

Awareness, Prevention and Treatment of world-wide marine stings and bites

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Abstract

The most common world-wide first aid treatment used by the average lifesaver/lifeguard is the treatment of marine envenomation, especially the treatment of jellyfish stings.

It is important to use the correct first aid treatment for each type of envenomation. This study provides a simplified protocol for: -

1. Awareness of the geographical distribution and possibilities of envenomation enabling: -
2. Preventative strategies to reduce morbidity and mortality from marine envenomation
3. First aid treatment of marine envenomation by jellyfish or other marine animals

This discussion is based on protocols developed for Surf Life Saving Australia and other first aid providers in Australia over the past ten years. Their success has been proven by a 30% reduction in the number of stings over the past 10 years (statistics from the author's records).

Information for this article has been taken from: -

1. Venomous and poisonous marine animals: a medical and biological handbook produced by Surf Life Saving Queensland
2. The global problem of cnidarian stinging. MD Thesis by the author for the University of London.

Introduction

The global problem of marine envenomation is not fully appreciated. Each year hundreds of deaths occur from poisoning (by ingestion or eating) or by envenomation (stinging by jellyfish, or biting by venomous marine animals).

The morbidity is even greater with jellyfish stings world-wide being numbered in their millions. Each summer it is estimated that up to half a million stings occur on the east coast of the United States from the Portuguese man-o'-war (*Physalia physalis*). Large numbers of stings also occur on the east and west coasts of both South Africa and Australia, where the author's records suggest some 20,000+ stings occur each year from both the similar, but smaller, *Physalia utriculus* (bluebottle), which has just one tentacle, and the smaller multi-tentacled Pacific man-o'-war (*Physalia physalis*).

There is usually little need to identify most species of jellyfish, as they simply cause skin pain. This pain varies from a very mild irritation through to the severe, unbearable pain of a multi-tentacled box jellyfish. However, this skin pain can be treated simply, using first aid protocols suggested below.

Some jellyfish envenomations may cause systemic symptoms – i.e. they may cause generalised muscle pains, painful breathing, breathing difficulty or breathlessness, anxiety, sweating, high blood pressure, heart failure and even death (see below). These symptoms usually occur after a time interval, which may be a few minutes or may be delayed for up to an hour. This syndrome occurs after envenomation by a tiny carybdeid (see below) in tropical Australian waters in summer months, which is called the “Irukandji syndrome”.

Other jellyfish world-wide may cause a similar syndrome and it is referred to as an Irukandji-type syndrome. Investigation into Irukandji envenomation and the developed treatment should also be effective in similar syndromes caused by other jellyfish species. These include a tiny hydroid (jellyfish), *Gonionemus* present in the Japan Sea, and other large carybdeid species world-wide, *Stomolophus nomurai* (the sand jellyfish) in the China Sea and *Physalia physalis* (Portuguese/Pacific man-o'-war) world-wide. Rarely, other jellyfish may cause spasm of the arteries causing local gangrene. As stings are often on the limbs this may be a severe complication. For the average lifesaver/lifeguard, these are symptoms that are impossible to treat and need urgent referral to medical aid.

Most jellyfish have tentacles that arise from all round the bell. One group of jellyfish called cubozoans, or Box-jellyfish. They have a box-shaped bell with tentacles arising from each corner.

There are two main types of box jellyfish: -

1. Chirodropids, which have more than one, and up to 15 tentacles arising from the corner of each bell. The bell may be up to 300mm in diameter and the tentacles may reach up to 3 metres in length.

Box jellyfish cause many deaths each year, mainly in the tropical Indo-Pacific region, although one death has occurred at Galveston Island, Texas in the United States.

There are approximately 6 types of chirodropid worldwide. However, they all appear to cause similar, if not identical symptoms. Thus the first aid and medical treatments suggested should prove effective for all chirodropid envenomations regardless of geographical location (see below).

2. Carybdeids, which have just one tentacle in the corner of each bell. They come in sizes ranging from a few millimeters to 500mm bell height. They cause varying symptoms from mild skin irritation to the severe systemic symptoms mentioned above; neither the size of the jellyfish, nor the size of the sting has any relation to the severity of the symptoms.

