



## Original Article

## Clinical characteristics of jellyfish stings in Japan

Toru Hifumi,<sup>1,2</sup>  Yoshimune Fukuchi,<sup>2,3</sup> Norio Otani,<sup>1,2</sup> Yutaka Kondo,<sup>2,4</sup>  Takeshi Kitamoto,<sup>2,5</sup> Kentaro Kobayashi,<sup>2,6</sup> Nobuaki Nakaya,<sup>2,7</sup> and Joji Tomioka<sup>2,8</sup>

<sup>1</sup>Emergency and Critical Care Medicine, St. Luke's International Hospital, Tokyo, <sup>2</sup>Japanese Society for Clinical Toxicology, Case study and Research committee, Tokyo, <sup>3</sup>Okinawa Prefectural Institute of Health and Environment, Uruma, <sup>4</sup>Department of Emergency and Critical Care Medicine, Juntendo University Urayasu Hospital, Urayasu, <sup>5</sup>Hasegawa Hospital, Mitaka, <sup>6</sup>Department of Emergency Medicine and Critical Care, Center Hospital of National Center for Global Health and Medicine, Tokyo, <sup>7</sup>Saitama Medical University Hospital, Saitama, and <sup>8</sup>Yonemori Hospital, Kagoshima, Japan

**Aim:** Jellyfish known as “habu-kurage” (*Chironex yamaguchii*) inhabit the waters surrounding Okinawa and Amami, Japan, and jellyfish stings are limited to areas outside the Japanese main island. However, the shifts promoted by global warming and increasingly intensive interactions with people have led to concerns regarding the possibility of increased jellyfish stings on the main island of Japan. Similar concerns are being raised all over the world. However, studies examining clinical characteristics of jellyfish stings have been limited to Australia, the USA, Europe, and South-East Asia. Thus, this study aimed to examine for the first time the clinical characteristics of jellyfish stings in Japan.

**Methods:** We undertook retrospective questionnaire surveys from January 2013 to December 2017 to determine patient characteristics, treatment, and clinical outcomes. We compared patient characteristics between tourists and non-tourists. The primary end-point of the present study was to clarify the clinical characteristics of jellyfish stings.

**Results:** Over the 5-year study period, 204 patients were identified from eight hospitals based on the basic questionnaire, and 35 patients with moderate-to-severe jellyfish stings were also identified. All patients recovered well, including five patients with severe jellyfish stings. Antivenom was not given. The time intervals from the occurrence of jellyfish stings to hospital arrival significantly differed between tourists and non-tourists ( $P = 0.049$ ), and all tourists visited the emergency department ( $P = 0.009$ ).

**Conclusions:** Approximately 40 cases of jellyfish stings occurred annually in Japan between 2013 and 2017. Patients recovered well without the use of antivenom.

**Key words:** Antivenom, emergency department, jellyfish, Okinawa, tourist

## INTRODUCTION

TROPICAL DISEASES AND heat-related injuries have gained increasing attention due to global warming.<sup>1,2</sup> Okinawa Prefecture is the southernmost prefecture in Japan with a climate ranging from humid subtropical to tropical rainforest. The annual number of tourists in Okinawa has increased to approximately 10 million, which is similar to that in Hawaii.<sup>3</sup>

To date, jellyfish known as “habu-kurage” (*Chironex yamaguchii*) (Fig. 1) inhabit the waters surrounding Okinawa and

Amami, and jellyfish stings are limited to areas outside the Japanese main island. However, the shifts promoted by global warming and increasingly intensive interactions among people have led to concerns regarding the potential for increased jellyfish stings on the main island of Japan.<sup>4</sup> Similar concerns are being raised all over the world. However, studies examining clinical characteristics of jellyfish stings have been limited to Australia, the USA, Europe, and South-East Asian countries, such as Malaysia and Thailand,<sup>5–13</sup> and those in other areas remain unknown. Thus, the current study aimed to examine for the first time the clinical characteristics of jellyfish stings in Japan, and also provide the clinical characteristics of jellyfish stings among tourists.

