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There's something in the water: an overview of jellyfish, their stings, and treatment

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ABSTRACT

An increasing presence on many beaches worldwide, jellyfish are a diverse group of Cnidarians equipped with stinging cells termed cnidocytes. Though few of the over 10,000 species are dangerous to humans, and most that are produce no more than a painful sting, some jellyfish can produce systemic symptoms and even death. Chironex fleckeri, the Australian box jellyfish, has a venom potent enough to kill in less than 10 minutes, and for which there is an antivenom of debatable efficacy. Stings from Carukia barnesi can cause Irukandji syndrome, characterised by severe pain and hypertension. Jellyfish stings have also been associated with Guillain-Barre syndrome and anaphylaxis. Though optimal treatment of stings remains controversial, after removal from the water and addressing any immediate life threats, the tentacles should be removed and the area washed, with seawater being the best choice due to its low likelihood of inducing further cnidocyte discharge. Hot water immersion may be beneficial for pain control for non-tropical jellyfish stings, and cold packs for tropical stings. In general, there is no consensus for the optimal treatment of jellyfish stings, and so further research is needed into species-specific guidelines and whether there are any overarching rules.

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Key words: jellyfish, venoms, marine envenomation

INTRODUCTION

Whether local residents or far-flung visitors carried by the currents, jellyfish are a presence on beaches throughout the world [1]. With over 10,000 species, only 100 or so are dangerous to humans, but these produce around 150 million stings per year, primarily during the warmer months [2, 3]. Jellyfish stings are the greatest threat on the coasts of subtropical and tropical Atlantic and Pacific coasts, home to some of the most dangerous jellyfish [1]. In states in southern Brazil, thousands of cases of jellyfish stings are recorded in the summer [4]. Jellyfish blooms have increased in the past few decades, damaging fish stocks and disrupting water-based industries [5]. Among divers in Thailand, almost 32% reported jellyfish stings as their most frequently encountered injury [6]. Given their increasing prevalence worldwide, it is important for clinicians to be familiar with jellyfish, their stings, and treatment of injuries sustained from jellyfish.

OVERVIEW

Although the term 'jellyfish'' is commonly used to refer to any gelatinous water creature equipped with tentacles, only the class Scyphozoa (home to the lion's mane jellyfish among others) are considered true jellyfish [1]. Other well-known 'jellyfish,' such as the Portuguese man-of-war (*Physalia physalis*) or the Australian box jellyfish (*Chironex fleckeri*), belong to different classes (Hydrozoa and Cubozoa, respectively). For the purposes of this review we will consider all members of the subphylum Medusozoa, which includes both the true jellyfish as well as their jellyfish-like cousins, and use the familiar term 'jellyfish' in reference to them both.

As members of the Cnidaria phylum, jellyfish are equipped with cnidocytes, cells commonly found in their tentacles that contain organelles (cnidocyst) which inject venom in a harpoon-like fashion when triggered mechan-

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ically or chemically [4]. The venom differs in composition and potency among species, and can include neurotoxins, catecholamines, histamine, hyaluronidases, and haemolytic toxins among others [1]. In general, the venom causes pain by activating transient receptor potential vanilloid-1 in nociceptive neurons [7]. The cnidarian-exclusive family of pore-forming CrTX/CaTX toxins is found widely among jellyfish, including both Cubozoans and some Scyphozoans [8].

Jellyfish stings can cause localised pain and erythema, with rare (though dependent on the species involved) systemic symptoms [4]. Local skin reaction at the sites of tentacle contact can begin within minutes to hours and is often linear, urticarial and painful [1]. These lesions can progress to becoming vesicular or even necrotic. Generalised skin lesions are likely due to a hypersensitivity response to the venom. Seabather's eruption, a pruritic rash on areas covered by swimsuits, is due to jellyfish larvae that become trapped between the skin and suit [1]. There is no specific treatment for the rash, which may last for days to weeks [9].

