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# Box jellyfish (*Carybdea alata*) in Waikiki

## The analgesic effect of Sting-Aid, Adolph's meat tenderizer and fresh water on their stings: A double-blinded, randomized, placebo-controlled clinical trial.

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### Abstract

The study measured the analgesic effects of three popular Hawaii remedies for stings from the box jellyfish, *Carybdea alata*. Analysis of data showed that aerosol sprays of Sting-Aid (an aluminum sulfate solution), Adolph's meat tenderizer dissolved in water, and fresh water neither increased nor decreased the pain of box jellyfish stings more than the control (seawater).

### Introduction

Each month, swarms of spawning<sup>1</sup> box jellyfish, *Carybdea alata*, appear in the nearshore waters and on the beaches of Honolulu on the 9<sup>th</sup> or 10<sup>th</sup> days after the full moon.<sup>2</sup> It is not known why this occurs in this area.

*Carybdea alata* is about 3 to 4 inches high and about 2 inches wide, and has pinkish tentacles trailing from the four corners of the square bell. The tentacles, which measure about 2.5 feet long, bear stinging cells called nematocysts, which sting and immobilize jellyfish prey. These nematocysts also sting people when the two species inadvertently collide.

Each nematocyst consists of a barbed, toxin-bearing tubule folded inside a fluid-filled capsule. A touch to the outside wall of the capsule causes hydrostatic pressure inside to evert the tubule and force toxin through the barbs and into the skin. This eversion and discharge occurs within 3 microseconds making it one of the fastest known events in biology.<sup>3</sup> A nematocyst, therefore, can be thought of as a lightning-fast shotgun, the capsule being the cartridge case, the tubule being the shell, and the toxin-loaded barbs the buckshot.

The rash and pain caused by these box jellyfish stings are self-limited, usually disappearing with no treatment from 20 minutes to one day. A few victims suffer generalized reactions, persistent pain and/or recurring, itching rash. No confirmed deaths have occurred in Hawaii from box jellyfish stings, but the pain they inflict can be severe.

Home remedies for treating the pain of jellyfish stings are regional. Throughout the world people apply figs, mustard, manure and other substances on stings to ease the pain. Urine, usually the victim's own, is a widespread remedy common throughout the world, including Hawaii. Numerous Hawaii residents report that as

children they were taught to urinate in a jar at home and then take the jar to the beach to pour on stings. Meat tenderizer is also an accepted remedy in Hawaii. Beach-goers commonly keep bottles of it in their vehicles or beach bags to treat stings.

Another sting treatment in the U.S. emerged in 1991. A Pompano Beach Florida company, Knight Industries, began selling Sting-Aid, a solution marketed to "relieve the pain from stings and bites of sea lice, jellyfish, hydroids, stingrays, spiked fish, stinging nettles, fire coral, wasps, bees, ants, ticks, mosquitoes and sand fleas." Hawaii lifeguards began using Sting-Aid on jellyfish and Portuguese man-of-war stings and it was sold in some Hawaii dive shops and drug stores.

The authors undertook this study because neither Adolph's meat tenderizer, Sting-Aid nor fresh water had been studied as sting treatments in controlled, blinded clinical trials. Fresh water was included because some people report that taking a fresh water shower at the beach or at home after a sting relieved their pain. Others, however, report that applying fresh water to box jellyfish stings increased their pain. Before this study was done, it was not known if these treatments increased, decreased or had no effect on the pain of a sting.

Besides the value of this trial to victims, lifeguards and health care workers, Sting-Aid and Adolph's meat tenderizer have been a significant expense to the Honolulu City and County's Division of Ocean Safety.

### Methods

This is the second part of an ongoing study examining the efficacy of different temperatures and solutions in treating the pain of box jellyfish (*Carybdea alata*) and Portuguese man-of-war (*Physalia* spp.) stings in Hawaii. The authors have neither applied for nor received funding to conduct or support any part of this study, which has been approved by The University of Hawaii's Human Subjects Committee.

This part of the study was carried out from January 1999 through December 2000 at Waikiki lifeguard towers 2C and 2D. During these two years, no ambulance service was required for any victims in the study.