## METHODS

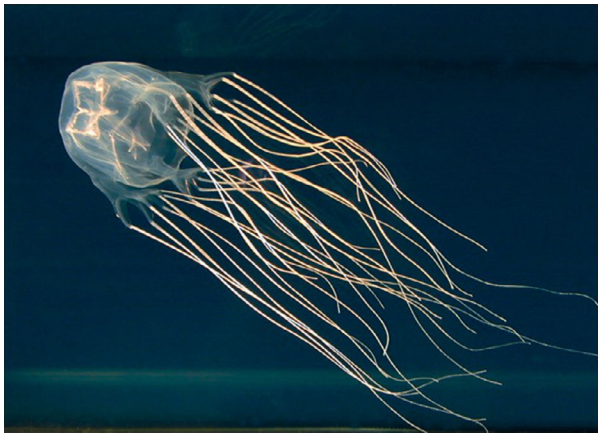
THE INSTITUTIONAL REVIEW board of St. Luke's International Hospital (Tokyo, Japan) approved this cross-sectional, survey-based study (approval no. 18-R052).

**Corresponding:** Toru Hifumi, MD, Department of Emergency and Critical Care Medicine, St. Luke's International Hospital, 9-1 Akashi-cho, Chuo-ku, Tokyo 104-8560, Japan. E-mail: hifumitoru@gmail.com.

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**Fig. 1.** *Chiropsalmus quadrigatus* Hackel. Photograph courtesy of Okinawa Prefectural Institute of Health and Environment.

## Patients and setting

We prepared a questionnaire to examine the clinical characteristics of jellyfish stings in Japan. The questionnaires comprised basic and advanced items. The basic questionnaire was sent to and completed by 12 medical institutions (Okinawa Main Island: Okinawa Prefectural Chubu Hospital, Okinawa Prefectural Hokubu Hospital, Okinawa Prefectural Nanbu Medical Center and Children's Medical Center, Misato Dermatology Clinic, Northern Okinawa Medical Center, Naha Municipal Hospital, and Tomishiro Central Hospital; and other areas: Okinawa Prefectural Yaeyama Hospital, Okinawa Prefectural Miyako Hospital, Miyakojima Tokushukai Hospital, Iriomote Seibu Clinic, and Kumejima Hospital) originally listed in the reports from the Okinawa Prefectural Government.<sup>14</sup> The questionnaire was sent in February 2019 and collected by March 2019. The advanced questionnaire was sent to nine hospitals that responded completely to having treated patients with moderate-to-severe jellyfish stings in the basic questionnaire. The questionnaire was sent in May 2019 and collected by July 2019. The surveillance period of the questionnaire spanned 5 years, that is, from January 2013 to December 2017 (Fig. 2).

## Data collection

In the basic questionnaire, the following parameters were recorded: age, sex, severity, date of injury, and hospital names. In the advanced questionnaire, the following parameters were recorded: age, sex, severity, date of injury, time interval from stings to hospital arrival, department visited, prehospital management (topical application of vinegar and removal of tentacles), vital signs (systolic blood pressure

and heart rate), clinical symptoms (local pain and swelling), in-hospital management (analgesics, tetanus vaccination, and antivenom), and clinical outcomes (hospital admission and good recovery rate).

## Diagnosis of jellyfish stings

No definite diagnostic criteria exist. Diagnosis of jellyfish stings was based on either the patient's history or the positive identification of jellyfish presented by the patient.

## Severity of jellyfish stings

We defined the severity of jellyfish stings as follows: (i) mild stings were limited to local envenomation, with local symptoms confined to mild pain and swelling at the sting site; (ii) moderate stings resulted in moderate pain and swelling at the sting site, but rarely required hospital admission; (iii) severe stings resulted in systemic envenomation, such as Irukandji syndrome and anaphylaxis, and most often required hospital admission.<sup>15</sup>

## Definition of tourists

Tourists were defined as individuals residing outside Okinawa.

## Location of hospitals that responded completely to having treated patients with moderate-to-severe jellyfish stings in the basic questionnaire

The hospital locations are shown in Figure 3.

*Okinawa Main Island:* Okinawa Prefectural Chubu Hospital, Okinawa Prefectural Hokubu Hospital, Okinawa Prefectural Nanbu Medical Center and Children's Medical Center, Misato Dermatology Clinic, and Northern Okinawa Medical Center.

