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Australian taipan (*Oxyuranus* spp.) envenoming: clinical effects and potential benefits of early antivenom therapy – Australian Snakebite Project (ASP-25)

Context: Taipans (*Oyxuranus spp.*) are medically important venomous snakes from Australia and Papua New Guinea. The objective of this study was to describe taipan envenoming in Australian and its response to antivenom.

Methods: Confirmed taipan bites were recruited from the Australian Snakebite Project. Data were collected prospectively on all snakebites, including patient demographics, bite circumstances, clinical effects, laboratory results, complications and treatment. Blood samples were taken and analysed by venom specific immunoassay to confirm snake species and measure venom concentration pre- and post-antivenom.

Results: There were 40 confirmed taipan bites: median age 41 years (2 to 85y), 34 were males and 21 were snake handlers. Systemic envenoming occurred in 33 patients with neurotoxicity (26), complete venom induced consumptive coagulopathy (VICC) (16), partial VICC (15), acute kidney injury (13), myotoxicity (11) and thrombocytopenia (7). Venom allergy occurred in seven patients, three of which had no evidence of envenoming and one died. Antivenom was given to 34 patients with a median initial dose of one vial (range: 1 to 4), and a median total dose of two vials (range 1 to 9). A greater total antivenom dose was associated with VICC, neurotoxicity and acute kidney injury. Early antivenom administration was associated with a decreased frequency of neurotoxicity, acute kidney injury, myotoxicity and intubation. There was a shorter median time to discharge of 51h (19 to 432h) in patients given antivenom <4h post-bite, compared to 175h (27 to 1104h) in those given antivenom >4h. Median peak venom concentration in 25 patients with systemic envenoming and a sample available

was 8.4ng/L (1 to 3212ng/L). No venom was detected in post-antivenom samples, including 20 patients given one vial initially and five patients bitten by inland taipans.

Discussion: Australian taipan envenoming is characterised by neurotoxicity, myotoxicity, coagulopathy, acute kidney injury and thrombocytopenia. One vial of antivenom binds all measurable venom and early antivenom was associated with a favourable outcome.

Keywords: Australia; snakebite; taipan; envenoming; antivenom.

Introduction

Taipans (*Oxyuranus spp.)* are highly venomous elapids that inhabit Australia and Papua New Guinea. Long revered for the lethality of their venom in mice [1], three distinct species of taipan are now recognised; the coastal taipan (O*xyuranus scutellatus),* the inland taipan (O*xyuranus microlepidotus)* and the central ranges taipan (O*xyuranus temporalis).* The snakes are distributed along the northern coastline of Australia and southern coast of Papua New Guinea (*O. scutellatus),* semi-arid central east Australia *(O. microlepidodus)* and the western desert (*O. temporalis*) [2].

Most reports of taipan envenoming come from Papua New Guinea, with a small number of cases from Australia [3-5]. In many they are unconfirmed cases, with only one previous study reporting venom concentrations, but limited clinical information [5]. Clinical effects that have been described include a descending flaccid paralysis that may require intubation and mechanical ventilation, venom induced consumption coagulopathy (VICC), myotoxicity, early cardiovascular collapse and an acute kidney injury associated with microangiopathic haemolysis [3-9]. There is less information on the frequency of each of these clinical syndromes or their severity, particularly in comparison to other Australian elapids.

Seqirus Ltd taipan antivenom is currently the only specific treatment for taipan envenoming in Australia, which is also frequently used in Papua New Guinea. It is raised against Australian coastal taipan (*Oxyuranus scutellatus*) venom but is recommended and used in cases of suspected taipan envenoming from any taipan species [10, 11]. *In vitro* studies have shown efficacy of antivenom at preventing neurotoxicity from the venoms of Australian and Papua New Guinean coastal taipans, as well as the inland taipan, when venom and antivenom are pre-mixed [12]. Clinical studies in Papua New Guinea by Trevett *et al* demonstrate a favourable outcome in patients treated with early antivenom, based on a lower

rate of endotracheal intubation and more rapid recovery from neurotoxicity [13]. This is because the neurotoxicity from taipan venom appears to be mainly presynaptic[14], and therefore irreversible.