Each patient 7 years old or older who came to a lifeguard tower complaining of pain from a sting, and was not in need of emergency assistance (as determined by the lifeguards), was sprayed with vinegar. Immediately after the liberal spraying, the researchers sprayed one of four solutions in unmarked, opaque spray bottles labeled A, B, C, and D. Field workers chose one of the four bottles

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randomly by reaching into a container and choosing the first one at hand. The spray bottles contained: A. fresh water, B. seawater (control) C. Sting-Aid, a commercial pain reliever consisting of water, detergent and aluminum sulfate (alum) and, D. Adolph's meat tenderizer, a commercial food compound consisting of more than 99 percent salt, sugar, food starch and less than 1 percent papain. A mixture of one part Adolph's powder in four parts of tap water produced a saturated solution.

Although applying a victim's own urine to his or her stings and marine injuries is one of the most common local remedies used in Hawaii, the authors deemed that testing it was inappropriate at a public beach.

After receiving the unmarked sprays, the victim made a single mark on a visual analog (VAS) pain scale from 1 to 100 millimeters at 0, 5, 10, and 15 minutes.

## Results

### Sample and Data Analysis

The dataset contained information on 63 individuals. However, one (in the fresh water group) dropped out after the vinegar dousing. The sample size for the analysis of pain score after treatment is therefore 62.

More serious sample attrition begins by the 5-minute mark. Only 56 participants gave complete data at 5 minutes, and only 32 at 10 minutes. Only 12 participants provided pain scores at 15 minutes, too few for analysis of treatment effects.

Thus, the most reliable results are those from the pain scores at 0 and 5 minutes. There were no clear associations between the treatment group and the rate of dropping out.

Starting at the 5-minute pain score, two different analytic methods were used: one which considered only the data actually collected, and another method in which missing pain scores were imputed with the last pain score recorded. Both methods give results that are limited in comparison to the results from the pain score at 0 minutes. The former method does not take into account any treatment effect on dropping out, and the latter relies on imputed pain scores.

The pain scores were analyzed as both continuous and binary outcomes. Graphical analyses indicated the pain scores were somewhat skewed, so a square root transformation was used for the analysis of covariance. The results were similar to those with the untransformed data, however, so the latter are presented here for ease of interpretation. Nonparametric statistical tests also corroborated the results obtained with the untransformed data. The analysis of covariance described the inter-treatment differences in the mean pain scores at 0, 5, 10 and 15

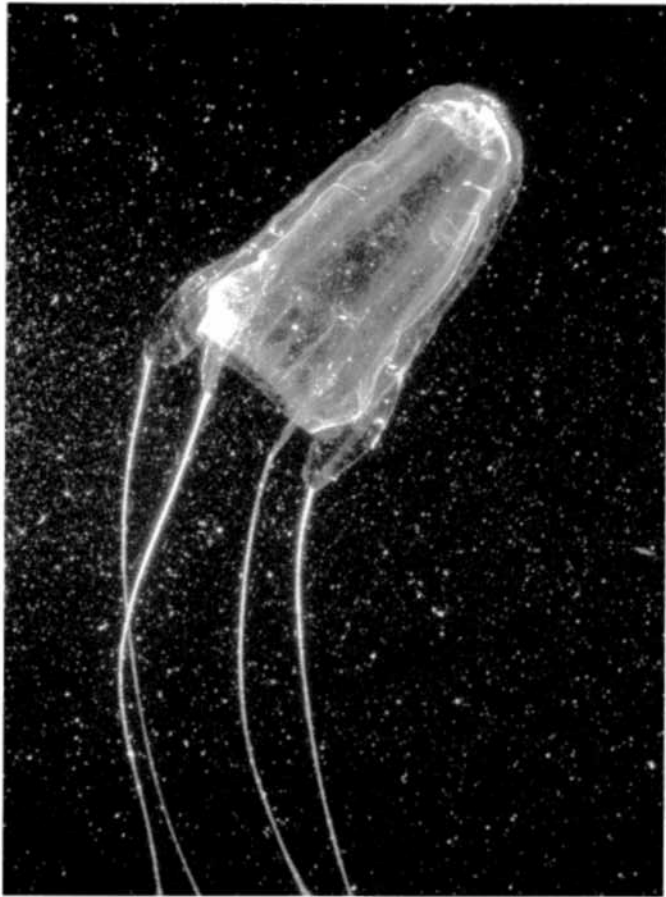
minutes, with statistical control for the pain score at 0 minutes for the last 3 outcomes.

