

Successful use of *Chironex* Antivenom by Members of the Queensland Ambulance Transport Brigade.

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ABSTRACT

We report the first administration in Australia by ambulance bearers of Commonwealth Serum Laboratories *Chironex fleckeri* antivenom, in two separate major, potentially life-threatening *Chironex* envenomations. In both cases the antivenom was effective helping relieve signs and symptoms (including pain).

This antivenom is still the most specific part of treatment of a major *Chironex fleckeri* sting after stabilization of the airway, breathing and circulation. The additional use of verapamil may contribute to the prevention of some cardiac complications resulting from direct effects of the *Chironex* venom.

INTRODUCTION

The venom of *Chironex fleckeri* (the north Australian Box-Jellyfish) was first isolated from live specimens by Barnes in 1967,¹ and the antivenom was first produced by the Commonwealth Serum Laboratories in 1970.² Information provided to the authors by Dr. Struan Sutherland of C.S.L. indicates that this antivenom has now been used Australia-wide in over 300 cases of *Chironex* envenomation, with no documented untoward effects.

Since its introduction this antivenom has been used predominantly for severe stings that were life-threatening,^{2,3} although it has also been shown to alleviate the severe pain of less serious *Chironex* envenomation.³ However, recent laboratory experiments using rats suggested that the antivenom was of little value in recovering mice after a prior, lethal intra-venous injection of *Chironex* venom.⁴ Subsequently its efficacy was challenged in the lay press⁵ following its intra-venous use during the unsuccessful resuscitation of a 5 year old child who died shortly after sustaining a major *Chironex* sting. Retrospective analysis of this case suggested possible under dosage of the antivenom.⁶

Chironex antivenom has been kept in Surf Life Saving Clubs in north Queensland for the last 12 years, and qualified surf life savers with advanced resuscitation awards were trained to give antivenom injections by the intra-muscular route; they were taught when, where and to whom it should be administered, after an urgent radio or telephone conversation with a Medical Officer. Last year however, it was withdrawn from the Surf Clubs because of increasing cost and availability problems, and also because there had never been a major *Chironex* sting on a patrolled beach during that 12 year period. (This perhaps emphasises the efficacy of the Surf Life Saving Association beach patrols in preventing potentially dangerous envenomation situations for swimmers).

At almost the same time the antivenom was withdrawn from the Surf Clubs, ambulance bearers of the Queensland Ambulance Transport Board (QATB) were taught how to differentiate between the various jellyfish stings, and when, and how, to give intra-muscular injections of the CSL *Chironex* antivenom, if a major sting *Chironex* sting occurred. The antivenom was made available to all Ambulance Centres in north Queensland. This timing was fortuitous.

We now report two separate cases of the successful use of this antivenom on unpatrolled beaches, by ambulance bearers who were summoned to the scene of envenomation shortly after each of two potentially lethal-sized *Chironex* stings.

Case History 1

On 9th. January 1989, "quite a hot day with little breeze", the Ambulance was called to a suspected *Chironex* sting at Causeway Lake near Yeppoon, central Queensland at 1013hrs, approximately 30 minutes after the peak of a king tide. The caller stated that there were still tentacles attached to the legs of the 8-year-old male patient.

Two bearers in an ambulance with a *Chironex* antivenom kit (comprising of 3 ampoules of CSL *Chironex fleckeri* antivenom, sterile swabs, needles, syringes, gloves and a 'sharps' container) were sent to the scene, and arrived some 10-12minutes later. They were directed by a bystander to a child who was lying, screaming with pain, on the edge of a bank next to the water. No adherent tentacles could be seen but the 'frosting' effect, characteristic of a *Chironex* sting,⁷ was visible, reflected by the sunlight on the victim's legs, even from the ambulance as it stopped several meters from the victim. This 'frosted ladder' pattern was confirmed on closer examination of the stung area. No adherent tentacles remained, but a bystander who was a nursing sister had previously thoroughly doused the area with vinegar. She stated that adherent tentacles had been present on the skin before application of the vinegar, but after treatment they had simply fallen, or been washed off. Entonox ((50% nitrous oxide, 50% oxygen) was administered to the patient and appeared to give some relief from the severe skin pain of the envenomated area.

The sting was diagnosed as that of *Chironex* from the history of adherent tentacles, the obvious multiple tentacle marks that seemed as if they had "burnt" the skin, the characteristic frosting effect, and the savage pain of the sting.

This envenomated area was again flooded with vinegar and compression bandages were applied. Three ampoules (60,000 units) of CSL *Chironex* antivenom were drawn up (a total of 10.2mls) and approximately 25 minutes after the original envenomation it was injected by the intramuscular route, equally into three separate sites (left deltoid and both quadriceps). The injection appeared to be relatively painless (probably in view of the concomitant pain of envenomation) as the injected limbs were not moved much during injection, and there was no complaint of additional pain.

