Prospective study of *Chironex fleckeri* and other box jellyfish stings in the "Top End" of Australia's Northern Territory

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ABSTRACT

Objective: To describe the epidemiology and clinical features of box jellyfish envenoming in the Top End of the Northern Territory and, in particular, confirmed stings from the major Australian box jellyfish, *Chironex fleckeri.*

Design: Prospective collection of clinical data and skin scrapings or sticky-tape tests for nematocyst identification from patients presenting to Royal Darwin Hospital and remote coastal community health clinics in the Northern Territory, spanning 10 950 km of coastline; analysis of tidal, weather and seasonal data.

Patients: All patients with jellyfish sting details recorded between 1 April 1991 and 30 May 2004.

Main outcome measures: Demographic and clinical features, use of *C. fleckeri* antivenom, and associations between weather, seasonal and tidal factors and confirmed *C. fleckeri* stings.

Results: Of 606 jellyfish stings documented, 225 were confirmed to have been caused by *C. fleckeri.* 37% of *C. fleckeri* stings were in children, 92% occurred during the "stinger season" (1 October to 1 June), 83% occurred in water 1 m or less deep, and 17% occured while victims were entering the water. Stings were least common on outgoing tides ($P < 0.001$) and commonest between 15:00 and 18:00 ($P < 0.001$) and on days with wind speed less than that month's average ($P < 0.001$). Nearly all victims experienced immediate pain, but this could often be controlled with ice; only 30% required parenteral narcotics and 8% required hospital admission. Cardiorespiratory arrest occurred within several minutes of the sting in the one fatal case, involving a 3-year-old girl with only 1.2 m of visible tentacle contact. *C. fleckeri* antivenom was given to another 21 patients, none of whom had life-threatening features at the time they were given antivenom.

Conclusions: Most *C. fleckeri* stings are not life-threatening; patients who die usually have cardiopulmonary arrest within minutes of the sting. The potential benefit of antivenom and magnesium under these circumstances remains to be shown, but a protocol with their rapid use is recommended if cardiopulmonary arrest has occurred. Unfortunately, this is unrealistic for many rural coastal locations, and the priority remains prevention of stings by keeping people, especially children, out of the sea during the stinger season.

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Chironex fleckeri, the major Australian box jellyfish (Class *Cubozoa*), has been the attributed cause of around 70 fatal jellyfish envenomings in tropical Australian waters.[1] *C. fleckeri* is a multitentacled (Order *Chirodropidae*) box jellyfish with a bell up to 35 cm in diameter, with up to 15 tentacles off each of the four pedalia of the bell. The taxonomy of multitentacled box jellyfish remains poorly defined, with a number of other species implicated in deaths in the northern hemisphere and the northernmost distribution of *C. fleckeri* not established.[1]

A second chirodropid species has long been recognised in northern Queensland waters.[1-4] This was originally called *Chiropsalmus quadrigatus*, but is now recognised to be a different species from the *C. quadrigatus* responsible for many fatalities in the Philippines and Japan.[1,5] Furthermore, another multitentacled box jellyfish, the Gove chirodropid, has recently been described from the Gove Peninsular in north-east Arnhem Land, Northern Territory.[6] To date, these two species have not been associated with documented fatalities; their stings are similar to mild *C. fleckeri* envenoming.

Stinging cells (nematocysts) from the three species, seen on microscopy of skin scrapings or sticky tape samples from victims, cannot reliably distinguish between the species.[1,3,6] The Gove chirodropid and northern Queensland *Chiropsalmus* spp. have, as yet, not been reported from the Darwin harbour or Tiwi islands (Phil Alderslade, Northern Territory Museum of Arts and Sciences, personal communication).

Here, we present an analysis of prospectively collected data from jellyfish sting patients who were stung in NT coastal areas where *C. fleckeri* is present, but the other two Australian chirodropid species have not been documented.

METHODS

The Northern Territory has a coastline of 10 950 km, and the Royal Darwin Hospital (RDH) is the 300-bed referral hospital servicing the region. There is a small regional hospital in Gove for those in eastern Arnhem Land, as well as a number of community health centres scattered along the coast servicing remote Aboriginal communities.