Methods that are suggested in this article promoting awareness and prevention have contributed to the reduction of mortality from chirodropid envenomation in Australia by 30% over the past ten years, and should prove effective elsewhere. However continued seasonal promotion is essential.

Other venomous creatures, including sea snakes, spiny fish, cone shells and blue-ringed octopus also cause severe systemic (generalised) symptoms that may cause fatalities. However, these are less common and for the lifesaver the most important early treatment is the immediate and correct first aid treatment. This provides most victims of envenomation with the best chance of a successful outcome, however severe the envenomation may be.

AWARENESS

The problem of world marine envenomation

Work by the author and his colleagues has enlarged the knowledge on the world-wide problem of marine envenomation and suggested methods to promote awareness and prevention of the problem. Further research has also suggested simplified first aid treatments for the lifesaver, in addition to medical treatments for hospital-based care.

Marine envenomation, especially jellyfish envenomation, emerges as a significant global problem. Despite this, research remains vestigial with both undergraduate and post-graduate medical teaching conspicuous by its absence.

Promotion of awareness

Information on Australia jellyfish is now distributed via information pamphlets, illustrated charts on identification and treatment, teaching videos, a simple book on identification and treatment and, more recently, by a major textbook on International marine envenomation by the author and his colleagues.

Most of the information contained in this article is derived from a newly published major textbook named "Venomous Marine Animals: a Medical and Biological Handbook", co-edited and co-authored by the author, which has been released by Surf Life Saving Queensland. It contains the latest first aid and medical information on jellyfish and all aspects of marine envenomation on a global basis.

Mortality rates from chirodropid envenomation in Australia have previously averaged about one per year; morbidity was even higher. However, a significant reduction has been achieved in reducing this average in the past ten years. The author in his role as "Marine Stinger Officer" for Surf Life Saving Queensland has made this a principal aim, producing a simplified book called "The Marine Stinger Guide", distributed by Surf Life Saving Queensland, to provide simplified information on identification and treatment of jellyfish stings to the average surf lifesaver. He has also produced jellyfish identification and treatment charts jellyfish and marine envenomation videos, and jellyfish brochures described in this article.

Other measures to bring the problem to the attention of the general population who live in risk areas in tropical Australia, or for people who visit these places, include talk-back radio shows, newspaper articles and interviews and all other forms of media education. These initiatives, through Surf Life Saving Queensland have also been adopted by State Governments in Queensland, the Northern Territory and Western Australia.

Similar strategies are suggested to tackle the global problem of jellyfish stings causing mortality and morbidity. Current geographical locations of human death from jellyfish and other marine animal envenomation are shown in the Tables below: -

Table 1 - Geographical locations of deaths from non-box jellyfish

Human fatalities from non-chirodroid envenomation
China (east coast) – <i>Stomolophus nomurai</i> United States of America – <i>Physalia physalis</i>

Table 2 - Geographical locations of deaths from box jellyfish

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

Table 3 - Geographical locations of other marine envenomations

Animal	Distribution	Fatalities
Pufferfish	Worldwide	110 deaths (1975-1992) - currently 10% mortality of the total poisoning
Paralytic Shellfish Poisoning	Europe, North America, Venezuela, Indo-Pacific (Including Japan)	Brunei, Sabah, PNG, Philippines, Thailand, USA, Venezuela
Chirodropids (Box jellyfish)	Tropical waters of:- Pacific – west coast Indian – east/west coasts Atlantic – east/west coasts	Australia, “Borneo”, Japan, Malaysia, Solomon Is, Philippines, PNG, USA Some 30-50/year at present
<i>Physalia physalis</i>	Worldwide	USA - 3 deaths (total)
<i>Stomolophus nomurai</i>	China Sea- around Qindao	8 deaths
Sea Snake	Tropical Indian & Pacific Oceans	Burma, China, India, Indonesia, Malaysia, Thailand, Vietnam.
Cone Shell	Tropical Indian & Pacific Oceans	Australia, Fiji, Japan (Okinawa), New Caledonia, India, Vanuatu.
Spiny fish (exc. Stingray) Weeverfish Stonefish Zebrafish Catfish	Worldwide	Europe, West Africa. Seychelles, Mozambique, Okinawa, Thursday Is (?) Philippines USA (septicaemia – in a diabetic)
Stingray	Worldwide temperate Waters	Australia, Colombia +++, New Zealand, Fiji, Surinam, USA (Ca, NC, Texas)
Blue Ringed Octopus	Australia, central Indo West Pacific Region (Inc. South Japan and New Zealand)	Singapore, Australia.