Observations of the victim three minutes after the injection of the antivenom showed him to be conscious, stable, and with a clear airway; respiration was shallow at a rate of 18 per minute; blood pressure was 90/45 mm. Hg. and he had a dry pale skin. There was a brisk pupil reaction and a Glasgow coma scale rating of 15. Following the injection the patient did not obtain total pain relief from the stings, but it became tolerable.

Whilst in transit to the Hospital in the ambulance, the patient complained that the pain in his left leg was "moving". At times it was at the bottom of his leg, other times it was at the top. Entonox administration was discontinued, and 8 litres of oxygen/ minute via a facemask was commenced. However, as his pain level increased, he was changed back to Entonox, with good effect.

On arrival at the Hospital 15 minutes later, the patient was conscious, with stable observations, not distressed, and was breathing spontaneously at a rate of 36 per minute; he had good circulatory perfusion and a clear chest on auscultation; his blood pressure was 110/60mm. Hg., his pulse was regular at 118 per minute, and his temperature was 36.3°C, although he was complaining of feeling cold. He was covered with a blanket but ice packs were applied to the stung areas.⁸

Over the next 30-40 minutes the patient's blood pressure increased slightly to 120/80mm. Hg., his pulse settled to 80 beats per minute, his respiratory rate dropped to 28 per minute and his temperature remained unchanged.

On examination 1 hour 45 minutes later he had no pain, seemed more alert and there were no signs of blistering or tissue necrosis on or around the tentacle marks. He was discharged home with the instruction to return if there was any deterioration.

Case History 2

Three days following Case 1, at 0905 on the 12th. January 1989, a "hot day with little breeze and an incoming tide", the ambulance was called to Farnborough Beach, Yeppoon, central Queensland. The caller stated that a child had run from the water screaming, with tentacles adherent to his legs. The caller thought it was a box jellyfish sting.

The ambulance arrived 5 minutes later with two bearers and a *Chironex* antivenom kit. Another 8-year-old male patient who was screaming with pain was lying on the beach with his head on an adult's lap. Adherent tentacles, identified by the ambulance bearer as being those of *Chironex fleckeri*,^{6,7} were visible on both legs, and extensive stings with the characteristic ladder pattern of *Chironex fleckeri* stings were apparent on both lower legs and the back of the right hand. The width of the tentacle marks was about 3mm. Smaller stings were present on the backs of the fingers of the left hand, and a single tentacle mark was visible on the left upper thigh.

Vinegar was applied to the stung area and Entonox administered by facemask. There was no relief of pain. At this time, 15 minutes after the initial sting, the patient had no obvious breathing problem with a respiratory rate of 18 per minute; his blood pressure was 110/70mm. Hg., but he had an irregular pulse with an apparent rate of 85 per minute.

Because of the obvious major *Chironex* sting (more than 50% of one limb⁷) and the unbearable pain, 60,000 units (10.2ml) of CSL *Chironex* antivenom was divided into two equal volumes and injected by the intramuscular route into both lateral thighs. There appeared to be no pain from the injection of the antivenom.

The patient was then transferred to the local hospital where he arrived 11 minutes later, 27 minutes after the original envenomation. On arrival at the patient was still in some pain, although this had now become bearable. His blood pressure was 120/70mm. Hg.; he had a regular pulse of 110 beats per minute and a respiratory rate of 24 per minute. Twenty-one minutes after administration of the antivenom, the appearance of the tentacle marks had visibly improved, and the patient was more comfortable; the pain had also obviously decreased, although it was not completely relieved. The total length of tentacle marks was measured to be 2.1 meters. Ice packs were applied to this area, and 1 hour later the patient had little pain and seemed much improved. Ice was continued on the right calf only.

The sting area continued to be swollen and tender; the patient's observations remained stable. He was transferred from the Casualty to the ward where pethidine 50mg. was given by the intramuscular route. Further treatment was not required and the boy was discharged home the following morning pain-free, and with the sting lesions "looking better".

DISCUSSION

To the authors' knowledge, these are the first documented occasions that CSL *Chironex* antivenom has been given on the beach within minutes of a major *Chironex* sting (defined as being greater than 50% of one limb⁷). It is also the first time we are aware that the antivenom has been administered in this country by other than a medical practitioner or nursing sister.

Recent training of the Ambulance bearers in north Queensland was designed to enable them to differentiate between the numerous jellyfish stings possible on the Queensland Coast in their area. This was obviously effective as shown by the speed with which they correctly diagnosed, and then treated a sting due to *Chironex fleckeri* - despite the fact that it was rare (although not unknown⁹), in this central Queensland coastal area.

The actual intramuscular administration of the antivenom appeared to be relatively pain-free in both cases, and although it seemed to provide some analgesia for the *Chironex* sting, this was not as rapid nor as great as that reported previously following intravenous use.³ In our first patient both the pulse and respiratory rate decreased after its administration, and our second patient had an apparently irregular pulse which became regular shortly following administration.