To describe the spectrum of illness caused by *C. fleckeri*, we report a subset of 225 patients with stings found to be positive for chirodropid nematocysts.

From April 1991, a standard data collection form has been used for patients presenting to RDH with suspected jellyfish envenoming; these forms have also been available at Gove Hospital and the coastal community health centres. Variables listed include demographic, weather and sea details, nature of the suspected sting and clinical parameters reflecting jellyfish envenoming. Treatment details, including the nature and route of analgesia and the use of antivenom, are also recorded. Skin scrapings and, more recently, sticky tape samples from the sting site are collected and processed at the Menzies School of Health Research.[7,8] Nematocyst description and identification is based on previous publications.[1,7,8] Skin sample results are divided into those with predominantly cigar-shaped nematocysts and therefore consistent with chirodropid

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1 Details and circumstances of 225 *Chironex fleckeri* stings*

Factor	No. (%)
Male	140 (62%)
Aboriginal	34 (15%)
Northern Territory resident	204/214 (95%)
Age (range, 3–67 years; median, 17 years)	
Adult (⩾ 15 years)	142 (63%)
Activity when stung	
Entering water	37/222 (17%)
Standing in water	95/222 (43%)
Swimming	67/222 (30%)
Diving into water	7/222 (3%)
Fishing on shore	6/222 (3%)
Boating	10/222 (5%)
Depth of water (range, 0.1 m–5.0 m; median, 1.0 m)	
0–1 metre	152/182 (84%)
> 1–2 metres	29/182 (16%)
> 2–5 metres	1/182 (1%)
Weather conditions	
Fine	128/221 (58%)
Cloudy	88/221 (40%)
Raining	5/221 (2%)
Wind conditions	
Still	79/208 (38%)
Slight breeze	99/208 (48%)
Moderate breeze	26/208 (13%)
Strong wind	4/208 (2%)
Sting length (range, 0.01 m–4.2 m; median, 0.3 m)	
0–0.09 metre	25/190 (13%)
0.1–0.49 metre	95/190 (50%)
0.5–0.99 metre	39/190 (21%)
1.0 metre and above	31/190 (16%)
Adherent tentacles	62/191 (32%)
Crosshatching	35/137 (26%)
Intensity of pain	
Nil	6/218 (3%)
Mild	54/218 (25%)
Moderate	102/218 (47%)
Severe	56/218 (26%)
Vinegar applied	218/219 (99%)
Ice applied	129/181 (71%)
Analgesic given	108 (48%)
Intramuscular or intravenous narcotic used	68 (30%)
Antivenom used	11 (5%)
Hospital admission	18 (8%)

* Denominator is 225 unless indicated, where data was not available for all cases. ◆

box jellyfish, and those with predominantly lemon-shaped or round nematocysts and consistent with four-tentacled box jellyfish (Order *Carybdeidae*) such as the Darwin carybdeid.[8] The National Tidal Centre provided tidal information, regional hourly wind speed and hourly sea surface and air temperatures over the duration of the study.

Data were stored in EpiData (version 3.02; EpiData Association, Odense, Denmark) and statistical analysis was performed using Intercooled Stata (version 7.9; Stata Corporation, College Station, Tex, USA). The study was approved by the Human Research Ethics Committee of the Menzies School of Health Research and the NT Department of Health and Community Services.

RESULTS

Between April 1991 and May 2004, of the 606 jellyfish report forms returned, 70 had clinical features consistent with classical descriptions of the Irukandji syndrome,[1] while 110 others had no nematocysts seen on microscopy, and a further 108 did not have skin samples taken for microscopy. Of the 318 that were positive on microscopy, 35 had nematocysts not consistent with *C. fleckeri* or the other two chirodropids (29 of these were stung in Darwin Harbour and had nematocysts consistent with the Darwin carybdeid). The remaining 283 had cigar-shaped nematocysts consistent with chirodropid envenoming. Of these, 58 were from Arnhem Land where both *C. fleckeri* and the Gove chirodropid are present, and 225 were stung in Darwin Harbour or the Tiwi Islands and were thus classified as *C. fleckeri* envenoming.

