Emergency Medicine (2000) **12**, 285–294

Emergency Medicine

TROPICAL EMERGENCY MEDICINE SERIES

Snakebite in tropical Australia, Papua New Guinea and Irian Jaya

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Abstract

While snakebite numbers are decreasing in temperate Australia, snakebite remains an important cause of morbidity in tropical Australia and of mortality in Papua New Guinea and Irian Jaya. The Australasian elapid snakes have complex mixtures of venom components, with distinct clinical syndromes defined for the potentially lethal species. Life-threatening scenarios are progressive neuromuscular paralysis with taipan (*Oxyuranus* spp.) and death adder (*Acanthophis* spp.) envenoming and early hypotensive collapse and severe coagulopathy with fibrinogen depletion and major bleeding (especially intracranial haemorrhage) with brown snake (*Pseudonaja* spp.) bites. The 'brown snake paradox' is that textilotoxin is one of the most potent neurotoxins known, yet neurotoxicity is uncommon in brown snake envenoming. Prospective studies using assays of serial patient serum venom levels will provide better evidence for efficacy or otherwise of various first-aid methods used and help define appropriate doses of antivenoms for specific clinical scenarios. Financial and distribution constraints have resulted in antivenoms being unavailable for use in most regions of Papua New Guinea and Irian Jaya.

Key words: *Australia, Papua New Guinea, snakebites, snake venoms.*

Epidemiology

It is thought that the incidence of snakebite in Australia is falling, with an estimated 1000–3000 snakebites each year.[1,2] There has also been a dramatic fall in the incidence of antivenom use.[3] Reasons for the falling incidence of snakebite in Australia include both decreasing numbers of venomous and other snakes and decreasing human exposure to snakes because of lifestyle and demographic changes.[3] Proposed factors affecting snake populations include increasing urban development, especially in coastal regions, the spread of the introduced cane toad (*Bufo marinus*) whose poisonous secretions are thought to be in part responsible for the demise of frog-eating snakes, such as the red-bellied black snake in Queensland and the Papuan black snake in Papua New Guinea, and increasing use of fertilizers and pesticides in rural regions.[3–5] Cane toads had crossed from Queensland to the Northern Territory by December 1989 but have yet to become established in the capital city, Darwin.

Limited data show that, within Australia, snakebite incidence is highest in the less populated tropical northern regions, but is still far below that of Papua New Guinea. A 1940 report showed more snakebite

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admissions in tropical than in subtropical coastal Queensland, despite the tropical region having less than one-third the subtropical population.[6] In children from the populated area of south-east Queensland, the incidence of snakebite fell from 7.1 per 100 000 children annually in 1971–1975,[7] to 2.0–3.5 per 100 000 in 1978–1987.[8] This compares with an annual incidence in the 1990s in children in the 'top end' of the Northern Territory of 18.3 per 100 000 (BJ Currie, unpubl. data., 1998). The recent incidence of envenoming in Northern Territory children of 4.0 per 100 000 (BJ Currie, unpubl. data., 1998) contrasts with 0.2 per 100 000 in the later Queensland study[8] and 17.6 per 100 000 reported for children from Port Moresby, Papua New Guinea.[5] Within Papua New Guinea the incidence of snakebite overall has been reported to be highest in the Papuan coastal Kairuku subprovince, which is north of Port Moresby, with a rate of 526 per 100 000.[9] The extremely high rate of snakebite in parts of Papua New Guinea approach those of areas of West Africa and French Guinea, which are the highest rates documented in the world.[10,11]

In temperate Australia, snakebite is commonest in January and is very unusual in winter months, reflecting snake activity and hibernation.[12] As in Papua New Guinea,[5,9] snakes in the tropical north of Australia are active all year,[4] so envenoming can occur in any month, although it is less common in the cooler months of June to August (BJ Currie, unpubl. data., 1998).

