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A prospective study of 750 definite spider bites, with expert spider identification

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Summary

Background: Spider bite is a subject of much medical mythology with prevalent fears that spiders cause severe envenoming, with neurotoxic effects or necrotic ulcers. Clinical experience and small studies suggest otherwise, but this has not been confirmed by prospective studies of bites by identified spiders.

Aim: To describe the clinical effects of bites by accurately identified spiders, and determine whether early clinical features and circumstances can predict spider type.

Design: Prospective follow-up study.

Methods: Patients were recruited from admissions to two emergency departments ($n = 48$) and referrals from three state poison information centres ($n = 1426$), over 27 months. Overall, there were 750 people with definite spider bites where the spiders were immediately collected and expertly identified.

Results: Significant effects occurred in 44 bites (6%), including 37 (of 56) redback spider bites (*Latrodectus hasselti*) with significant pain lasting >24 h. Of these, only 6 (11%) received antivenom. One severe neurotoxic envenoming by an Australian funnelweb spider required antivenom. No definite spider bites resulted in necrotic ulcers (0%, 99%CI 0–0.7%). There were no early allergic reactions and secondary infection occurred in seven cases (0.9%, 95%CI 0.4–1.9%). Circumstances and early clinical effects were strongly associated with taxonomic spider identification, with positive predictive values >0.95 for common groups of spiders.

Conclusions: Australian spider bite caused minor effects in most cases and is unlikely to cause necrotic ulcers, allergic reactions or infection. Redback spider bite (widow spider) caused prolonged pain, and antivenom could have been used more frequently. The circumstances and early clinical features of spider bites may allow early appropriate advice and treatment of spider bite without taxonomic identification.

Introduction

Spider bite is often a topic of fear, and is associated with much mythology[1] resulting from media attention focussed on rare fatal cases.[2] However, the majority of spiders appear not to be of any medical significance,[2] although there is little published data to support this perception. Many spiders are small

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and have tiny jaws that are too small to penetrate human skin effectively and inject venom. Larger spiders may cause medically significant envenoming if their venom is sufficiently toxic and their habits and distribution promote the likelihood of human encounters. Internationally, the most important groups of spiders based on distribution and severity of their bites are the widow spiders (*Latrodectus* spp.) and the recluse spiders (*Loxosceles* spp.).[3] A few spiders with much smaller distributions can cause more severe envenoming, including the Australian funnel web spider (*Atrax* and *Hadronyche* spp.)[4] and the armed or banana spider (*Phoneutria* spp.) from Brazil.[3,5]

Clinical toxinology is generally lacking in well designed prospective observational studies, and studies of spider bite are no exception.[6] There are a few large studies of suspected spider bites, but the number of cases where the spider was caught and expertly identified was usually $<5\%$.[7–11] In two of the largest studies of suspected spider bites, 80% of cases proved to be injuries from other arthropods or due to micro-organisms.[9,10] The largest study published of 2144 cases of suspected redback spider bites in Australia was based on a retrospective review of reports of antivenom use to the manufacturer.[11] It was biased by including only treated cases, and had poor case definition, relying only on clinical suspicion of bites.

There are a few studies of definite bites with expert spider identification, but these have been either small studies or single species studies, and almost all retrospective.[12–16]

Large prospective cohort studies of definite spider bites with expert identification of spiders are required to define clearly the severity and spectrum of effects of bites from different groups of spiders. This should not only help to remove much of the mythology surrounding spiders, but may also provide the basis for developing algorithms for the diagnosis of spider bite where the spider is not collected or identified.[6]

Here we report the findings of a large prospective study of definite spider bite in Australia with expert identification of all spiders. The identifications are reported to the level of family in the majority of cases, for clarity and relevance to spider bite in other parts of the world.