Box 1 shows the circumstances and features of those with C. fleckeri envenoming. Most stings occurred in the months November–April, with only 17 (8%) occurring outside the official NT “stinger season” of 1 October till 1 June (eight in June, five in July, 2 in August and 2 in September). Box 2 shows the time of day, tide cycle and weather parameters for the C. fleckeri envenomings.

Nearly all of those stung by *C. fleckeri* were NT residents; their median age was 17 years and 37% were children aged under 15 years. Stings were almost twice as likely to occur between 15:00 and 18:00 than in either of the two preceding 3-hour periods of daylight. Most *C. fleckeri* stings (84%) occurred at a depth of 1 metre or less, with 17% occurring on entering the water and 43% while standing in the water. The only sting in water over 2 metres deep occurred while the victim was pulling an anchor aboard a boat in 5 metres of water. There was a statistically significantly lower proportion of stings on the outgoing tide than for the rest of the tidal cycle. Stings were rare during strong winds, and wind speeds at

2 Sting time, tidal cycle and weather parameters for *Chironex fleckeri* stings

Variable	Results	*P*
Sting time*		< 0.001
06:00–08:59‡	9/214 (4%)	
09:00–11:59	40/214 (19%)	
12:00–14:59	41/214 (19%)	
15:00–17:59‡	77/214 (36%)	
18:00–05:59	47/214 (22%)	
Tide cycle†		0.017
High	65/220 (30%)	
Outgoing‡	35/220 (16%)	
Low	58/220 (26%)	
Incoming	62/220 (28%)	
Water temperature	range, 24.2–32.3°C; median, 30.5°C	
Air temperature	range, 23.5–31.8°C; median, 28.2°C	
Wind speed	range, 0–8.6 m/s; median, 1.3 m/s	

* Goodness-of-fit test for proportions between the four daylight periods of 3 hours each, night time excluded: $\chi^2 = 55.5$; 3 df; $P < 0.001$. † Tide cycle divided into four equal time periods, with goodness-of-fit test for proportions between the four periods: $\chi^2 = 10.1$; 3 df; $P = 0.017$. ‡ Outlying values. ◆

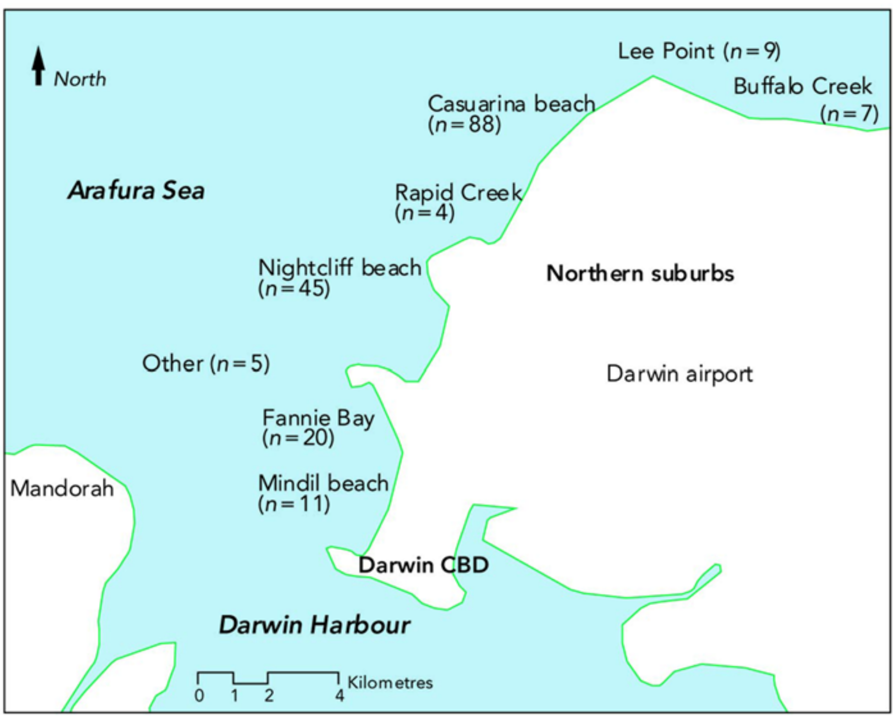
time of sting were below the median for that month in 72% of stings; median wind speed during the hour of each sting was 1.3 m/s (2.5 knots), compared with a median monthly speed of 2.7 m/s (5.2 knots) for all stings (Wilcoxon signed rank test, $P < 0.001$). Box 3 shows the location of the Darwin Harbour beaches which were the sites of 189 stings.