A truly unpleasant event, ocular stings have also been reported [10]. Unsurprisingly, pain is the most common symptom but stings can also produce temporary mydriasis and loss of vision. Rarely they are associated with increased ocular pressure. Care is primarily supportive and involves removal of any tentacles and cnidocytes and ophthalmologic consultation.

Envenomation is not the only concern when stung by a jellyfish. Stings can also trigger allergic responses such as anaphylaxis due to the proteins contained within the venom [4]. Sensitisation can occur due to repeat stings during water-based activities or ingestion of jellyfish [11].

SPECIFIC JELLYFISH

The most lethal jellyfish worldwide, *Chironex fleckeri*, or the Australian box jellyfish, is a Cubozoan found in the tropical waters of the Indian and Pacific oceans ranging from Northern Australia to Southeast Asia [1]. Due to the rapid cardiorespiratory depression and death it can cause, an antivenom — the only one of its kind for jellyfish — has been developed, though its efficacy is debatable [1, 12]. Magnesium sulphate may improve efficacy of the antivenom [1]. Stings from *C. fleckeri* initially cause severe pain at the site of contact, which can progress to full-thickness necrosis in 1–2 weeks. Associated systemic symptoms of fever, vomiting, and malaise may also occur, which can progress to respiratory distress, haemolysis, and renal failure [1]. The venom also includes a cardiotoxic component [13]. Death can occur due to respiratory and cardiac arrest from the venom or due to drowning if the individual becomes incapacitated while in the water, and death from envenomation can occur in as little as 2–10 minutes [1, 2].

Another Australian native, *Carukia barnesi* is one species of Cubozoan jellyfish that can cause Irukandji syndrome, which includes delayed onset of muscle cramps, vomiting, anxiety, and diaphoresis sometimes with severe hypertension and cardiac failure [1, 12]. Intracranial haemorrhage from severe hypertension may also result [7]. The pathophysiology of Irukandji syndrome is not entirely clear, but may be primarily though not exclusively due to excess catecholamine release [2, 3, 9]. Formation of pores in myocardial cell membranes may also contribute to cardiac damage [7]. Hospitalisation is often necessary for Irukandji syndrome and IV magnesium sulphate may be helpful in reducing both pain and hypertension, though this is controversial, and pain control will likely require opioids [2, 3, 7, 9]. There is no antivenom. Other species capable of causing Irukandji syndrome include *Carybdea alata*, another Cubozoan, which is common in Hawaiian and Eastern Pacific waters [13].

A Hydrozoan siphonophore, which uses a gas-filled float to ride along the water surface, the Portuguese man-of-war is found in hot non-tropical waters of the Atlantic, Pacific, and Indian oceans as well as the Caribbean and Sargasso Seas [1, 2]. It has tentacles that can reach up to 30 m in length [2]. Stings cause severe pain, which usually subsides in 24 hours, as well as nausea, vomiting and loss of consciousness.

Scyphozoa have increased lately in the Northeast Atlantic and Mediterranean as well as along the coast of Korea, China, and Japan, leading to a decrease in tourism and interference in fishing and aquaculture industries [14]. Although less deadly than other jellyfish, Scyphozoa are responsible for the majority of jellyfish stings, and some envenomations can lead to death. Stings from *Stomolophus meleagris*, found along the southeastern coast of the United States and the eastern Pacific Ocean, can result in myalgias, dyspnoea, shock and death [14]. Common in the Mediterranean, *Pelagia noctiluca* produces painful stings and has also been associated with at least one cause of Guillain-Barre syndrome [14]. The largest jellyfish in the world, *Cyanea capillata* or the lion's mane jellyfish, is found in the northern Pacific and Atlantic oceans as well as the North and Baltic Seas [1]. Its stings can cause systemic symptoms as well as an Irukandji-like syndrome [14]. Rinsing wounds in seawater increases venom delivery for this species by not inactivating the cnidocysts, allowing them to discharge as they are washed off the affected area [15].