A binary outcome was also constructed, depending on whether the participant experienced complete cessation of pain or not over the 15 minute testing period. However, only 4 of the 62 participants reported a final pain score of "0", 2 in the salt water group, and 1 each in the fresh water and Adolph's group. (One participant reported a 0 score at 0 minutes, but re-elevated pain scores after 5 and 10 minutes.) Because of this low number, the definition of cessation of pain was widened to include a final pain score of 10, which then included 16 participants. A logistical regression model was used to analyze the odds of the cessation of pain across the treatment groups, while controlling for initial (after vinegar dousing) levels of pain. Results are summarized in the following table. The 4 treatment groups had comparable pain scores after the vinegar dousing, suggesting the treatment randomization resulted in 4 similar groups. There were no statistically significant differences in pain scores between the treatment groups at any of the 3 succeeding pain score estimations: at 0, 5 and 10 minutes. This lack of treatment effect was consistent across both methods of analysis. In Method 1, there were some differences of magnitude between groups at 5 minutes (e.g. Adolph's vs. salt water group) and 10 minutes (e.g. fresh water vs. Sting-Aid), but the corresponding small group sizes by these times make it difficult to detect statistically significant differences. (Note the standard error estimates increase at the 5- and 10-minute marks

Estimated* average pain scores, by 5-minute intervals and treatment group.							
Group	time:	Method 1 <sup>1</sup>			Method 2 <sup>2</sup>		
		vinegar dousing	0 min.	5 min.	10 min.	5 min.	10 min.
Adolph's	n	14	14	11	6	14	14
	pain score	40.7	36.5	36.9	38.6	38.4	38.2
	standard error of pain score	6.7	3.7	5.8	9.9	5.1	5.1
Fresh water	n	19	19	18	8	19	19
	pain score	44.3	38.9	34.5	40.7	33.9	32.3
	standard error of pain score	5.8	3.2	4.6	8.8	4.4	4.4
Salt water	n	16	16	14	9	16	16
	pain score	42.5	35.2	28.1	35.2	29.9	29.1
	standard error of pain score	6.3	3.5	5.2	8.0	4.4	4.8
Sting-Aid	n	13	13	13	9	13	13
	pain score	46.9	34.2	35.3	32.8	35.0	30.0
	standard error of pain score	7.0	3.8	5.4	7.9	5.3	5.3

\*Estimates at 0, 5, and 10 minutes are adjusted for pain level after vinegar dousing (vinegar dousing).  
<sup>1</sup>Method 1 utilized only non-missing data in estimation of average pain scores.  
<sup>2</sup>Method 2 imputed missing values after 5 minutes, using the last recorded pain level for all subsequent missing values.

The bottom of a box jellyfish (*Carybdea alata*) bell is almost perfectly square with tentacles about 2 feet long trailing from each of the four corners. These jellyfish swim about 2 miles per hour stinging shrimp and small fish with the abundant nematocysts on their tentacles. (Waikiki Aquarium)



This box jellyfish (*Carybdea alata*) was found swimming vigorously in the Ala Wai Boat Harbor on the 8th day after the full moon. The authors have handled these jellyfish by their bells often and suffered no stings. (Susan Scott)



in Method 1).

#### **Prediction of the cessation of pain, by treatment group**

The proportion of participants who experienced the cessation of pain within the study period was highest in the salt water group (6 of 16, or 38%) and lowest in the Adolph's group (2 of 14, or 14%). The proportions in the fresh water and Sting-Aid groups were 26% and 23%, respectively.

A logistical regression model was used to analyze the odds of cessation of pain across the treatment groups, while controlling for initial (after vinegar dousing) levels of pain. However, no significant differences were found for the odds of pain cessation across these 4 treatment groups.