All people with *C. fleckeri* envenoming had sting marks with linear welts the most common presentation. The legs were most commonly affected and the maximum sting length was 4.2 metres. Although it is unusual for more than two limbs to be affected, 25 (11%) had five or more discrete body sites affected. Adherent tentacles were present in 32%, and the cross-hatching which reflects bands of nematocysts perpendicular to the tentacle line was present in 27%. Onset of pain after tentacle contact was immediate in 94%, vinegar was applied in all but one case where this was documented, and ice in 71%. Analgesia in addition to ice was required in 48%, with parenteral narcotic required in 30%. Eight per cent of those with of *C. fleckeri* stings required hospital admission. In accordance with long-standing NT policy, pressure-immobilisation first aid was not used for any sting.

Box 4 gives details of the 22 patients with jellyfish stings of any kind who were given antivenom. Eleven patients given antivenom were considered to have C. fleckeri envenoming, being either from Darwin or the Tiwi Islands. It is probable that the four patients with chirodropid-positive stings from Arnhem Land who were given antivenom were also stung by C. fleckeri. Of the seven Arnhem Land patients given antivenom who were nematocyst negative or in whom the skin test was not done, one had Irukandji syndrome and was given antivenom inappropriately, one was stung in September which is before the official stinger season and was possibly stung by a Gove chirodropid,[6] and the other five may well have been stung by C. fleckeri. There were no documented adverse reactions to antivenom.

Box 5 shows the clinical features of the one fatality. In addition to the fatal case, two other patients experienced collapse with loss of consciousness within several minutes of the sting. Both woke after brief cardiopulmonary resuscitation; the 10-year-old boy (Box 4) who was subsequently given antivenom; and a 4-year-old boy with 3.6 metres of tentacle contact whose skin stickytape sample was positive for nematocysts consistent with C. fleckeri, and who was subsequently treated with intravenous narcotics, but no antivenom. Immediate excruciating pain over the tentacle contact sites was universal in all severe stings, and sinus tachycardia and sinus arrhythmia were common in severe cases. More worrying electrocardiogram findings were unusual, but conduction abnormalities included: periods of sinus arrest in a 5-year-old with 1.7 metres of tentacle contact, which persisited after 1 ampoule of intravenous antivenom, but subsequently resolved; unifocal ventricular ectopic beats with runs of bigeminy in a 27-year-old with 0.6 metres of tentacle