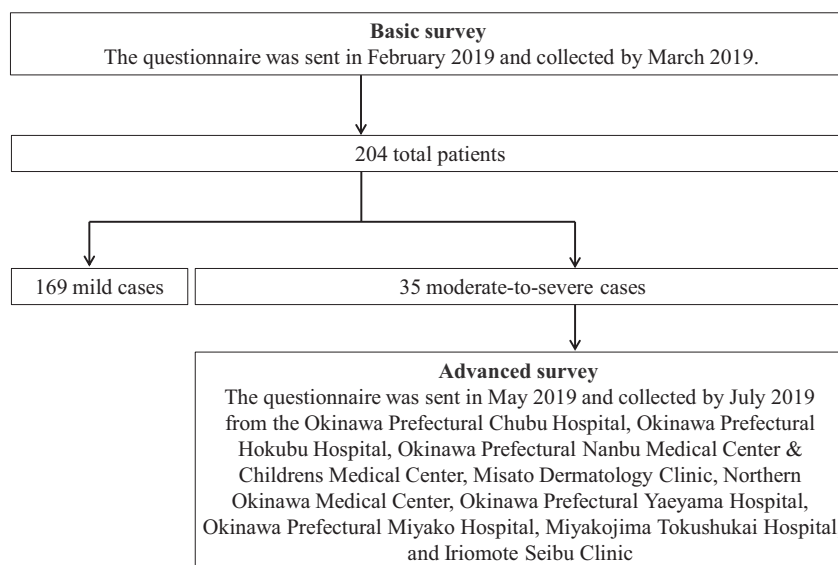
*Other areas:* Okinawa Prefectural Yaeyama Hospital, Okinawa Prefectural Miyako Hospital, Miyakojima Tokushukai Hospital, and Iriomote Seibu Clinic.

## Study end-points

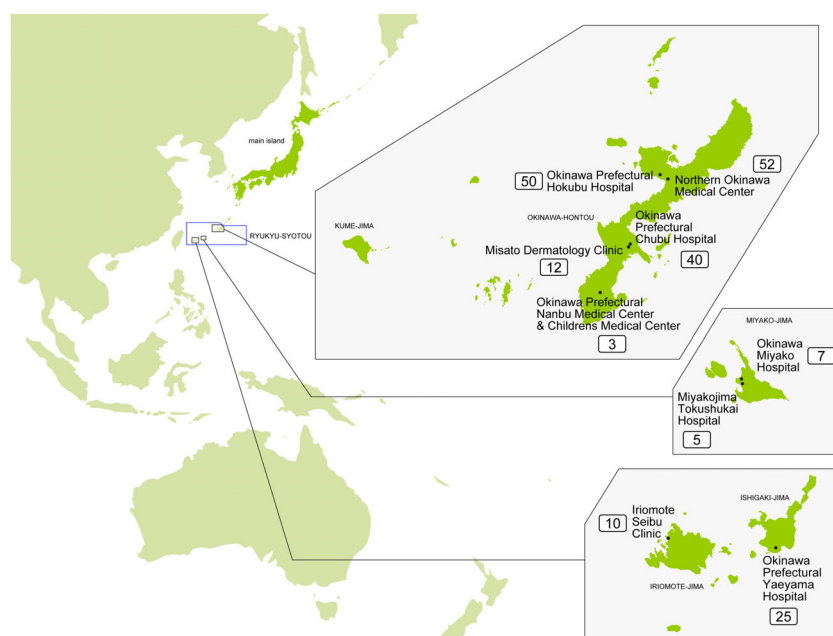
The primary end-point of the present study was to clarify the clinical characteristics of jellyfish stings.

## Primary data analysis

Patient characteristics, treatment-related factors, and clinical outcomes were compared between the tourists and non-tourist groups using the Mann–Whitney *U*-test and Fisher's



**Fig. 2.** Flow chart of enrolment of study participants in Japan who were affected by jellyfish stings (January 2013–December 2017).