Dosing guidelines in the form of the approved Australian product information and the CSL antivenom handbook provide somewhat unclear instruction on antivenom therapy, with doses of one vial, three vials and up to eight vials recommended based upon the presence of mild envenoming or ‘severe defibrination’ and a confusing and potentially harmful guide that ‘children may become critically ill and may need more antivenom’ [10, 11]. Other clinical guidelines recommend a single vial for treatment which is not based on arbitrary measures of severity or subjective responses to therapy [15, 16]. A clear understanding of the frequency and severity of different clinical syndromes in taipan envenoming and their response to antivenom therapy is required.

The aims of this study were to better describe the clinical effects resulting from confirmed taipan bites in Australia and the response of taipan envenoming to antivenom treatment.

Methods

This study was a prospective cohort study of patients with definite taipan (*Oxyuranus spp.*) bites recruited to the Australian Snakebite Project (ASP). The Australia snakebite project is a large multicentre prospective observational study recruiting patients with suspected snakebite from all over Australia. The study has pre-defined aims to investigate the clinical effects and treatment of snake envenoming in Australia, including the use, dose and effectiveness of antivenom therapy. The collection of clinical and laboratory data, and venom enzyme immunoassay methods have been described previously [5, 17, 18]. The study has recruited over 1800 patients to date from over 100 hospitals Australia-wide and from the Australian Poisons Information Centre network. Human research ethics committee approval for the study has been obtained from the 19 human research ethics committees responsible for the facilities involved. All patients recruited to the study gave informed consent.

Data is collected from all suspected snakebites recruited to the Australian snakebite project including patient demographics, bite circumstances, clinical effects of snake envenoming, hospital laboratory results, complications and treatment. Faxed datasheets are provided to the treating hospital after the patients have consented to the study. These are filled out by the treating team and then faxed back to the study coordinators. Any missing data are obtained from the hospital medical records. All data are entered into a relational database (Microsoft Access™) by a trained research assistant and then reviewed and checked by the chief investigator. Additional blood samples are collected from each patient on admission, after antivenom and then with every additional clinical blood collection (recommended 6h, 12h, 18h, 24h and daily thereafter). Blood is centrifuged and the serum aliquoted and frozen for subsequent analysis according to a faxed protocol to the hospital laboratory.

Previously defined clinical syndromes were used to describe clinical effects (Supplementary Table 1) [19]. VICC was defined as undetectable fibrinogen and/or a raised D-Dimer (at least 10x upper limit of normal or > 2.5mg/L) and an international normalised ratio (INR) > 3. Partial VICC was defined as low but detectable fibrinogen/elevated D-Dimer and a maximum INR < 3. Systemic hypersensitivity reactions to antivenom administration were defined as anaphylaxis per NIAID-FAAN consensus criteria and graded according to grading system of Brown [20, 21].

A venom specific enzyme immunoassay is used to identify venom type (and species) and quantify venom present in pre-antivenom samples. The assay measures only the venom antigens that generate specific antibodies, but the term venom concentrations is used throughout. Venom measurement in post-antivenom samples is used to determine if sufficient antivenom has been administered to bind all free venom. If no pre-antivenom samples are available, the post-antivenom samples are subjected to a previously described heat dissociation treatment and then venom is measured with the enzyme immunoassay [22].

For this study the Australian snakebite project database was searched from May 2003 to April 2016 for potential cases of taipan bites. Potential cases were defined by either expert identification of the snake in question, a positive Seqirus snake venom detection kit (sVDK) result for taipan, or snake envenoming of unknown type with suggestive clinical features in a region within the known geographic distribution of the taipan species. Confirmed cases were then defined as those with taipan venom antigen detected on venom specific enzyme immunoassay or those with expert identification of the snake. An expert was defined as someone who either owned the snake, and therefore had a licence for venomous snakes, or someone working professionally with snakes at a museum or zoo. Brief clinical details of 17 of the patients in the cohort have previously been published in a study which describes the development of the venom specific enzyme immunoassay [5].