Methods

Subjects were recruited prospectively for a 27-month period from February 1999 to April 2001 by two different processes. The first group consisted of patients presenting to two Australian emergency departments, Royal Prince Alfred Hospital, Sydney, and Royal Darwin Hospital. Patients were examined by the attending medical officer or one of the authors (GKI). They were asked to participate in the study by providing the spider and allowing phone follow-up. Written consent was obtained. Follow-up was done over the telephone by GKI after 1 week, or longer if required. The second, much larger group consisted of phone referrals from three of the four state poison information centres (PIC) in Australia, including the Western Australia (WA) and Queensland (QLD) PICs, and New South Wales (NSW) PIC, the latter which provides an overnight service to the whole of Australia. Callers to these three PICs who enquired regarding a spider bite, and had caught the spider, were asked to participate in the study. Verbal consent was obtained and their details were recorded. These subjects were re-contacted and interviewed by GKI, then followed up after 1–2 weeks, or until the clinical features had resolved.

The study had strict inclusion criteria so that analysis was made only of definite bites or reactions, where the spider was collected for identification. For inclusion as a definite bite, there needed to be a clear history of the spider biting and collection of the spider at the time of the bite. In addition, it was recorded whether there was a clear history of a reaction to the spider but good evidence that the subject was not bitten. These were coded as definite contact reactions, and both bites and contact reactions were referred to as spider injuries.

The following information was recorded for each spider bite: demographics (age, gender, geographical location), circumstances of the bite (location, time, date, activity at the time, season), bite site, local and systemic effects (onset, duration, severity), and past medical history (full details available from the authors). Duration of effects was defined as the length of clinical signs and symptoms of the bite. The presence of a mark alone following a bite was insufficient, and other symptoms such as pain or swelling needed to be present, for this to be included in the duration of effects. Severe pain was defined as pain greater than a bee sting or equivalent. Increasing pain refers to pain that increased within the first hour.

The spider was collected directly from the patient or mailed to the authors for identification. Spiders were stored in 70% ethanol and kept at the Australian Museum. Spider identification was done by an expert arachnologist: MRG in the majority of cases. In this study, spider identification is analysed at family level, except for *Latrodectus hasselti* (redback spider).

To investigate the relationship between the initial features of a bite (circumstances and early clinical effects), and the spider group involved, the diagnostic value of one of these features in distinguishing between one spider group and all other spiders was quantified. The following initial features were investigated: activity at the time of the bite (washing-related, dressing, putting on shoes, gardening, catching the spider) and initial clinical effects (puncture mark/bleeding, increasing pain). Washing-related activities included hanging, bringing in or folding washing, and dressing in clothes from an outdoor washing line. Sensitivity, specificity, positive and negative predictive values were calculated for each of these features in distinguishing between one spider group and all other spiders, using taxonomic identification of spiders as the 'gold standard'.

Ethical approval was obtained from the Central Sydney Area Health Service Ethics Review Committee (RPAH Zone), the Joint Institutional Ethics Committee of the Royal Darwin Hospital and the Menzies School of Health Research and the Ethics Committee of Royal Children's Hospital and District, Brisbane to cover all institutions involved.

For descriptive statistics, median and interquartile ranges (IQR) are used for data not normally distributed. For comparison of proportions of two groups, Fischer's exact test was used. 95% or 99%CIs were calculated. All statistical analysis was done using GraphPad Instat (Version 3.05 for Win 95/NT).

Results

We recruited 1474 subjects during the 27-month period: 48 from the two emergency departments and 1426 from the three poison information centres. There were 750 definite spider bites, eight definite contact reactions to a spider, and three cases where it could not be established whether the effects were due to a reaction or bite. In all 761 cases, the spider was obtained by the authors and identified.

There were 713 excluded cases: 539 of these were definite spider bites (355 where no spider was received and 184 where the spider was lost) and 163 (11%) excluded for other reasons (no actual bite or reaction, 55; unable to contact subject, 45; suspected bites not fulfilling inclusion criteria, 43;[6] the creature obtained was identified as an insect, 21; refused consent, 5; and the spider sent was not the culprit, 5). Baseline characteristics of subjects with included bites compared to those with excluded definite bites are detailed in Table 1.