PREVENTION

Educational Policy: prevention of jellyfish envenomation

Facts derived from stings investigated by the author and his colleagues, together with early work conducted by Dr Jack Barnes for Surf Life Saving Queensland, assisted in the development of an educational policy on the prevention of stings from dangerous jellyfish in tropical Australian waters. This policy was then accepted as the standard by Surf Life Saving Australia in their Training Manual. With its success in simplicity and effectiveness it was then presented, and accepted for teaching in schools in tropical Queensland (see below). The most important points are awareness of the problem (as discussed above) and prevention of envenomation. The treatment is then presented – in case: -

Prevention of envenomation

Knowing some of the habits of dangerous box jellyfish such as *Chironex* or the Atlantic *Physalia*, which causes severe or even fatal stings, it is possible to use strategies to prevent envenomation, rather than the need to treat it. The thread tubes of the stinging nematocysts are just long enough to penetrate the dermis. Consequently, any clothing worn on the outside of the skin will prevent penetration of the integument, and prevent envenomation: -

Protective clothing/ slow entry into the water

`Stinger suits' in Australia are made of lycra, which covers the body and limbs, but not the head, hands or feet. Most stings occur on the lower limbs, with less than 5% occurring on the face. If people do dive head first into the sea, they will not be stung on the face. If they walk slowly into the sea, box jellyfish such as *Chironex* will invariably swim away, and the large floats of *Physalia* may be seen, hopefully before envenomation. With stinger suits, if the victim should be unfortunate enough to sustain a sting on the feet whilst walking slowly into the water, the area stung, although being acutely painful, will not allow a sting of sufficient size as to cause systemic, or potential fatal effects.

Prior to the introduction of stinger suits in Townsville in 1985, lifesavers and people entering the sea used to wear ladies pantyhose! One pair was worn on the legs, as usual, although the feet were cut out and the ends were taped to the ankles. The other pair was worn upside down with a hole cut in the crotch for the head to go through, with the arms in the leg holes, and with hand holes cut out with the ends taped to the wrists.

Any clothing covering these major areas of the body is sufficient for protection, however, normal "street clothing" carries with it the danger of the weight when waterlogged, and may present a problem if immersion may occur accidentally, or if victims suddenly find themselves in deep water where swimming is necessary. For this reason it cannot be recommended that `street clothes' as such, be worn.

`Stinger resistant enclosures'

Originally conceived by the late Professor Stark of James Cook University of North Queensland, enclosures are large, netted safer areas in the sea that effectively exclude larger, lethal box jellyfish such as *Chironex*. The area consists of nets, hanging from a

floating pontoon that extends 50-100 meters out into the sea, a similar distance along the beach and then back to shore. The pontoon is held in position by strong anchors and the net hangs down from the pontoon, secured by weights to keep it on the bottom. These nets were designed by the Engineering Dept. of the James Cook University to prevent *Chironex* of a lethal size entering the enclosed area. This they do exceptionally well as *Chironex* only becomes lethal at a certain size when it has grown sufficient tentacles to be able to cause a fatal envenomation on a child (approximately 7cms diameter across the bell [Hartwick 1987]).

These enclosures are NOT effective against smaller jellyfish such as the Irukandji (Fenner et al 1986) as they are small enough to swim through the mesh net, which is about a 13mm size.

Swim on a patrolled beach

Surf lifesavers and lifeguards are both taught and made aware how to recognise times and places when dangerous jellyfish may be present in the sea. They also have on hand, first aid treatments, and the knowledge necessary to treat jellyfish stings.