3 Darwin Harbour, showing locations of the occurrence of *Chironex fleckeri* stings



CBD = central business district. ◆

4 Details of 22 patients given *Chironex fleckeri* antivenom

Age and sex	Month/year and location	Skin test for nematocysts	Total sting length	Antivenom dose*	LOC†	Comments
10 m	4/94 Island Community	+ve	0.2 m	2 IM	No	Not severe sting
3 f	2/96 Island Community	+ve	1.2 m	3 IM, 3 IV	Yes	Fatal case; see Box 5
13 m	12/97 Island Community	+ve	1.6 m	3 IV	No	AV with narcotic; decreased pain
10 m	4/99 Island Community	+ve	2.5 m	1 IV	Yes	Woke after brief CPR; then AV with narcotic; decreased pain, but needed more narcotic
28 f	1/92 Darwin	+ve	2.5 m	2 IV	No	Tourist. AV after narcotic; decreased pain
22 f	4/92 Darwin	+ve	4.2 m	1 IV	No	AV after narcotic; decreased pain
5 f	4/92 Darwin	+ve	2.6 m	1 IV	No	AV with narcotic; decreased pain
25 m	4/92 Darwin	+ve	2.2 m	1 IV	No	Tourist. AV after narcotic; no response, given more narcotic
25 f	4/92 Darwin	+ve	2.6 m	1 IV	No	Pain not severe. No narcotic; still mild pain post AV
28 f	5/92 Darwin	+ve	0.5 m	1 IV	No	AV with narcotic; decreased pain
20 f	4/03 Darwin	+ve	1.8 m	3 IV	No	AV with narcotic; decreased pain; residual scarring
5 m	1/92 Arnhem Land	+ve	ND	1 IV	No	AV with narcotic; decreased pain
13 m	1/94 Arnhem Land	+ve	1.0 m	1 IV	No	AV with narcotic; decreased pain
7 m	12/96 Arnhem Land	+ve	0.2 m	1 IV	No	Not severe sting
22 m	10/00 Arnhem Land	+ve	ND	1 IV	No	AV with narcotic; decreased pain
11 m	11/94 Arnhem Land	Not done	0.5 m	1 IV	No	Face sting. AV given at 6 hr for swollen lips; no effect
32 m	4/97 Arnhem Land	Not done	Nil	1 IV	No	Irukandji syndrome; AV no benefit
10 f	2/98 Arnhem Land	Not done	0.2 m	2 IM	No	Pain already settled with narcotic before AV
7 f	10/92 Arnhem Land	-ve	1.0 m	1 IV	No	AV after narcotic, but pain persisted
8 m	9/95 Arnhem Land	-ve	ND	1 IV	No	AV with narcotic; decreased pain
7 m	1/96 Arnhem Land	-ve	0.2 m	1 IV	No	AV with paracetamol; decreased pain
11 m	4/97 Arnhem Land	-ve	0.2 m	1 IV	No	AV with narcotic; decreased pain

* Number of vials of antivenom given intravenously (IV) or intramuscularly (IM). † LOC = witnessed loss of consciousness on beach after sting. ND = not determined. AV = antivenom. ◆

5 Fatal *Chironex fleckeri* envenoming, February 1996.

A healthy 3-year-old girl was playing in shallow water in a remote Northern Territory Aboriginal island community. She screamed out in pain and was carried from the water with "jellyfish rope" hanging from her arm and leg.

Time after sting	Events
Several minutes	Cardiorespiratory arrest on the beach.
10 minutes	Brought to health centre with no detectable pulse or respiration, and dilated pupils; cardiopulmonary resuscitation (CPR) commenced.
20 minutes	3 vials (20 000 units each) of *C. fleckeri* antivenom given intramuscularly (no intravenous access); CPR continued; adrenaline and atropine given intramuscularly.
40 minutes	Intravenous access obtained; adrenaline and bicarbonate given intravenously.
70 minutes	Two 1.5 mg doses of verapamil given intravenously.
85 minutes	Aerial Medical evacuation plane arrived with retrieval doctor; patient intubated and given two further vials of antivenom intravenously; ongoing resuscitation, further cardioactive drugs; six attempts at electrical cardioversion.
110 minutes	Declared dead.

Visual tentacle contact length of 1.2 metres; sticky tape sample confirmed multiple nematocysts consistent with *C. fleckeri* . ◆

contact which resolved after intramuscular narcotic; and right bundle branch block in a 25-year-old with 0.7 metres of tentacle contact which resolved after intramuscular narcotic.

DISCUSSION

C. fleckeri has been described as "the world's most venomous animal"[1] because of the dramatic nature of severe envenoming, where death may occur within a few minutes of tentacle contact. However, our prospective study has confirmed that the vast majority of *C. fleckeri* envenomings are not life-threatening.