Mortality and antivenom availability

Last century, patient death from snakebite was a more common event for doctors in north Queensland than in southern Australia. In 1893, Byrne reported four deaths in Mackay over 18 months and in 1895 Macdonald reported there were six deaths from 60 cases he had treated at Ingham.[13] In a 5.5 year period from 1950 there were 75 admissions with suspected snakebite to Cairns Base Hospital, with five patients developing neuromuscular paralysis, probably all from taipan envenoming.[14] The three patients who required placement in an iron lung all died.

Deaths from snakebite in tropical Australia are now rare, with no confirmed death in the Northern Territory for over 10 years, despite the Northern Territory having the highest incidence of snakebite within Australia. In contrast, yearly snakebite fatalities in Papua New Guinea as high as 34 have been reported.[5,9]

Over 30 months from January 1987, 56/189 patients (30%) admitted to Port Moresby General Hospital with snakebite required intubation and ventilation for progressive neuromuscular paralysis and 12 (6%) died.[15] The vast majority of admissions were due to taipan envenoming. Of the 56 ventilated patients, 29 (52%) had evidence of aspiration pneumonitis (BJ Currie, unpubl. data., 1989). In taipan envenoming, the critical need for meticulous attention to posture and clearing of oral secretions and airway protection with timely intubation was emphasized in subsequent studies.[9,16]

In 1989, it was estimated that with substantial increases in antivenom costs, Papua New Guinea's expenditure on antivenoms could have been almost 5% of its entire drug budget.[17] The increasing cost of antivenoms, with one ampoule of Commonwealth Serum Laboratories polyvalent antivenom currently approximately $A1300, has necessitated decisions to not stock antivenom in most rural locations in Papua New Guinea. At times, even Port Moresby General Hospital, the national referral centre, has had no antivenom available. Reports from Irian Jaya also confirm a lack of antivenom (related to both cost and distribution difficulties).[17,18]

The venomous snakes of the region

All potentially lethal terrestrial snakes in Australia, Papua New Guinea and Irian Jaya belong to the family Elapidae. Of note, tiger snakes (*Notechis* spp.) are absent from tropical regions. In addition, a number of potentially lethal sea snakes (family Hydrophiidae) are present in the surrounding seas and occasionally inland up tidal rivers. It is important for clinicians to be aware of which venomous snakes are present in their catchment area. Regional distribution of the potentially lethal terrestrial snakes is shown, by decreasing frequency of envenoming for each region (Table 1). Deaths have been documented for each of the species in Table 1. More detailed distribution maps for all snake species are provided in herpetological reference texts.[19–21]

Central mountain ranges separate Papua New Guinea and its herpetofauna into southern (Papua) and northern (New Guinea) regions. It is to be expected that there is a continuous distribution of the Australasian elapids between Irian Jaya and Papua New Guinea, with the central mountain ranges extending into Irian Jaya being more of a barrier than the political border. Hence,

Papuan taipans and Papuan black snakes appear limited to the Papuan side of Papua New Guinea and southern Irian Jaya, while death adders and the New Guinea small-eyed snake occur throughout the island. Irian Jaya was formerly known as west Papua and has recently been re-named Papua by Indonesia.

In addition to the snakes listed in Table 1, there are many other species of less venomous elapids in the region and several species in the black (*Pseudechis*) and brown (*Pseudonaja*) snake genera which may not have been associated with fatal human envenoming. These include the red-bellied black snake (*Pseudechis porphyriacus*) and Collett's black snake (*Pseudechis colletti*) in north Queensland and *Pseudonaja guttata, Pseudonaja ingrami* and *Pseudonaja modesta* in various locations across northern and central Australia.[19]

Whip snakes (*Demansia* spp.) are distributed across tropical Australia and the Papuan side of Papua New Guinea. They are fast and aggressive snakes, easily mistaken for taipans, brown snakes or Papuan black snakes.[21] In the top end of the Northern Territory black whip snakes (*D. atra* and *D. papuensis*) account for more confirmed elapid bites than all other species except the western brown snake (*Pseudonaja nuchalis*) and mulga snake (*Pseudechis australis*), but life-threatening envenoming has never been documented.[22]