It has previously been shown in experimental animals that intravenous verapamil has a place in the acute management of dangerous ventricular arrhythmias from *Chironex* envenomation,¹⁰ and it was recently reported that a combination of verapamil and C.S.L. antivenom was superior to either of these alone when given to mice who were challenged with a lethal dose of intravenous *Chironex* venom.¹¹ On these grounds we would suggest that I.V. verapamil be administered to victims of *Chironex* envenomation in whom cardiac stability cannot be achieved with CSL *Chironex* antivenom alone.

In our first case the characteristic 'frosted' ladder pattern was easily seen, even from a distance, making the diagnosis of a *Chironex* sting more certain.⁷ There were no tentacle marks present on the palms of the hands of the second victim, although the backs of both hands were stung - especially the right hand. Even in children the thick keratin of the palms of the hands prevents the fine thread tubes of the nematocysts (stinging cells) penetrating deep enough to cause pain or an inflammatory response,⁶ whereas the thinner skin on the backs of the hands is easily stung. This pattern of sting distribution is characteristic of *Chironex* stings in children as they tend to stand where stung, trying to pull off adherent tentacles with their hands, thus making the sting inadvertently worse. When adults are stung they usually retreat very quickly from contact with the tentacles.

Chironex has a specialized nematocyst, which acts like a 'grappling iron',¹² helping to anchor the tentacle to its prey, which is usually a struggling fish or prawn, but may be an unfortunate human. For this reason, with human *Chironex* stings, the tentacles are usually torn off the jellyfish and remain adherent to the victim. Whilst the tentacles remain adherent, and particularly if they are rubbed, more and more batteries of nematocysts are brought into contact with the skin and progressively discharge. This increases the venom dose injected. For this reason, liberal dousing of any remaining adherent tentacles with vinegar (4-6% acetic acid) for a minimum of 30 seconds is an important first aid measure, as it prevents further envenomation by dehydrating the adherent tentacles and inactivating any unfired nematocysts. This prevents further stinging.¹³ The tentacles fall off harmlessly. Contrary to some persisting misconceptions, the vinegar has no effect on the pain of envenomation.

These cases lead further support to the belief that the existing CSL *Chironex* antivenom works reasonably well clinically, although continued immunological¹⁴ and toxicological⁴ studies can be expected to produce significant advances in its safety and specificity. Further, the training of ambulance bearers to diagnose and treat major *Chironex* stings is of obvious benefit to the community, having the potential to reduce morbidity, and possibly mortality, from these explosive envenomations.

Warning Beach Signs

Obviously prevention is better than cure and knowledge of the area and times of the year that stings may occur is essential. At present newly designed signs have been suggested to the northern Australian coastal Shire Councils. The design has also been updated to include a small box attached to the poles bearing the warning signs. In these boxes vinegar is stored for emergency use, and warning pamphlets can be placed for distribution. On one of the three sides of the box is a translation of instructions into other languages, notably Japanese; the second side will contain a standard resuscitation flow chart, and the third side will contain patrol details by the nearest Surf Life Saving club.

It is hoped that signs of this nature will not only give factual advice, but also provide the materials and information to save a life, should a major sting occur before antivenom can be brought by trained members of the Queensland Ambulance. The Livingstone Shire, where the stings reported here occurred has agreed to erect such signs, and all other coastal Shire Councils are being lobbied to make the design analogous.

TREATMENT OF *CHIRONEX* STINGS: -

First Aid ⁷

1. Retrieve the victim from the water if necessary (children) or restrain if necessary (adults).
2. Send others for the ambulance / medical help and the antivenom.
3. Assess the conscious state and treat airway, breathing and circulation if necessary.
4. Liberally pour vinegar over the stung area for a minimum of 30 seconds to inactivate remaining stinging cells on any adherent tentacles.
5. Apply compression bandages to major stings (one covering an area greater than 50% of one limb or one causing impairment of conscious state).
6. Remain with the victim, treating with cardio-pulmonary resuscitation if necessary.

Hostpital Treatment

1. Continue treating A.B.C. if necessary. Add oxygen if available.
2. Secure an I.V. line with a crystalloid solution running, and give a minimum of one ampoule (20,000 units) slowly I.V. if none has been given. Up to 3 ampoules may be used if the sting is severe, or if the response to less antivenom is not clinically sufficient.
3. Monitor breathing and circulation, and give verapamil 5mg. by the intra-venous route for any heart abnormality (arrhythmia and/or hypotension), which persists despite antivenom therapy.
4. I.V. analgesia (i.e. 1-2mg/kilo of pethidine via the intra-venous route - 50mg. for the adult patient) whenever necessary in conscious patients.

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