Attributing stings to specific jellyfish species is problematic because of uncertainties about jellyfish taxonomy and similar nematocyst morphology between species such as the multitentacled box jellyfish (chirodropids).[1,3,4,6] Because both *C. fleckeri* and *Chiropsalmus* spp. occur in northern Queensland waters, and both *C. fleckeri* and the Gove chirodropid occur in Arnhem

6 Skin lesions from two patients with severe *Chironex fleckeri* envenoming

7 Summary of treatment of *Chironex fleckeri* stings — the revised Northern Territory protocol

Hospital treatment:

- Treat airway, breathing and circulation if necessary, and add oxygen. Apply vinegar.
- If the patient is unconscious or if there is life-threatening cardiac or respiratory decompensation, or a significant arrhythmia is present, give a minimum of 1 vial of antivenom intravenously (each vial 20 000 units, diluted 1:10 with an isotonic crystalloid solution such as Hartmann's solution or isotonic saline, given as an intravenous push). In a life-threatening situation, up to 3 vials may be given consecutively if the response remains inadequate, together with magnesium sulfate (0.2 mmol/kg up to 10 mmol, adult dose) as an intravenous bolus over 5–15 minutes.
- Cardiopulmonary resuscitation should be continued in patients with ongoing cardiac arrest until after further therapy with even more antivenom (at least 6 vials total dose, if available) and a repeat dose of magnesium sulfate, and after considering other cardioactive drugs.
- In patients with stings that are not life-threatening (no cardiac or respiratory decompensation), use ice-packs for initial pain relief, together with oral, intravenous or intramuscular analgesia if necessary (0.1 mg/kg morphine up to 5 mg adult dose initially, but can be repeated). For pain not relieved by ice-packs and narcotic analgesia, give magnesium sulfate (0.2 mmol/kg up to 10 mmol, adult dose) as an intravenous bolus over 15 minutes and/or 1 vial of antivenom diluted as above and given intravenously over 5–10 minutes. For further pain, use more narcotic analgesia and consider a second dose of magnesium sulfate. ◆

Land waters, chirodropid nematocysts from stings from these locations cannot usually be definitively attributed to *C. fleckeri*. Nevertheless, it is likely that the reported severe stings and fatalities from northern Queensland and the NT were *C. fleckeri* envenomings.[9-11] However, in chirodropid-nematocyst-positive stings from Darwin Harbour and the Tiwi Islands, where the other two chirodropids have not been found, attribution to *C. fleckeri* is considered valid even for less severe stings. This enables us to report the clinical spectrum of 225 *C. fleckeri* stings.

One limitation of our study is that we are unable to quantify the risks as we do not know how many people were in the water during various times of day, tidal cycles and weather conditions. However, most *C. fleckeri* stings occur when the weather is "fine" and the wind is "still" or slight. Stings are also most common in shallow water, and frequently occur on entering the sea. These features reflect the natural history of *C. fleckeri* which develops and replicates as polyps in tidal estuarine creeks and enters the sea at the beginning of each stinger season.[12] The species is generally a shallow-water feeder, but is easily damaged by surf or rough seas and has the ability to sink to the ocean floor to rest.[13] However, our data do not support the observation that this resting occurs from 15:00,[13] as stings in our study were most common between 15:00 and 18:00. The significantly lower proportion of stings during the outgoing tide is likely to reflect *C. fleckeri* avoiding potential stranding by moving further offshore. In adverse weather, *C. fleckeri* may swim offshore and sink to calmer deep water until storms pass, or may move up tidal creeks. This is different from the natural history of the smaller four-tentacled box jellyfish (carybdeids) which cause the Irukandji syndrome. Humans may encounter these carybdeids during periods of onshore winds in shallow water or in deeper water offshore in the case of divers.[1,14,15]

C. fleckeri stings affected people of all ages, with a slight male predominance. Interestingly, the vast majority of stings were in NT residents, which reflects both the risk-taking behaviour of local residents and visitors heeding the well publicised health warnings about not entering the water during the stinger season. Overall, Aboriginal patients were not over-represented in terms of NT demographics, but most stings outside Darwin were in Aboriginal people from remote communities. All *C. fleckeri* envenomings had sting marks, with linear welts being the most common presentation, adherent tentacles in almost a third, and cross-hatching of the welts in one quarter (Box 6). Vinegar was almost universally used, ice was often adequate for pain relief, but half required some form of analgesia, and almost a third required parenteral narcotics. Few required hospital admission. In some of those with severe pain not controlled by narcotics, antivenom appeared helpful, although attribution of improvement to the antivenom cannot be definitive.