All surf lifesavers are well taught in resuscitation and first aid techniques for marine envenomation, and many have oxygen on hand if necessary.

TREATMENT

Developing policies for first aid

Many years of watching and discussing sting treatments whilst on surf patrol have confirmed the author's view that first aid treatment had to be simple, and easy to remember. Initially treatments were designed around each different jellyfish species - thus needing prior, positive identification of the animal. Most people, even the trained lifesavers who have access to the charts, videos and publications prepared for them, find it practically impossible to positively identify different jellyfish. The policies suggested (see below) have been simplified as much as possible for treatment 'groups' of jellyfish (and other marine animals causing envenomation) so that they are easily remembered.

Table 3 - Vinegar – effects on jellyfish stinging cells (nematocysts)

Total nematocyst inhibition	Causes nematocyst Discharge	No nematocyst discharge
All multi-tentacled box jellyfish (chirodropids)	<i>Physalia physalis</i> – Portuguese man-o'-war) – <u>some specimens, not all!</u>	<i>Physalia utriculus</i> (Bluebottle)
All single-tentacled box jellyfish (carybdeids)	<i>Cyanea</i> (Blubber)	
- <u>Tested to date</u>	<i>Stomolophus nomurai</i> (in China)	
	<i>Pelagia noctiluca</i> (the mauve)	

	stinger)	
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Summary of Marine envenomation treatment

VINEGAR

For major jellyfish stings (see below), apply compression bandage - first, **directly over the stung area**, then cover the full limb starting from the furthest point, bandaging towards the body; then immobilise the limb in a splint.

Vinegar: -

- * Is usually ineffective for the skin pain of a jellyfish sting
- * Does NOT reverse the effects of venom already injected
- * Vinegar PREVENTS FURTHER STINGING on any tentacles that may remain on the skin after a Box-jellyfish (especially *Chironex fleckeri*) sting.
- * Vinegar may prevent further discharge of stinging cells after an Irukandji sting, or Portuguese man-o'-war sting

Vinegar should not be used without first testing a small area of the sting for adverse effects. It may cause further discharge of stinging cells, increasing skin pain or systemic envenomation effects.

COLD PACKS

Ice or cold packs stop the majority of SKIN PAIN in jellyfish stings tested to date. It does NOT prevent further stinging. However, major Chironex box-jellyfish stings should first be treated in the usual way with vinegar, compression bandaging and antivenom.

NOTE: Recent evidence shows that fresh water will cause discharge of stinging cells, and may make the sting worse; sea water should be used to wash off tentacles and ice wrapped up to keep the area dry.

1. IF there are remaining tentacles on the skin, wash them off with sea water, or pick them off with the pads of your fingers.
2. Apply a cold pack or ice, wrapped in a thin cloth, to the stung area for 5-15 minutes.
3. Re-apply the cold pack or ice if skin pain remains, or returns.
4. Send for medical aid for other symptoms, or skin pain remains despite the two applications of cold packs.

Treatment of multiple stings when cold/ice packs are not available

At times there are so many bathers with stings at one time that lifeguards or lifesavers may not have enough ice to treat them effectively. Policies to overcome this and use alternative treatments that were more readily available were developed, using the principle of "first do no harm". They use the power of suggestion to overcome any discomfort caused by jellyfish sting. Such treatments are ineffective for more serious stings and all first aid policies call for trained help if simple treatments do not help, or the patient's condition causes concern. The simple 'alternate' suggested, that will cause no further harm, and so may help the trauma of enveno-

mation in such mass cases, is simply to spray the area with sea water from a hand-held spray with a fine nozzle. This is applied with 'plenty of reassurance from the treating lifesaver' that is will often be effective in relieving symptoms. Close monitoring is needed to ensure the patient does not deteriorate and need medical follow-up.

HEAT (for penetrating injuries such as fish spines/spikes etc)

E.g. stonefish, stingray, bullrout, sea urchin envenomation, other spiky fish envenomations.

1. Place the area (usually a limb) in hot water:

NOTE: First test the temperature of the water yourself to prevent scalding the patient!!