A particularly interesting Scyphozoan, *Cassiopea xamachana*, or the upside-down jellyfish, is found in the western Atlantic as well as the Caribbean Sea and the Gulf of Mexico [8]. It discharges 'cassiosomes,' which are cnidocyte-containing masses, into surrounding mucus. The purpose of the cassiosomes is to kill prey via the venom-con-

taining cnidocytes, but unwary swimmers in the area can also be stung, though for humans the venom is primarily an irritation. The venom does contain haemotoxic, cardiotoxic, and dermonecrotic components, suggesting exposure may not be entirely benign to humans. Other members of order Rhizostomeae contain cassiosomes as well, including *Mastigias papua* and *Phyllorhiza punctata*.

MANAGEMENT

Prevention is the best cure for jellyfish stings, and if jellyfish are known to frequent an area it may be best to look elsewhere for recreational activities. Stinger nets or stinger suits, as well as topical sting inhibitors, may be beneficial in preventing stings at the covered areas [1]. If nonetheless a sting occurs, it is important to remember that severity of jellyfish envenomation is related to the dose injected [5]. Therefore, inactivation and removal of any remaining tentacles and cnidocytes is essential. Unfortunately, evidence for optimal treatment of jellyfish stings is limited with no consensus guidelines and with studies being done on only a few species [1, 5]. In general, the first step is to remove the affected individual from the water to prevent drowning and further contact with the jellyfish [1]. The individual should also be advised not to rub the site of contact to avoid discharging more cnidocysts.

Less than 1% of cnidae, for Cubozoans, discharge upon initial contact, so removal of clinging tentacles is essential [16]. Fresh water should not be applied to the site of contact as it can cause cnidocyst firing via osmosis [1]. Seawater can be used to wash off any remaining tentacles, though for some species this may increase cnidocyst discharge, and for others may simply move the still-active cnidocysts to new targets [1, 14, 16]. Clinging tentacles should be removed, though the best method is controversial [1, 14]. Any application of pressure to the tentacles, including pressure bandages, is inadvisable as they may cause the cnidocyst to fire [14]. A variety of home remedies for jellyfish stings exist (vinegar, ethanol, urine, baking soda, meat tenderizer, etc.) but these have limited evidence of efficacy, and in the cases of ethanol, meat tenderizer, urine, and in some cases vinegar, can cause undischarged cnidocysts of some species to fire [1, 5, 17]. The same remedy that produces injurious results in one species can be beneficial in another [5]. Vinegar in particular is a controversial remedy for *Chironex fleckeri* and other Cubozoan stings, with some studies suggesting it has a beneficial effect on the affected site, but one study finding that vinegar increases the amount of *C. fleckeri* venom delivered to victims [1]. The consensus thus appears that there is no one optimal solution for rinsing all jellyfish stings, and that the ideal solution may be species-specific. As this is impractical in the field, seawater appears to be the best compromise as it is readily available and appears to cause the least amount of harm in the majority of envenomations.

Pain is a significant complication of jellyfish stings, and the optimal pain control method is also debated. Cold packs, warm and hot water immersion have all been found to be beneficial, though heat may increase systemic absorption of *C. fleckeri* venom [1]. For non-tropical jellyfish stings, hot water immersion may be optimal, while cold packs may be best for tropical jellyfish stings.

Some sources recommend application of topical antibiotics such as chloramphenicol or erythromycin to the affected site, while others regard this as unnecessary due to low rates of secondary infection [1].

Also key to remember for beachcombers is that jellyfish, including their isolated body parts that wash ashore, still contain active cnidocysts that can discharge and cause envenomation, though discharge rate does decrease after death [1, 13].

Already a cause for concern for swimmers and beach-goers, jellyfish stings are likely only to increase as jellyfish populations rise. Therefore, it is important for the clinician to be familiar with management of jellyfish stings. Although there is broad agreement on the importance of removing tentacles and cnidocysts, pain control, and management of systemic symptoms, the specifics of achieving these goals lacks a consensus and may be species-specific. Clinicians should thus be familiar with local jellyfish and management of their species-specific stings, and more research is needed into if there are any overarching specific principles for treating jellyfish stings.

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