Standard curves for the venom assays were fitted by linear and non-linear regression. Normality of the data were assessed by the Kolmogorov-Smirnov test and the Shapiro-Wilk normality test. Continuous outcomes are reported with medians, interquartile ranges (IQR) and ranges. All analyses and graphics were carried out in GraphPad Prism version 6.07 for Windows, GraphPad Software, San Diego California USA, www.graphpad.com.

Results

There were 44 potential taipan bites that were identified from the Australian snakebite project database. Of these, four were excluded because they did not have expert identification of the snake in question or taipan venom antigen was not detected by immunoassay in pre- or post-antivenom samples. Details of the 40 confirmed cases of taipan bite are contained in table 1.

Patient demographics and bite circumstances

The median patient age was 41 years (IQR: 24 to 53; Range 2 to 85 y); 34 of the patients were male (85%). Twenty four patients (60%) were interfering with the snake at the time of the bite and 21 of these patients were snake handlers (53%).

There was an expert identification of the snake in 24 cases; coastal taipan (17) and inland taipan (7). All known inland taipan bites occurred from captive snakes. Patients were bitten by a snake in the wild in 17 cases, 16 in Australia and one in Papua New Guinea. All 16 of the Australian cases involving wild snakes occurred in Queensland, the furthest south being Gympie (Figure 1). Patients were bitten by captive snakes in 23 cases, 21 of which were snake handlers, and two patients who were at the dwelling of a snake handler.

Clinical effects

Only one patient had local bite site effects, limited to mild pain and swelling at the bite site. The remainder only had fang marks with no other obvious local effects. Seven patients did not have systemic envenoming, but three of these patients had evidence of venom allergy (see below).

Systemic envenoming was present in 33 (83%) of the patients with taipan bites. Systemic envenoming included VICC in 31 patients (94%), neurotoxicity in 26 (79%), myotoxicity in 11 (33%), acute kidney injury in 13 (40%) and non-specific systemic symptoms in 28 (85%)

(Table 2 and Supplementary Figure 1). There were no cases of early cardiac collapse, seizures or death from envenoming (except in the patient with fatal anaphylaxis). Four patients had systemic envenoming and venom allergy.

Of the 33 systemically envenomed patients complete VICC occurred in 16 patients (48%), partial VICC in 15 patients (45%) and two envenomed patients did not develop coagulopathy (Table 2). The median time for the INR to decrease to less than 2.0 in patients with VICC was 12.3 hours (IQR: 12.3 to 18.7 h; range 8.5 to 42 h). One patient developed life-threatening bleeding. The patient had a bronchoscopy approximately 12 hours after intubation resulting in a major pulmonary bleed from a lesion in the left lung resulting in aspiration of a large amount of blood. Coagulation results at that time were; PT 18 seconds, aPTT 48 s, INR 1.6, fibrinogen 1.6 g/L and D-Dimer 2.08 mg/L.

Neurotoxicity was characterised by a flaccid descending paralysis and occurred in 26 patients (79%) (Table 2). Features included ptosis (19), diplopia (19), ophthalmoplegia (16), bulbar weakness (8), intercostal weakness (4) and limb weakness (7). Of the patients with neurotoxicity it was defined as severe in 12 cases based on bulbar or respiratory muscle paralysis, or the requirement for endotracheal intubation and mechanical ventilation. Endotracheal intubation and ventilation was required in nine patients.

Myotoxicity occurred in 11 patients, characterised by elevated CK and myalgia in three patients and isolated CK elevation in eight patients (Table 2). Of the 11 patients with myotoxicity, the median peak CK was 3430 U/L (IQR 1655 to 7480; range 1170 to 15300 U/L), two patients had a peak CK >10000 U/L (11495 and 15300 U/L), median time to peak CK was 26 hours (IQR 11 to 36; range: 8 to 78 h). Supplementary Figure 2 shows serial CK measurements in the 11 patients with myotoxicity. A further five patients had an elevated peak CK between 500 to 1000 U/L.