In this study, 22 patients had been given *C. fleckeri* antivenom, one inappropriately as the patient had Irukandji syndrome for which the antivenom is ineffective.[16] The biological basis of the lethal activity of *C. fleckeri* venom remains to be fully elucidated, with the specific toxins involved yet to be characterised.[17,18] In animals, *C. fleckeri* venom causes abnormalities in ionic transport across membranes resulting in altered membrane permeability which affects both sodium and calcium channels.[19] Cardiac and skeletal muscle, smooth muscle, cardiac conduction pathways, and, possibly, central neurological pathways are affected. Cardiotoxicity appears to be the major outcome, with impaired cardiac contraction, hypertension then hypotension, arrhythmias (such as various conduction blocks and ventricular tachycardia), and decreased coronary flow.[17] The most recent studies in rats[20] support previous concerns about suboptimal activity of *C. fleckeri* antivenom against lethal factors in *C. fleckeri* venom,[21] while also supporting studies in piglets which suggested that the previously recommended use of calcium antagonists such as verapamil may be harmful in *C. fleckeri* envenoming.[22] In addition, the recently reported potential benefit of magnesium for the Irukandji syndrome[23,24] was also seen in the *C. fleckeri* rat study. In particular, a combination of intravenous magnesium and antivenom was beneficial, and this should be considered in severe human envenoming.[20]

The last 10 people who have died from jellyfish envenoming in the NT have all been children, reflecting the greater risk of a smaller body mass exposed to the billions of nematocysts on jellyfish tentacles.[17] The single fatality from *C. fleckeri* in this study shows how rapidly cardiopulmonary arrest can follow severe envenoming.[11] The 1.2 m of tentacle contact in this case is the smallest yet described in a fatality. There have been two further deaths from northern Queensland, both with similar rapid cardiopulmonary arrest following tentacle contact; the victims were a 5-year-old boy in January 2000 and a 7-year-old boy in March 2003. The NT case is the only one, to our knowledge, in which verapamil was used, but the chronology suggests that verapamil and the antivenom were given at a time when irreversible hypoxic damage had already occurred. Nevertheless, it is important to note that intramuscular antivenom given to a patient in cardiac arrest and circulatory shutdown is unlikely to be absorbed. Other reports of use of intramuscular *C. fleckeri* antivenom[25,26] were not in situations of cardiac arrest and the subjective reports of improvement may well have reflected spontaneous improvement, which was seen in the vast majority of stings in this study. While there are a number of published reports of people with severe envenoming who have survived and who have been given antivenom,[9,10] there are similar case reports where antivenom was not given, but patients survived with expert critical care management. These included a 12-year-old boy in the pre-antivenom era with a documented 16 metres of tentacle contact.[27] On the other hand, there have now been four documented deaths despite the use of *C. fleckeri* antivenom, including two where it was given intramuscularly.[17] In none of the 21 survivors in this study who were given antivenom could survival be attributed to the antivenom. Indeed, in one of these, and in another child not given antivenom, recovery from documented rapid loss of consciousness occurred after attempted cardiopulmonary resuscitation at the scene and before arrival at a health facility.

Because of the rapidity of fatal *C. fleckeri* envenoming, the critical window of opportunity for potentially life-saving use of antivenom is much smaller than that for snake envenoming, possibly only minutes. Furthermore, from animal study data, it was calculated that around 12 ampoules of antivenom may be required to counter the effects of a theoretical envenoming containing twice the human lethal dose of venom.[21] Therefore, the situation where *C. fleckeri* antivenom may save a life is a severe sting with cardiorespiratory arrest near a health centre or hospital, where immediate resuscitation and rapid use of large volumes of intravenous antivenom is possible. It is for this scenario that the NT revised protocol for managing severe *C. fleckeri* envenoming is written,[8] with the potential use of intravenous magnesium recently added (see Box 7).

Our prospective study has confirmed that, for most *C. fleckeri* stings, treatment with vinegar, followed by pain relief with ice and oral or parenteral analgesia if required, is adequate.

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COMPETING INTERESTS

None identified.

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