#### **Discussion**

Analysis of early data showed that pain relief from the tested solutions was so similar to pain relief from the control (seawater) the authors terminated the study even though the dataset was smaller than needed for statistical significance. Continuing the study was not warranted since even with statistical significance, it was extremely unlikely that clinical significance would be achieved. Clini-

cal significance was defined according to two emergency department studies on VAS scores that found the minimum clinically significant difference in VAS pain scores was 9 and 11.<sup>4,5</sup>

In discussing and studying the effects of jellyfish sting treatments, it is important to identify which facet of the sting is being addressed. Medically, there are three:

1. **PREVENTING FURTHER INJURY.** After a sting, invisible, undischarged nematocysts may remain on the skin's surface. To prevent further injury, these need to be inactivated.
2. **CONTROLLING PAIN.** Box jellyfish stings are painful. Sometimes the pain is severe, especially in sensitive areas, such as the face, neck, armpit or groin.
3. **TREATING TOXIC REACTIONS.** A few victims react to Hawaii's box jellyfish toxin more severely than others and have symptoms such as weakness, dizziness, nausea, vomiting and/or shortness of breath.

*Continues on p. 210*

In addition, nematocysts vary between species, so that a treatment that works for one facet of an injury in one species may or may not work for the same facet in another. For example, vinegar inactivates unfired nematocysts in box jellyfish but discharges them in some Portuguese man-of-wars. Because of this variability, and because jellyfish stings in Hawaii are usually self-limiting injuries, it is understandable that victims perceive a wide range of treatments as effective.

Meat tenderizer became a popular treatment in Hawaii after Honolulu dermatologist Harry L. Arnold recommended it for Portuguese man-of-war stings in a 1971 local publication.<sup>6</sup> Arnold developed this treatment based on a newspaper article he read in 1969 suggesting that meat tenderizer may relieve the pain of insect stings. He advised a patient to dissolve a teaspoon of meat tenderizer in a quarter cup of water and rub the solution into the stings. Because the pain was gone in "a minute or two" and the marks disappeared within 30 minutes, Arnold began treating his patients with meat tenderizer and published a paper recommending it.

Nine years later, in 1980, Australian researchers discovered that both household vinegar (2–10% acetic acid in water) and acetic acid (1.2%–100% mixed in either water or seawater), rapidly, completely and irreversibly inhibited the discharge of nematocysts on the tentacles of the box jellyfish *Chironex fleckeri*.<sup>7</sup> Although the effect of vinegar on the nematocysts of *Carybdea alata* has not been published, the treatment is used routinely on those stings in Hawaii. Sometime after 1980, Hawaii residents began mixing Arnold's treatment for the pain of Portuguese man-of-war stings (Aldolph's meat tenderizer) with the Australians' treatment for preventing box jellyfish nematocysts from discharging toxin (vinegar). For years, this mixture of meat tenderizer and vinegar has been the accepted treatment among lifeguards, emergency workers and beach-goers in Hawaii for both Portuguese man-of-war and box jellyfish stings.

In theory, the papain contained in meat tenderizer hydrolyzes the protein components of box jellyfish venom, and therefore, lessens the severity of the sting. In a bee venom study, however, applying Aldolph's meat tenderizer either topically or injecting it beneath the skin on mice with bee stings did not reduce the size of the lesion. Only when papain and bee venom were mixed in a syringe first, and then injected into the mice, was there inhibition of lesion formation.<sup>8</sup>

Because human skin consists of proteins, it was conceivable that applying a proteolytic enzyme to skin might cause further injury to a sting victim. The data did not support this theory, perhaps due to the small amount of papain (less than 1 percent) found in Aldolph's meat tenderizer.

One study testing the effects of substances on live, unfired *Chironex fleckeri* nematocysts, found that freshly collected human urine caused massive discharge after a 1 to 2 minute delay.<sup>7</sup> This treatment, therefore, is not recommended for stings from the related *Carybdea alata*.

Based on the results of this study, the authors recommend the following treatment, in this order, for *Carybdea alata* stings:

1. Liberally spray or pour vinegar on the sting area to inactivate nematocysts.
2. Flush any clinging tentacles away with either fresh or salt water.

3. Apply either hot or cold packs, or take hot or cold showers (whichever makes the victim feel better) to ease pain.
4. Severe toxic reactions require analgesics and may improve with antihistamines and epinephrine.

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