

Primary hospital treatment of Irukandji stings

Accident and Emergency
Analgesia -IV - morphine infusion with boluses 5 - 10mg (adult) pethidine 50mg IV 3hrly prn “Catecholamine-like effects - phentolamine 5 - 10mg boluses (adult) +/- infusion Chest pain - IV GTN (50mg in 500ml 5% dextrose) commence at 3ml/hour Pulse oximetry – administer oxygen to keep haemoglobin oxygen saturation > 93% Check BP regularly (automatic machine – dynamap, if possible) Monitor ECG Chest X-ray if respiratory rate increases, or O ² 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

(Carney & Fenner 1997)

Note: there is no first aid treatment available; one is being trialled to date.

Table 6

First Aid Treatment of Non-chirodripid envenomation

First Aid Treatment of <u>Non-chirodripid envenomation</u>
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). Ice in a polythene 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. The ice or cold packs can be re-applied if the skin pain is unrelieved, or returns. Unresolved pain, or any further systemic symptoms are immediately referred to medical care. Inhaled analgesia (such as entenox or penthrane) may be available from the local Ambulance for more severe pain, but further medical aid should be sought.

Points of note:

Cold packs are useful for the skin pain of ANY jellyfish stings

Heat is the treatment of choice for penetrating stings (e.g. stonefish, stingray etc.)

Vinegar is used to PREVENT further stinging when there are remaining tentacles on the skin in Chironex box-jellyfish stings (or any box jellyfish sting)

Compression bandaging is useful to retain large amounts of venom in one area (e.g. sea snakes, blue-ringed octopus, cone shell and major Chironex box-jellyfish stings)

Competent cardiopulmonary resuscitation may be necessary, and is life-saving in any major marine envenomation

Antivenom is available for Chironex box-jellyfish stings, sea snake and stonefish envenomations

Premedication for marine sting antivenom seems unnecessary

Chironex antivenom is carried by the Ambulance in North Queensland

Distribution of *Chironex* stings



Further reading

Fenner PJ. The Marine Stinger Guide. Surf Life saving Queensland

Williamson JA, Fenner PJ, Burnett JW, Rifkin JR (eds). Venomous and Poisonous Marine Animals: a Medical and Biological Textbook. NSW University Press, Sydney.