2. Further 'top-ups' of hot water may be necessary, but the water **MUST** be tested each time to prevent scalding the victim.

COMPRESSION / IMMOBILISATION bandages

Compression/immobilisation bandaging is used for envenomations where a large amount of venom is placed in one area - e.g.:

- a) Snake bite (land or sea)
- b) Cone shell envenomation
- c) Blue-ringed octopus envenomation
- d) Major box-jellyfish stings

Major box-jellyfish stings are those that: -

- a) affect the conscious state (the victim is difficult to rouse)
- b) affect breathing (shallow, weak breathing - or absence of breathing, needing expired air resuscitation)
- c) affect the circulation (pulse may be weak, fast or possibly slow or irregular - or absent, needing external cardiac compression).
- d) covers a large area - more than 1/2 the area of 1 limb).

Compression immobilisation bandaging is **NOT** used on any injury from penetrating spines (e.g. stonefish, stingray - see above) as it causes increased pain.

The bandage is first applied, **directly over the envenomated area**, then extended to cover the full limb starting at the furthest point from the body; the limb is then immobilised in a splint.

Table 5 -Current First Aid Treatments of Jellyfish Envenomation

First Aid Treatment of most jellyfish stings (including Portuguese man-o'-war)
<ol style="list-style-type: none">1. When a jellyfish stings a person the victim usually suffers from skin pain, which may be severe. They may also have more serious reactions, such as muscle pains and cramps, difficulty breathing or even collapse.2. If the symptoms are severe or if they are not controlled by the simple first aid measures described here, send for medical assistance or take the victim to advanced medical care.3. To reduce pain from the sting, remove any tentacles still adhering to the skin of the victim by flushing the area with seawater. Do not use fresh water and do not rub the area, as this can increase stinging and pain. If necessary the tentacles may be picked off the skin with the fingers, preferably while wearing gloves. (If gloves are not available the finger pads will receive only a harmless `prickling').4. The next step to reduce pain is to apply cold packs or ice to the area. If ice is used, wrap it in a material that will keep the skin dry. Reapply cold packs or ice as necessary until the pain subsides.5. The major problem with these stings is that they can continue to cause pain and increase any systemic envenomation effects if any portion of the tentacles remains on the skin. Numerous solutions have been advocated throughout the world to stop further stinging. These include lemon juice, papaya, ammonia, meat tenderizer, sodium bicarbonate, and boric acid. <u>None of these has proven scientifically, to be effective.</u> Vinegar however, has shown an ability to prevent further stinging in some cases, particularly for box jellyfish, although it may worsen some other stings. If vinegar is available, it is suggested that it is tested on a small area of the wound to see if there is a negative reaction. If not, it may be applied with caution to the remainder of the wound.6. Even if a victim appears to be recovering from a jellyfish sting, the patient's condition should be monitored closely. Victims who do not respond to the simple first aid measures suggested and those with extensive stings or stings to the face (particularly children), should also be transported or referred to a hospital – “do not dive into the water”

Table 6

First Aid Treatment of <u>Chirodropid envenomation</u>	
1.	Retrieve the victim from the water and restrain them, if necessary.
2.	If other helpers are available, immediately send them for ambulance / medical help (emphasise that the sting is from a Box jellyfish as the Ambulance may have antivenom available).
3.	Assess the victim's airway, breathing and circulation (ABC). Treat with mouth-to-mouth resuscitation (EAR), or heart massage (CPR), if necessary.
4.	If others are available to help, 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: 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 (only a faint, harmless prickling will be felt) - before applying the compression bandages
6.	If available, use <i>Chironex</i> antivenom for all major cases (see above). Three ampoules each containing 20, 000 units may be given intramuscularly, above the bandages, if there is a trained health professional on the beach. Medical personnel may give one ampoule intravenously.
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 to assist with any breathing difficulty; 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.

CONCLUSION

Jellyfish envenomation has emerged as a major medical problem in both modern and third world Countries. Despite this knowledge, research remains vestigial with both undergraduate and post-graduate medical teaching remaining conspicuous by its absence.