Acute kidney injury occurred in 13 patients (Table 2). Median peak serum creatinine concentration in these 13 patients was 366 µmol/L (IQR 194 to 485; range: 172 to 922 µmol/L). Haemodialysis was required for three of these patients. Per the RIFLE criteria patients were staged as having; risk (2), injury (1), failure (9) and loss of function (1).

Thrombocytopenia occurred in seven envenomed patients. Median minimum platelet count was 41 x 10^9 (IQR 41 to 96; range: 18 to 122 x 10^9) in these patients. A reduction in haemoglobin concentration occurred in all seven of these patients, with a median fall in haemoglobin concentration of 68 g/L (IQR 68 to 80; range 28 to 92 g/L). All seven of these patients developed acute kidney injury and six of the seven had a blood film with red cell fragmentation, schistocytes or spherocytes consistent with microangiopathic haemolytic anaemia (Table 2).

Venom allergy occurred in seven patients, three of which had no other evidence of systemic envenoming (Table 3). All seven of the patients were snake handlers who had previously handled taipans. The clinical effects occurred prior to the administration of antivenom and were characterised by a pruritic and urticarial rash, facial swelling, limb swelling and in two cases cardiovascular collapse and loss of cardiac output. One patient, who had no evidence of systemic envenoming and severe anaphylaxis, was unable to be resuscitated and died. This patient was a snake handler with previous bites by a pet coastal taipan. The patient had a history of diabetes, leukaemia requiring bone marrow transplantation and bronchiolitis obliterans syndrome secondary to bone marrow transplantation. They presented to hospital asymptomatic with a pressure bandage and immobilisation. Their initial pathology tests were normal so the pressure bandage was released. Approximately 20 minutes after bandage release the patient was witnessed to have seizure activity, and promptly had a ventricular fibrillation cardiac arrest with loss of cardiac

output. The patient initially had return of spontaneous circulation after defibrillation and was given two vials of antivenom. The patient subsequently had a bradycardic arrest and died.

A bite site sVDK was done in 21 of the envenomed patients; 17 were found to be positive in the taipan well, three were negative and one was positive in the brown snake well. Urine sVDK was performed in nine patients; five were positive for taipan, three were negative and one was positive for brown snake (a different patient to the one that tested positive to brown at the bite site).

Taipan Species

There were 24 (60%) of cases where the species of the snake was directly identified by an expert. There did not appear to be any difference between coastal and inland taipan species in clinical syndromes, severity and treatment (Supplementary Table 2).

Treatment

Seqirus Ltd. snake antivenom was given to 34 patients, 32 of which had evidence of envenoming and two patients who had venom allergy only. Several types of antivenom were used for the initial dose; taipan antivenom (17), polyvalent antivenom (16) and brown snake antivenom (1). Median initial dose of antivenom was one vial (range 1 to 4 vials). Median total dose of antivenom was two vials (range 1 to 9 vials). A greater total dose of antivenom was associated with VICC (median dose of 2 vs. 0 vials), neurotoxicity (median dose of 2 vs. 1 vial) and acute kidney injury (median dose of 2 vs. 1 vial) (Supp Fig 3). A similar total antivenom dose was given for patients with myotoxicity and those intubated compared to those not (Supp Fig 3).

Median time to first dose of antivenom post-bite was 3.6 hours (IQR: 2 to 5.5 h; range: 0.2 to 35.5 h). Differences in the proportion of patients developing particular clinical outcomes or complications based on time to first dose of antivenom are shown in Supplementary Table 3.

Early administration of antivenom was associated with a decreased frequency of neurotoxicity, requirement for intubation, myotoxicity and acute kidney injury if given early within 2 h and within 6 h (Figure 2). Early administration of antivenom was not associated with a decreased incidence of VICC.