**Fig. 3.** Distribution of jellyfish sting cases in Japan (January 2013–December 2017). Numbers in boxes indicate the number of jellyfish stings.

exact test for categorical variables, as appropriate. Comparison of the severity of jellyfish stings between Okinawa Main Island and other areas, and comparison of the departments visited between tourists or non-tourists were carried out using Pearson's  $\chi^2$ -test. Two-tailed  $P$ -values  $\leq 0.05$  were considered statistically significant. Statistical analysis was carried out using JMP version 11 (SAS, Cary, NC, USA).

## RESULTS

OVER THE 5-year study period, 204 patients were identified from nine hospitals based on the basic questionnaire, and 35 patients with moderate-to-severe jellyfish stings were also identified. In 2017, the number of jellyfish stings increased to 67 (Table 1).

## Baseline characteristics of study population

The patient characteristics are summarized in Table 1; 50.7% of patients were male, and the median age was 14 years. More than 80% of patients developed mild symptoms, and five patients (2.5%) suffered severe stings. The distribution of cases with jellyfish stings is shown in Figure 3.

## Comparisons of severity of jellyfish stings between Okinawa Main Island and other areas

Severe jellyfish stings have significantly occurred on Okinawa Main Island compared with those in other areas of Okinawa (Okinawa Main Island: severe, 5 [3.2%]; moderate, 29 [18.5%]; mild, 123 [78.3%]; other areas: severe, 0 [0%]; moderate, 1 [2.1%]; mild, 46 [97.9%];  $P = 0.008$ ) (Fig. 4).

**Table 1.** Baseline characteristics of study participants affected by jellyfish stings in Japan (January 2013–December 2017)

Variable	<i>n</i> = 204
Age, years	14 (9–28)
Male (%)	103 (50.7)
Date of injury (year)	
2013	48 (23.5)
2014	41 (20.0)
2015	17 (8.3)
2016	31 (15.2)
2017	67 (32.8)
Severity of jellyfish stings	
Mild	169 (82.8)
Moderate	30 (14.7)
Severe	5 (2.5)
Hospitals	
Okinawa Main Island (Okinawa Prefectural Chubu Hospital, Okinawa Prefectural Hokubu Hospital, Okinawa Prefectural Nanbu Medical Center and Children's Medical Center, Misato Dermatology Clinic, Northern Okinawa Medical Center)	157 (77.0)
Others (Okinawa Prefectural Yaeyama Hospital, Okinawa Miyako Hospital, Miyakojima Tokushukai Hospital, Iriomote Seibu Clinic)	47 (23.0)

Data are expressed as number (percentage), or median (interquartile range).

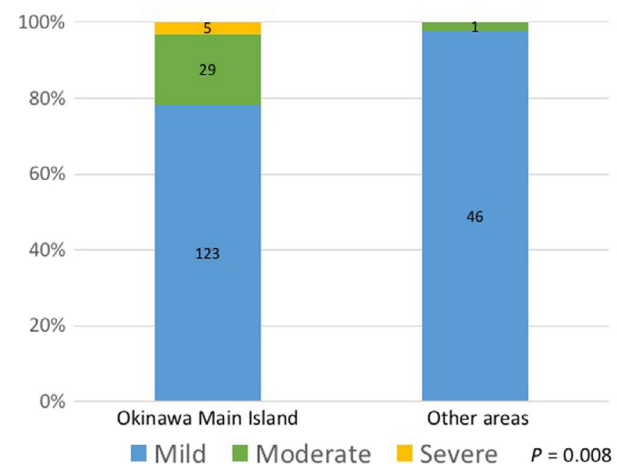
## Baseline characteristics and comparison between tourists and non-tourists among patients with moderate-to-severe stings

A total of 35 patients with moderate-to-severe jellyfish stings were identified. Regarding prehospital management, topical application of vinegar was initiated in 82.9% of cases, whereas removal of tentacles was obtained in only 40%. All patients recovered well, including five patients with severe jellyfish stings. Antivenom was not administered.