There are a number of uncertainties regarding taxonomy and distribution of elapids in the region. The death adders have traditionally been classified as 'northern' (*Acanthophis praelongus*), present across tropical northern Australia, 'desert' (*A. pyrrhus*), present in central and Western Australia and 'common' (*A. antarcticus*), present in eastern and southern Australia.[19] However, distributions overlap and various forms have been proposed as new species. Furthermore, death adders are common in Papua New

Table 1. The distribution of potentially lethal terrestrial snakes in tropical Australia, Papua New Guinea and Irian Jaya, in decreasing order of bites seen in each region

Tropical Western Australia	Northern Territory	Tropical Queensland	Irian Jaya	Papuan region of Papua New Guinea	New Guinea region of Papua New Guinea
Pseudonaja nuchalis Western brown snake (Gwardar)	*Pseudonaja nuchalis* Western brown snake (Gwardar)	*Pseudonaja textilis* Common (Eastern) brown snake	*Acanthophis* spp. Death adder	*Oxyuranus scutellatus canni* Papuan taipan	*Acanthophis* spp. Death adder
Pseudechis australis Mulga	*Pseudechis australis* Mulga	*Oxyuranus scutellatus* Taipan	*Micropechis ikaheka* New Guinea small-eyed snake	*Acanthophis* spp. Death adder	*Micropechis ikaheka* New Guinea small-eyed snake
Acanthophis spp. Death adder	*Acanthophis* spp. Death adder	*Pseudonaja nuchalis* Western brown snake (Gwardar)	*Oxyuranus scutellatus canni*† Papuan taipan	*Pseudechis papuanus* Papuan black snake	*Pseudonaja textilis*‡ Common (Eastern) brown snake
*Oxyuranus scutellatus** Taipan	*Oxyuranus scutellatus** Taipan	*Pseudechis australis* Mulga	*Pseudechis papuanus*† Papuan black snake	*Micropechis ikaheka* New Guinea small-eyed snake	
		Acanthophis spp. Death adder	*Pseudechis australis*† Mulga snake	?*Pseudonaja* sp.‡ brown snake ?species	
		Tropidechis carinatus Rough-scaled snake *Rhinoplocephalus nigrescens* Eastern small-eyed snake	?*Pseudonaja* sp.‡ brown snake ?species		

**Taipans have been found in the 'top end' of the Northern Territory and across to the Kimberley in north-western Australia, but are very uncommonly encountered in these regions, with no recorded human bites. †Present only in southern Irian Jaya. ‡Eastern brown snakes have been confirmed from the north-east coast of Papua New Guinea (Oro and Milne Bay Provinces), but appear very rare in the country. Brown snakes are also possibly present in other southern locations.*

Guinea and Irian Jaya and extend westwards beyond the island of New Guinea among Indonesian islands as far as Ceram.[19,21,23] While similarities between death adders in Papua New Guinea and Australia have been noted, it has been recommended that more study is required to speciate the death adders outside Australia.[21] From a clinical perspective, multiple species names within a genus are useful if there are clinical differences in envenoming syndromes among the species and especially if there are differences in antivenom types required and in antivenom responses expected. To date there is no evidence for major differences in death-adder clinical presentations and an excellent response of neurotoxicity to Commonwealth Serum Laboratories death adder antivenom is seen in Papua New Guinea as in Australia,[24] although other data from Papua New Guinea suggested laboratory evidence of subclinical myotoxic and haemostatic abnormalities not documented elsewhere.[23]

There have been several confirmed specimens of eastern brown snakes (*Pseudonaja textilis*) from north-east coastal locations (Oro and Milne Bay Provinces) in Papua New Guinea and it has been suggested the snake may have been introduced from Australia as eggs transported in military or agricultural equipment.[21] However, the suggestion from patient blood venom assays of *P. textilis* envenoming on the Papuan side of Papua New Guinea (D. Lalloo, D. Theakston, pers. comm., 1998) and the possibility of *Pseudonaja* sp. in southern Irian Jaya (D. MacRae, pers. comm., 1999) necessitate further studies of the distribution and speciation of brown snakes in Papua New Guinea and Irian Jaya.