Seven of the patients receiving antivenom therapy developed immediate hypersensitivity reactions and four of these were snake handlers One had been bitten by brown snakes twice previously and not received antivenom treatment. Another had previously received antivenom and developed a hypersensivity reaction. Three had mild reactions limited to skin reactions, one had a moderate reaction with chest tightness, and the remaining three had severe reactions with altered level of consciousness, hypotension and in one case a cardiac arrest. One patient re-presented to hospital six days after antivenom therapy with features consistent with serum sickness (nausea, abdominal pain, headache, corzyal symptoms and rash).

Factor replacement was given in two patients with abnormal INR (4.8 and 2.0), but neither had clinical evidence of bleeding at the time.

Time to hospital discharge

The median time to discharge in envenomed patients was 82 hours (IQR: 41 to 199 h; range: 19 to 1104 h). Patients who received antivenom less than four hours post-bite had a shorter length of hospital stay with a median time to discharge of 51 h (IQR 25 to 121 h; range 19 to 432 h), compared with those given antivenom greater than four hours post-bite of 175 h (IQR 65 to 308 h, range 27 to 1104 h; Figure 3). Figure 3 shows the time to discharge based on the clinical syndromes, interventions and time to antivenom.

Venom specific enzyme immunoassay

Venom assays were performed on pre-antivenom samples that were available for 28 of the

patients. No venom antigen was detected in three of the 28 samples. All three of these patients had no evidence of systemic envenoming, with one patient having features of venom allergy. The four other patients without evidence of systemic envenoming did not have samples available for testing. Two cases in which the species of snake was unknown were identified as taipans using the heat dissociation method in post-antivenom samples.

Of the remaining 25 samples the median peak venom concentration was 8.4 ng/L (IQR: 3 to 30 ng/L; range: 1 to 3212 ng/L). All patients with detectable venom antigens had systemic envenoming. There was no association between venom concentration and symptom severity. No venom was detectable in post-antivenom samples that were available for 27 patients, including 20 that had only one vial of antivenom as the initial dose, and five patients where the snake was known to be an inland taipan (Supplementary Table 4). One patient had half a vial and one patient that received one vial of brown snake antivenom also had undetectable venom post-antivenom.

Discussion

This study describes the spectrum of envenoming syndromes that occurs following Australian taipan envenoming, the most important of which is neurotoxicity. Whilst neurotoxicity, myotoxicity and coagulopathy have been described in Australian and Papua New Guinean taipan envenoming prior to this study[5], the extent of microangiopathic haemolytic anaemia and acute kidney injury, sometimes severe, was not well recognised. These findings are largely consistent with a number of *in vitro* studies of taipan venom which have identified toxins including pre- and post- synaptic neurotoxins [23, 24], a procoagulant prothrombin activator [25] and myotoxins [26].

While the most important and life preserving treatment in the management of taipan envenoming is arguably endotracheal intubation and supportive care in a modern intensive care unit, this study highlights the potential benefits of early antivenom administration. The use of early antivenom (between 2 and 6 h post-bite) was associated with varying decreases in different envenoming syndromes and the need for interventions. There was an association between antivenom being administered within 2 h of the bite, and a reduced frequency of neurotoxicity. Antivenom given within 6 h of the bite was associated with a decrease in the number of patients that required intubation. There was a less clear association between time to antivenom and a decreasing proportion of patients developing myotoxicity (Figure 2). There was also an association between larger doses of antivenom and clinical syndromes (Supp Fig 3) which is most likely due to the fact that antivenom was given to patients with more severe clinical effects and the effects do not immediately reverse.

A previous study of taipan envenoming in Papua New Guinea also found a reduced frequency of patients requiring intubation if antivenom was administered within 4 h[13]. A recent study of krait envenoming, which also causes presynaptic neurotoxicity, did not find an association between time of antivenom administration and neurotoxicity. All patients with

severe envenoming progressed to intubation despite antivenom given a median of 3.5 h post-bite[27].

In contrast to neurotoxicity, the proportion of patients developing VICC did not appear to change with the timing to antivenom. This most likely reflecting the fact that VICC develops very rapidly within one hour post-bite [28]. In addition, the presence of VICC is often the trigger for clinicians to administer antivenom, explaining the association between higher doses and VICC (Supp Fig 3).