Table 2 lists the families of spiders and the number of bites/reactions they caused. Figure 1 shows the incidence for each month of the year, and Figure 2 shows the distribution of the bites/contact throughout Australia. The majority of bites occurred in the warmer months and occurred between 0800 and 2400. Figure 3 shows the number of bites for 4-h periods throughout 24 h.

Of the 761 subjects with definite spider injuries, there were 340 males (45%) and 421 females (55%). Age ranged from 1 to 86 years, with a median of 33 years (IQR 19–46 years). There were 158 paediatric cases (aged <15 years). Bites occurred to all parts of the body, with 49% distal (hand or foot), 27% on the proximal limb, 16% on the trunk, 7% on the head/neck and 1% on multiple regions. The median duration of effects was 3 hours (IQR 0.5–24 h), although this differed between groups (Table 3).

Pain or discomfort occurred in all 750 definite spider bites, was mild to moderate in 544 cases (63%) and severe in 205 cases (27%). Puncture marks or localized initial bleeding occurred in 33%

Table 1 Comparison of the characteristics of excluded (spider not obtained) and included (spider obtained) definite bites

Characteristic	Included ($n = 761$)	Excluded	p
Gender (female)	421 (55%)	231 (50%)	0.099
Age (median and IQR)	33 (19–46)	27 (15.5–36)	**<0.0001**
Geographical distribution			
NSW	292 (38%)	181 (35%)	0.195
WA	146 (19%)	101 (19%)	0.943
Season			
Summer (Dec–Feb)	299 (39%)	227 (43%)	0.954
Winter (Jun–Aug)	55 (7%)	45 (9%)	0.399
Time of day			
Daytime (0800–2000)	500 (66%)	292 (73%)	**0.014**
Night time (2400–0800)	97 (13%)	37 (9%)	0.082

Table 2 Numbers of spiders responsible for definite bites according to spider family

Common name, important members	Spider family	*n*	%
Huntsman spiders (Figure 4) including *Heteropoda* spp.	Sparassidae[a,b]	174[d]	22.9
Orb weavers	Araneidae[a,b]	163[e]	21.4
White-tail spiders, including *Lampona* spp.	Lamponidae[c]	122	16.0
Comb-footed spiders including: Widow spiders (*Latrodectus* spp.) (see cover); Cupboard spiders (*Steatoda* spp.)	Theridiidae[a,b]	82	10.8
Wolf spider including *Lycosa* spp.	Lycosidae[a,b]	43	5.7
Jumping spiders	Salticidae[a,b]	37	4.9
Lace web desid spiders including *Badumna insignis* (Black house spider)	Desidae[c]	26	3.4
Darting spiders	Corinnidae[a]	16	2.1
Spotted or ant spiders	Zodariidae[a]	15	2.0
Sac spiders including *Cheiracanthium* spp.*	Clubionidae[a,b]	13	1.7
Mouse spiders, including *Missulena* spp.	**Actinopodidae**[a,b]	12	1.6
Large jawed spiders	Tetragnathidae[a]	11	1.4
Funnel web spiders: *Atrax* spp. and *Hadronyche* spp.	**Hexathelidae: Atracinae**[c]	8	1.1
Trapdoor spiders	**Idiopidae**[a,b]	8	1.1
Ground spiders	Gnaphosidae[a]	6	0.8
Trapdoor spiders	**Nemesiidae**[a,b]	5	0.7
Whistling spiders or 'tarantulas'	**Theraphosidae**[a,b]	5	0.7
Crab of flower spiders	Thomisidae[a]	5	0.7

The common name of the family is included where its use is reasonably consistent worldwide, and members of the family are noted if they are medically important. Families from the mygalomorph group (primitive spiders) are marked in bold. The following eight families caused only 1–2 bites and are not included: Dysderidae (2), Miturgidae (2) (but see * below), Deinopidae, Mimetidae, Nicodamidae, Oxyopidae, Pholcidae and Segestriidae. [a]Spiders with a wide distribution outside Australasia; [b]Spiders known[14,18–23] to cause bites in countries other than Australia; [c]Spiders with no bites recorded outside Australasia; [d]two definite contact reactions and three unclear contact or bite; [e]six definite contact reactions. **Cheiracanthium* was a member of the Clubionidae at the time of analysis, but was recently transferred to the Miturgidae.

of bites. Swelling occurred in 13%, and redness or a red mark in 69% of cases. Systemic effects occurred in 13% of all spider bites. Table 3 gives information on the clinical effects produced by the most frequently biting families and important groups.