No significant differences were observed between the two groups with regard to age, sex, prehospital management, vital signs, symptoms, or in-hospital management. There were significant differences between tourists and non-tourists with regard to time interval from stings to hospital arrival and department visited. All tourists visited the emergency department (tourist: Emergency Medicine, 13 (100%); Dermatology, 0 (0%); Surgery, 0 (0%); and non-tourist: Emergency Medicine, 11 (50.0%); Dermatology, 9 (40.9%); Surgery, 2 (9.1%);  $P = 0.009$ ) (Table 2).

## Details of five severe cases

Details of severe cases in jellyfish stings are shown in Table 3. All patients were children (<12 years of age). Length of hospital admission was only for a few days without staying in ICU, and all patients recovered well.



**Fig. 4.** Comparison of the severity of jellyfish stings between Okinawa Main Island and other areas of Okinawa (January 2013–December 2017).

## DISCUSSION

APPROXIMATELY 40 JELLY fish sting cases per year occurred in Japan, and patients recovered well without the use of antivenom. Severe cases occurred on Okinawa Main Island. The time interval from jellyfish stings to hospital arrival was significantly different between tourists and non-tourists, and all tourist patients visited the emergency department.

Several jellyfish sting cases have been reported from Japan,<sup>16–18</sup> however, the current study is the first to comprehensively describe the clinical characteristics of jellyfish

stings in Japan. In an urban emergency department in Hawaii, approximately 20 cases of jellyfish stings are reported annually.<sup>19</sup> The annual number of jellyfish sting cases in Japan is relatively small compared with the annual incidence rate of jellyfish stings at approximately 100,000 cases on the Florida coast and east coast of Australia.<sup>7</sup> However, because the number of jellyfish stings increased in 2017, additional caution should be taken in the future. With regard to the severity of the stings, 2.5% of patients suffered severe stings in the current study. However, in a study undertaken at a hospital in Malaysia, approximately 12% of patients developed Irukandji-like syndromes which are

**Table 2.** Baseline characteristics and comparison between tourists and non-tourists among patients affected by moderate-to-severe jellyfish stings in Japan (January 2013–December 2017)

Variables	Total (n = 35)	Tourists (n = 13)	Non-tourists (n = 22)	P-value
Age, years	15 (10–32)	18 (9–22)	15 (10–46)	0.527
Male (%)	18 (51.4)	6 (46.2)	12 (54.6)	0.613
Severity of jellyfish stings				
Moderate	30 (85.7)	10 (76.9)	20 (90.9)	0.253
Severe	5 (14.3)	3 (23.1)	2 (9.1)	
Time from stings to hospital arrival, h				
<1	15 (42.9)	8 (61.5)	7 (31.8)	0.049
1–3	9 (25.7)	4 (30.8)	5 (22.7)	
3–6	1 (2.9)	1 (7.7)	0 (0.0)	
6–9	1 (2.9)	0 (0.0)	1 (4.6)	
9–24	0 (0.0)	0 (0.0)	0 (0.0)	
>24	9 (25.7)	0 (0.0)	9 (40.9)	
Department visited				
Emergency Medicine	24 (68.6)	13 (100.0)	11 (50.0)	0.009
Dermatology	9 (25.7)	0 (0.0)	9 (40.9)	
Surgery	2 (5.7)	0 (0.0)	2 (9.1)	
Prehospital management				
Topical application of vinegar	29 (82.9)	12 (92.3)	17 (77.3)	0.377
Removal of tentacles	14 (40.0)	7 (53.8)	7 (31.8)	0.288
Vital signs				
SBP	116 (106–130)	111 (97–128)	117 (111–150)	0.139
HR	91 (79–104)	86 (80–104)	94 (80–104)	0.954
Symptoms				
Local pain	25 (71.4)	8 (61.5)	17 (77.3)	0.444
Swelling	24 (68.6)	9 (69.2)	15 (68.2)	1.000
In-hospital management				
Analgesics	12 (34.3)	5 (38.5)	7 (31.8)	0.726
Tetanus vaccine	8 (22.9)	3 (23.1)	5 (22.7)	1.000
Antivenom	0 (0.0)			
Outcome				
Hospital admission	5 (14.3)	3 (23.1)	2 (9.1)	0.337
Good recovery	35 (100.0)			

Data are expressed as number (percentage), or median (interquartile range). HR, heart rate; SBP, systolic blood pressure.