In addition to the potential clinical benefits of early antivenom, we found that early antivenom was associated with a reduced length of hospital stay (Figure 3). It therefore appears that the timely administration of antivenom may benefit the patient by preventing morbidity and decreases the burden on health service resources. The use of early antivenom may also translate to a potential reduction in the need to transfer patients from smaller rural facilities where patients with taipan envenoming often present.

As well as clinical evidence of potential benefit, Seqirus Taipan and Polyvalent Antivenom efficacy was confirmed by our venom specific immunoassays. The lack of measureable venom in all available post-antivenom serum samples demonstrates successful binding of circulating venom antigens, including some patients with venom concentrations many magnitudes higher than the median, and those with severe envenoming (Supp Fig 4). Despite the fact that Seqirus Taipan antivenom is raised against the venom of the coastal taipan, antivenom was effective at binding all detectable circulating venom in the five cases where post antivenom samples were available from patients who had been bitten by an inland taipan. The large proportion of patients in the study who had received only one vial of antivenom before these samples were taken in which no venom was detected, supports giving one vial of antivenom as a standard dose for taipan envenoming. Interestingly, the patient who was initially given brown snake antivenom also had successful binding of all detectable

circulating venom antigens. This provides further evidence of the adequacy of one vial of taipan antivenom for the treatment of taipan envenoming given the small amount of taipan venom antibodies present in brown snake antivenom. However, the low volume monovalent antivenoms such as brown snake and tiger snake antivenom may not contain enough taipan antibodies to routinely treat cases [29, 30].

The adverse reaction rate from antivenom given in taipan envenoming may be a limiting factor in its routine early use in suspected taipan envenoming. The reaction rate of 21% in this study is consistent with the known overall reaction rate to Australian antivenom of approximately 25% [31]. Whilst most reactions were easily managed, nearly 10% of patients given antivenom developed life-threatening anaphylaxis. Careful consideration should be given to the capacity of hospitals to manage such reactions before antivenom is recommended, particularly for smaller or remote hospitals.

There were significant differences in this study between the known geographic distribution of taipans in Australia and the location of taipan bites in the wild. All wild cases in this study occurred in Queensland despite the presence of taipans in Western Australia, Northern Territory and northern New South Wales [2]. In addition all wild cases were identified coastal taipans. Most of the lack of case representation from these other areas can be explained by population and human activity, with most areas of the taipan's distribution being sparsely populated. However, this is not the case in northern New South Wales which is a reasonably densely populated area near the Queensland border and an area where large numbers of envenomed patients with bites from other snakes are recruited to the Australian snakebite project [29]. With geographical location being an important factor in the development of local snakebite investigation and management plan development, this study highlights that a distribution of snakebite cases rather than geographic distribution of the snake itself, is a more useful factor to consider in local policy implementation.

The Seqirus sVDK is a frequently used investigative test in Australian snakebite and used in a high proportion of cases in this study. Whilst being accurate in most cases, the result in the brown snake well in two patients with conclusive taipan envenoming is concerning, with one of the two patients being given brown snake antivenom inappropriately for their initial management. In this instance, the amount of taipan venom antibodies present in the brown snake antivenom appears to have been sufficient to bind circulating venom antigens, but this may not always be the case in all batches of antivenom or for all taipan bites.

Despite the fact that this study represents the largest cohort of Australian taipan envenoming cases published to date, the small number of confirmed cases that occur and are recruited, are a limitation of this type of study. In particular, the associations between early antivenom and more favourable outcomes may be chance findings. In addition, uncommon venom effects may only occur in larger sample sizes so it is not possible to make definitive conclusions on envenoming syndromes of antivenom treatment.

The observational nature of the study is also a limitation, with antivenom timing and dose decided by the treating physician. This limits the ability to definitively determine the effect of antivenom and early versus late antivenom. However, it could be unethical to randomly allocate patients to early or late treatment, or no antivenom treatment. Some of the envenoming syndromes described in this study, such as microangiopathic haemolytic anaemia, rely on laboratory tests such as blood film microscopy. As this test is not a routine protocol blood test for the management of a patients with snakebite, the proportion of patients developing some of these syndromes may be under reported.