While the mulga snake (*Pseudechis australis*) has been documented from southern Irian Jaya, its possible presence in the adjacent Western Province of Papua New Guinea is yet to be confirmed.[21]

Venom components

Snake venoms are a diverse and complex mixture of proteins. Elapidae venoms usually cause only minor local damage at the bite site, with systemic effects predominant. This is in contrast to Viperidae (vipers and rattlesnakes) venoms, which are not indigenous to Australia or New Guinea. Of the snakes in tropical Australia, the mulga snake (*Pseudechis australis*) can be the exception, with occasionally severe local damage, especially if tight first aid has been applied around or above the bite site.

Each of the snake species has a fairly consistent combination of venom components.[25,26] This usually results in a consistent clinical syndrome of envenoming from each species (Fig. 1, Table 2). The major venom components for Australasian elapids are as follows:

1. Neuromuscular paralysis (neurotoxins), either by presynaptic action (affecting acetylcholine processing and release from the nerve endings), or by post-synaptic action (blocking acetylcholine receptors on the muscle fibre).
2. Haemostatic abnormalites. Most important clinically is procoagulant action with prothrombin activators leading to fibrinogen depletion, fibrin(ogen) degradation products and incoagulable blood. Also sometimes occurring are anticoagulant action and haemorrhagin, directly affecting blood vessel walls (less common than in Viperidae) and thrombocytopenia or abnormal platelet function. Haemolysins causing anaemia and haemoglobinuria may also be present.
3. Rhabdomyolysis (myotoxins) with muscle breakdown leading to myoglobinuria. In the taipian the myotoxin is actually one of the three subunits (alpha subunit) of taipoxin, the principal neurotoxin.[27]
4. Nephrotoxicity, which is less common than with Viperidae. For Australasian Elapidae, nephrotoxicity is usually subsequent to myoglobinuria from severe rhabdomyolysis. It is uncertain if haemoglobinuria alone, or other haemostatic abnormalities or uncharacterized nephrotoxins cause renal failure in Australasian snakebites.
5. Early transient collapse (hypotension), up to 30 min after the bite and often with brief loss of consciousness, then full recovery until other features of envenoming occur. This can be a most

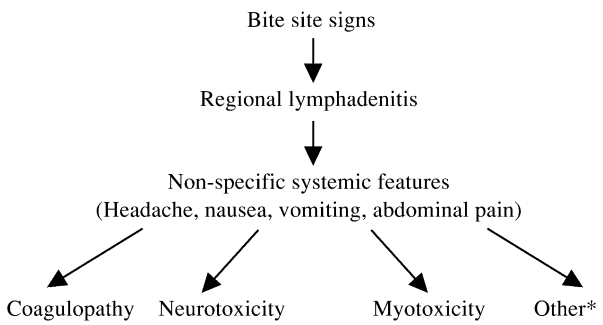

Figure 1. Australasian elapid envenoming. *Renal failure, other haemostatic effects, such as haemolytic, 'haemorrhagic' and 'anti-platelet' venom actions.

Table 2. Clinical syndromes of the major Australasian snakes

	Early collapse	Local swelling	Tender regional lymph nodes	N/S 'systemic features'*	Myotoxicity	Coagulopathy	Neurotoxicity
Brown snakes	+ +	±	±	±	–	+ + + †	Yes (uncommon)
Mulga snake	–	+ +	+ +	+ +	+ +	+ ‡	Yes (uncommon)
Death adder	–	±	±	±	–	–	+ + §
Taipans	+	±	+	+	+	+ †	+ + ¶
Rough-scaled snake	+	±	+	+	+	+†	+
Eastern small-eyed snake	–	±	+	+	+	±	?
Papuan black snake	–	±	+	+	–	+	+
New Guinea small-eyed snake	–	±	+	+	+	+ ‡	+ §
Whip snakes**	–	+	±	±	–	–	–
Tiger Snakes††	+	+	+	+	+ +	+ †	+ + ¶

**Abdominal pain, nausea, vomiting, headache. †Predominantly procoagulant with fibrinogen depletion. ‡ Anticoagulant, no fibrinogen depletion, usually mild. §Predominantly post-synaptic. ¶Predominantly presynaptic. **Not potentially lethal but common. ††Not in the tropics but included for comparison.*