**Table 3.** Details of five cases of severe jellyfish stings in Japan

Case	Age	Sex	Tourists	Injured sites	Time from stings to hospital arrival (h)	Removal of tentacles	Topical application of vinegar	Department visited	HR (b.p.m.)	SBP (mmHg)	Symptoms: Local pain	Symptoms: Swelling	Hospital admission	Length of hospital admission (days)	Length of ICU stay (days)	Hospital treatment	Outcome
1	6	Female	Yes	Upper arm, lower arm, thigh, lower leg	<1	Yes	Yes	EM	172	80	Yes	Yes	Yes	3	0	Analgesics	GR
2	7	Female	Yes	Upper arm, lower leg	1–3	Yes	Yes	EM	174	84	Yes	Yes	Yes	1	0	None	GR
3	8	Female	No	Thigh, lower leg	<1	No	Yes	EM	104	116	Yes	No	Yes	3	0	Analgesics, tetanus vaccine	GR
4	7	Female	No	Lower arm	<1	No	Yes	EM	79	N/A	Yes	Yes	Yes	3	0	Analgesics, tetanus vaccine	GR
5	12	Male	Yes	Lower leg	<1	Yes	Yes	EM	79	132	Yes	No	Yes	2	0	Antibiotics	GR

EM, Emergency Medicine; GR, good recovery; HR, heart rate; ICU, intensive care unit; SBP, systolic blood pressure.

categorized as severe stings in the current study.<sup>8</sup> Two cases of Irukandji-like syndromes were also reported in Thailand;<sup>12</sup> therefore, preparation for severe cases should be considered in Asian countries, including Japan.

The time intervals from the jellyfish stings to hospital arrival differed between tourists and non-tourists. Because the severity of jellyfish stings was not different between the two groups, other factors might be considered. In general, tourists have poor knowledge of and experience with jellyfish stings; therefore, they tend to visit the hospital more quickly. This suggests that there is a need for public health interventions tailored to tourists. According to prehospital management, more than 90% of jellyfish sting cases among tourists received topical application of vinegar; therefore, appropriate prehospital management was considered to be initiated. However, over 40% of patients in the non-tourist group visited the hospital more than 24 h after the injury. This might reflect the nature of characteristics among non-tourists, that is, sufficient experience with jellyfish stings, patience, and so on.

Prevention and education of home (non-hospital) treatment could decrease the cost of health-care by decreasing the total number of emergency department visits for a non-urgent injury.<sup>19</sup> All patients recovered well without use of antivenom. Although cases with appropriate indications for antivenom, such as cardiac arrest or cardiogenic shock, were not identified in the current study, considering the annual incidence rate of approximately 40 cases of jellyfish stings in Japan in the current study, antivenom could be prepared in Japan. To date, antivenom for jellyfish stings has not been available for clinical use in Japan; therefore, a clinical research use system similar to that for redback spider or Yamakagashi bites might be appropriate for the safe supply of antivenom.<sup>20–22</sup>

There are several limitations to our study. First, the sample size was small. Second, details of dermatological examinations were not studied because the dataset was unavailable. Third, this was a retrospective survey; therefore, some bias might exist. Fourth, the difference between mild pain and moderate pain is subjective to the respondents of the questionnaire, and there is no distinct definition with regard to pain. Finally, cases outside Okinawa Prefecture (i.e., mainland Japan) could be present.

## CONCLUSIONS

APPROXIMATELY 40 CASES of jellyfish stings occurred annually in Japan, and the patients recovered well without the use of antivenom. Severe cases occurred on Okinawa Main Island. The time interval from jellyfish sting to hospital arrival differed significantly between tourists and

non-tourists, and all tourists visited the emergency department.

## ACKNOWLEDGEMENTS

**WE WISH TO** thank all study participants for enrolling and providing data for the study.

## DISCLOSURE

Approval of the research protocol: The institutional review board of the hospital approved this cross-sectional, survey-based study (approval no. 18-R052).

Informed consent: N/A.

Registry and registration no. of the study/trial: N/A.

Animal studies: N/A.

Conflict of interest: None.

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