Taipan envenoming is a rare healthcare problem in Australia that carries with it significant morbidity, mortality, and associated hospital stay with resource allocation. It is a health problem that disproportionately affects remote and tropical coastal areas of Australia, particularly Queensland. Early antivenom is associated with a reduction in venom toxicity,

requirement for invasive therapy and length of hospital stay. Careful consideration, in areas where taipan bite is known to occur, should be given to administering taipan antivenom as early as possible when patients present with symptoms of envenoming. This needs to be weighed against the risk of hypersensitivity reaction to antivenom and the clinician's ability to manage such a reaction.

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Table 1. Demographics and bite characteristics of 40 patients with confirmed taipan bites

Age [yr] median (IQR, range)	41 (24-53; 2-85)	
Sex (Male)	34	85%
Bite site		
Upper limb	24	60%
Lower limb	14	35%
Torso	1	2.5%
Unknown	1	2.5%
Bite circumstances		
Intentional interference with snake	24	60%
Walking in bush	8	20%
Walking outside in built up area	4	10%
Inside	2	5%
On beach	1	2.5%
Gardening	1	2.5%
Captive snake	23	58%
Snake handler	21	53%
Snake ID		
Coastal taipan	17	43%
Inland taipan	7	18%
PBI in place on hospital arrival	36	90%
Under influence of alcohol	1	2.5%
Antivenom given	34	85%

PBI – Pressure bandage with immobilisation

Table 2. Summary of effects of systemic envenoming in 33 patients with taipan envenoming

Envenomed patients	33	
Venom induced consumptive coagulopathy		
Partial	15	45%
Complete	16	48%
Neurotoxicity	26	79%
Severe	12	36%
Myotoxicity		
Mild	9	27%
Severe	2	6%
Thrombocytopenia	7	21%
MAHA	6	18%
Acute kidney injury	13	39%
Risk	2	6%
Injury	1	3%
Failure	9	27%
Loss of function	1	3%
Non-specific systemic symptoms	28	85%
Vomiting	20	61%
Headache	18	55%
Abdominal pain	10	30%
Generalised diaphoresis	10	30%
Diarrhoea	3	9%
Leukocytosis	29	88%

Table 3. Clinical summary of patients with venom and antivenom allergy

Age/Sex	**Snake handler**	**Cause of allergy**	**AV type/dose (vials)**	**Features of Allergy**	**Other Evidence of envenoming**
62M	Yes	Venom and antivenom*	Polyvalent (2)	Urticaria, nausea, wheeze, chest tightness, hypotension, cardiac arrest	Yes
34M	Yes	Venom	Taipan (1)	Nausea and vomiting	No
23M	Yes	Venom	Polyvalent (1)	Pruritic rash, facial flushing, hypertension	Yes
50M	Yes	Venom	Taipan (1)	Urticarial rash	Yes
22M	Yes	Venom	Polyvalent (1)	Bilateral forearm and lip swelling, facial pallor, peripheral vasodilation	Yes
33M	Yes	Venom	None given	Urticarial rash, lip and eyelid swelling	No
52M	Yes	Venom	Taipan (2)	Cardiac arrest and death	No
39M	No	Antivenom	Taipan (1)	Urticaria	Yes
38M	No	Antivenom	Taipan (4)	Pruritic rash	Yes

45M	Yes	Antivenom	Polyvalent (2)	Urticaria, erythema	Yes
21M	Yes	Antivenom	Taipan (1)	Urticaria, angioedema, throat tightness, altered level of consciousness, diaphoresis	Yes
43M	Yes	Antivenom	Taipan (1)	Urticaria, angioedema, chest tightness, pruritis	Yes
43M	No	Antivenom	Taipan (1)	Urticaria, angioedema, hypotension, pruritis, tachycardia, dry throat and mouth	Yes

*This patient presented to hospital with severe anaphylaxis and was resuscitated and given antivenom, and then developed a further rash and anaphylaxis