N/S, Non-specific.

dramatic event, especially with brown snakes (*Pseudonaja* spp.) Initially, this distinct entity was considered possibly due to small molecular weight toxins that are rapidly absorbed to cause 'autopharmacological' effects.[28] However, the purified prothrombin activator component of brown snake venom has mimicked this response in dog experiments, with transient myocardial dysfunction associated with microvascular thrombi postulated to account for the transient hypotension seen.[29,30] Direct myocardial depression by venom components is also possible. In addition, specific hypotension-inducing proteins have been purified from the common tiger snake (*Notechis scutatus scutatus*).[31] The relative contributions of the various potential pathogenetic mechanisms for early hypotension and collapse remain to be determined and will be likely to vary for different snakes from different regions of the world. However, early collapse after snakebite in Australia does correlate strongly with those snakes with potent procoagulant venoms (Table 2).

Many of the specific toxins have been characterized,[26] such as the potent presynaptic neurotoxins of taipans (taipoxin),[32] common brown snakes (textilotoxin)[33] and tiger snakes (notexin),[34] and the post-synaptic neurotoxins of death adders (e.g. acanthophin a).[35] The molecules and mechanisms of prothrombin activation of taipan, brown snake and tiger snake venoms are different,[26] but clinically the end result is similar, with incoagulable blood and fibrinogen depletion.

Clinical syndromes

Fairley summarized the presumptive mortality rates from different snake species based on preantivenom data on bites and his extensive animal studies led to a correlation of clinical features with venom activity.[36] Fairley also stressed the higher mortality in children. The genus- or species-specific envenoming patterns and treatment recommendations were subsequently refined by Kellaway,[37] then Trinca[38] and more recently Sutherland[1,39,40] and White.[25]

Prospective studies by Campbell in Papua New Guinea of the Papuan taipan (*Oxyuranus scutellatus canni*)[13] and the death adder (*Acanthophis* sp.)[24] led to a more comprehensive understanding of clinical details of the envenoming process by Australasian elapids. Campbell's papers were the first to focus on details of envenoming from case series of single species, with the first similar Australian study being Trinca and colleagues' study of the rough-scaled snake (*Tropidechis carinatus*).[41]

Sutherland and Coulter used a newly developed 'sandwich' radioimmunoassay to confirm snake identity from tissue samples and provide a very informative series of three severe tiger snake envenomings.[42] The higher incidence of snakebite in Papua New Guinea has enabled further large studies on taipan[15,16] and death adder envenoming in the Papuan region,[23] as well as a retrospective study of snakebite from the Madang region of New Guinea, where the death adder causes most of the serious

envenomings.[43] The work of Hudson in Madang Province suggested that in addition to death adder bites there were serious envenomings and probably fatalities from the little-studied New Guinea small-eyed snake (*Micropechis ikaheka*).[44] This was confirmed in a subsequent study.[45]

More recent retrospective case series in Australia have described the clinical features of species of the brown snake (*Pseudonaja*) and tiger snake (*Notechis*) genera.[12,46–49]

The clinical manifestations of envenoming from the major Australasian elapids are summarized (Table 2). Of note is that the four important 'non-specific features of systemic envenoming' (headache, nausea, vomiting and abdominal pain) are common to envenoming from all species, but may be absent in bites from brown snakes even in the presence of total fibrinogen consumption. Similarly, in death adder envenoming, progressive neurotoxicity may develop in the absence of these non-specific features. Such a scenario may be life-threatening, especially in a sleeping child who is not being neurologically observed (Glasgow Coma Scale chart with an row added for ptosis).

The brown snake paradox

The presynaptic neurotoxin from *Pseudonaja textilis*, called textilotoxin, has been described as the most potent neurotoxin isolated from a snake venom[33] and, with a molecular weight of around 74 000, it is considered structurally the largest and most complex snake venom neurotoxin known.[50] However, despite the potency of textilotoxin, it is becoming evident from case series that neurotoxicity is both uncommon and generally not severe with brown snake envenoming.[12,25,46,49] This is the 'brown snake paradox' and requires explanation. It has been postulated that slow or poor binding or processing of textilotoxin may account for this.[22] Because of the early hypotensive collapse and rapid onset of coagulopathy with severe brown snake envenoming, antivenom is often given early and in large amounts, possibly averting the slower onset neurotoxicity described in cases before antivenom was available.[36,37]

The time course of envenoming

The progression of envenoming, with features depending on the snake species is shown (Fig. 1).

- The early collapse and recovery, if present, are the first features (5–30 min).
- Lymph node pain (tenderness on palpation may precede the symptom of pain), early non-specific systemic features and haemostatic abnormalities (manifest by oozing bite site or venepuncture sites, spitting blood, macroscopic or dipstick haematuria or prolonged glass tube clotting time) usually begin from 30 min to 120 min after the bite.
- Neuromuscular paralysis onset is often delayed for several hours, and occasionally even 24 h, possibly due to tissue sequestration of venom in the extreme case. First aid with bandaging and immobilization may also delay onset. The classical pattern of taipan envenoming without medical intervention is onset averaging 4 h after the bite, followed by steady progression for approximately 24 h to a maximum deficit. Ptosis is followed by ophthalmoplegia, then bulbar palsy and finally intercostal then diaphragmatic paralysis. Limb weakness is usually less severe and may be not evident. Death adder course may be faster (related to post-synaptic neurotoxins), but may also be delayed and less severe without progression in mild cases.
- The potential delay in neurotoxicity onset, although unusual, justifies all cases of possibly venomous snakebite in tropical Australia, Papua New Guinea and Irian Jaya being observed medically, ideally in hospital, for 24 h after the bite.

Important bedside tests

Urine dipstick

A urine dipstick positive for 'blood' can mean haematuria from consumptive coagulopathy, haemoglobinuria from intravascular haemolysis or myoglobinuria from rhabdomyolysis, or a combination of these.

Glass tube whole blood clotting test

A glass tube whole blood clotting test is a simple test that can be very useful to demonstrate procoagulant activity. A clot should normally be forming in the glass tube by 10 min. An assay validated in the field is the '20WBCT', which simply determines whether or not a clot is formed in the glass tube by 20 min.[51] With brown snake envenoming, it is not unusual for the blood to remain completely unclotted.

Therapeutic issues

There is a large amount of documented clinical experience in management of Australasian elapid

envenoming; however, a number of important uncertainties and controversies remain, justifying an evidence-based approach to toxinology as well as toxicology.[52]

First aid

Despite impressive case reports there remains a lack of data on overall efficacy of pressure–immobilization. Despite pressure–immobilization being central to all Australian snakebite protocols it has still only been correctly applied in 18–53% of snakebites.[8,12] The critical importance of strict immobilization has been reinforced by lymphoscintigraphy studies.[53] Overseas, prospective patient serum venom level studies have shown a pressure pad method of first aid to retard venom absorption.[54] Preliminary venom level studies in the Northern Territory support concerns that crepe bandages become loose.[18] Seven patients bitten by western brown snakes (*Pseudonaja nuchalis*) had severe coagulopathy on presentation to hospital despite documented full pressure–immobilization.[22] With the rapid onset of envenoming in brown snake bites (hypotensive collapse is usually within 30 min), direct vascular absorption of some venom components may be occurring, suggesting timing of first aid is critical.

Use of venom detection kits

The current venom detection kits (VDK) was released in 1991[3] and takes 25 min for a result. It should not be used to determine whether antivenom should be given, but if antivenom is clinically indicated it may enable monovalent antivenom to be used instead of polyvalent. Erroneous results occasionally occur, especially if blood is tested rather than bite swab or urine.[49] However, VDK are very useful if the positive result is a snake genus (e.g. 'brown') consistent with the patient's clinical syndrome and with the snake species known to be present in the region.

Use of monovalent antivenoms

Monovalent antivenoms should only be used in tropical Australia if: (i) the (dead or alive) snake brought to hospital with the patient is positively identified by a trained reliable expert and was definitely the snake that bit the patient; or (ii) the VDK result is consistent with the clinical findings and the snakes in the region. If there is uncertainty, polyvalent antivenom should be used. Relying on local 'experts' to identify snakes is dangerous and incorrect identification can have tragic consequences.[55]

Use of antivenom premedication

The use of subcutaneous adrenaline before antivenom as premedication against anaphylaxis is controversial. A recent study from Sri Lanka showed a significant decrease in acute adverse reactions to antivenom with use of subcutaneous adrenaline.[56] However, antivenom reactions occurred in 43% of controls in the study, a rate much higher than that now seen with the more purified current Commonwealth Serum Laboratories antivenoms. There appear to have been no deaths from snake antivenom reactions in Australia for over 40 years.[3,38,57] The concern with routine use of adrenaline is that it may occasionally exacerbate bleeding in snakebite patients with severe coagulopathy. The last five snakebite deaths from intracranial haemorrhage in Australia were all given adrenaline before antivenom, although three had intravenous adrenaline which is not recommended.[55,58] It was considered that the time course in the two given subcutaneous adrenaline made a causal association unlikely.[55] However, it remains possible that even subcutaneous adrenaline may occasionally be harmful, especially in the context of the severe haemostatic abnormalities with brown snake envenoming, with intracranial haemorrhage usually a fatal outcome if it occurs. With the very low rate of severe reactions to antivenom seen in Australia and New Guinea and the ability of emergency medicine physicians to adequately manage reactions that may occur, a policy of withholding premedication but always having adrenaline drawn up and ready is now recommended by many authorities[2] and is policy in the Northern Territory. The primary role of adrenaline in any severe reaction that does occur is well documented.[59]

Antivenom doses

The number of ampoules of antivenom used has been empirically determined over many years for the various snake species. Although one ampoule of each of the Commonwealth Serum Laboratories antivenoms was designed to neutralize venom from an 'average' bite, based on milking venom from snakes,[38] it is clear that larger doses are often required. This is especially evident for bites from brown snakes, where venom yields are very variable and may be substantially larger than previously thought[60] and animal studies

have suggested many ampoules of antivenom may be required for neutralization of venom components.[61,62] However, for bites from death adders and mulga snakes, clinical response has usually been adequate after one or two ampoules of antivenom.[18,23,24]

While antivenom reverses the post-synaptic neurotoxicity from death adder venom, established presynaptic damage from taipan venom is not reversed with antivenom.[13,15,16,63] Adequate antivenom may prevent deterioration in taipan envenoming by preventing further venom binding, but recovery requires time for neurotransmitter pathway restoration, not necessarily more antivenom. It appears that for taipan envenoming the timing of antivenom is especially important. After 4 h from the bite, giving more than one ampoule of antivenom usually has no additional benefit.[13,63] However, in a case series from Townsville, larger doses of antivenom given within several hours of taipan bites appeared effective in hastening neurological recovery.[64] This is consistent with reversal of early post-synaptic neurotoxicity while neutralizing presynaptic neurotoxins before binding. These findings have important financial implications for treatment in Papua New Guinea, where the cost of antivenom is prohibitive and most patients present beyond 4 h from the bite.

There have now been a number of well-conducted studies overseas comparing either different antivenoms or different doses of antivenom, using serial patient blood venom levels and clinical criteria to assess comparative efficacy.[65–68] Similar collaborative studies within Australia using serial venom levels before and after defined antivenom doses would enable a more objective understanding of antivenom dose requirements for the various Australasian elapids.

Treatment in the absence of antivenom

Anticholinesterase therapy such as neostigmine can be beneficial by competitively displacing post-synaptically acting neurotoxins. It has been beneficial in reversing death adder neurotoxicity in Papua New Guinea and should be considered, especially in remote locations in Irian Jaya and Papua New Guinea where antivenom is not affordable or available.[69] Prolonged use of pressure–immobilization with graded release has been considered useful for death adder envenoming in Papua New Guinea and requires further study (J. Oakley, pers. comm., 2000).

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