There were no necrotic lesions or ulcers as a consequence of any spider bites (0%, 99%CI 0–0.69%). There were no early allergic reactions to spider bites (0%, 99%CI 0–0.69%), despite 7/267 cases (2.6%) who gave a comprehensive allergy history, reporting bee sting anaphylaxis. There were delayed reactions in 20 cases, mainly itchiness and redness at the site, which had a median duration of 7 days (IQR 3–9.25 days). There were no cases of confirmed infection or severe infection, but seven cases (0.9%, 95%CI 0.37–1.89%) had clinical features consistent with local infection (redness, swelling and pain, often delayed).

Table 4 examines the diagnostic usefulness of the initial features investigated in this study for predicting the spider type involved in biting or contact. Almost all had positive predictive values over 0.95 with 95%CI of ± 0.02 (CI data not shown).

There were 38 bites by mygalomorph spiders, and eight of these were by Australian funnelweb spiders. Five of the eight funnelweb spider bites were managed in hospitals, but three were not requested or refused to attend hospital. There was major envenoming in one patient, who required three ampoules of funnelweb spider antivenom.

There were 56 redback spider (*L. hasselti*) bites (see cover) where the spider was identified to species. Of those bitten, 19 (34%) attended hospital, and six (11%) were given antivenom (all by the intramuscular route). However, 37 (66%) had significant pain lasting 24 h or longer, of whom four received antivenom (all within 4 h of the bite).

The only other medically significant bite was from an araneid spider (orb weaver), causing local and regional bruising which took 17 days to resolve. Less severe bruising occurred in another 17 cases of spider bite.

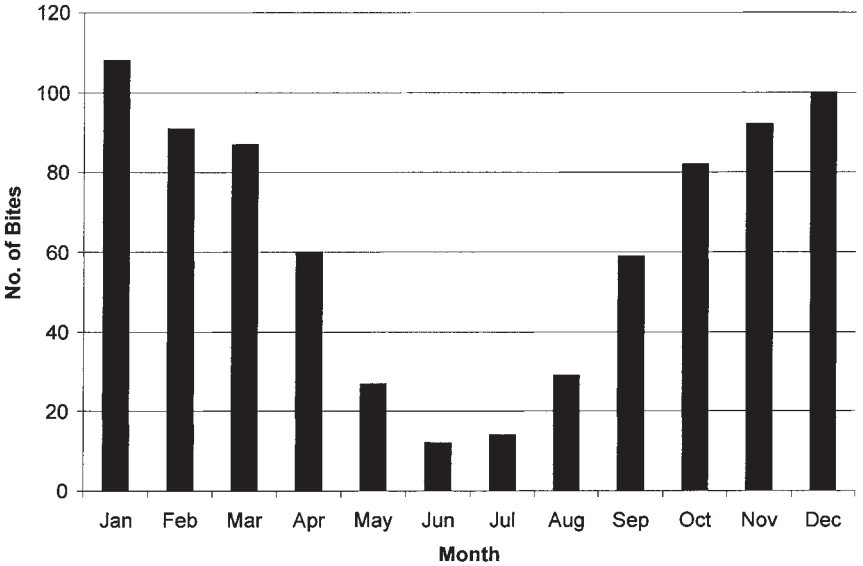

Figure 1. Seasonal distribution of spider bite in Australia. The majority of bites occurred in the spring, summer and autumn months of September to April.

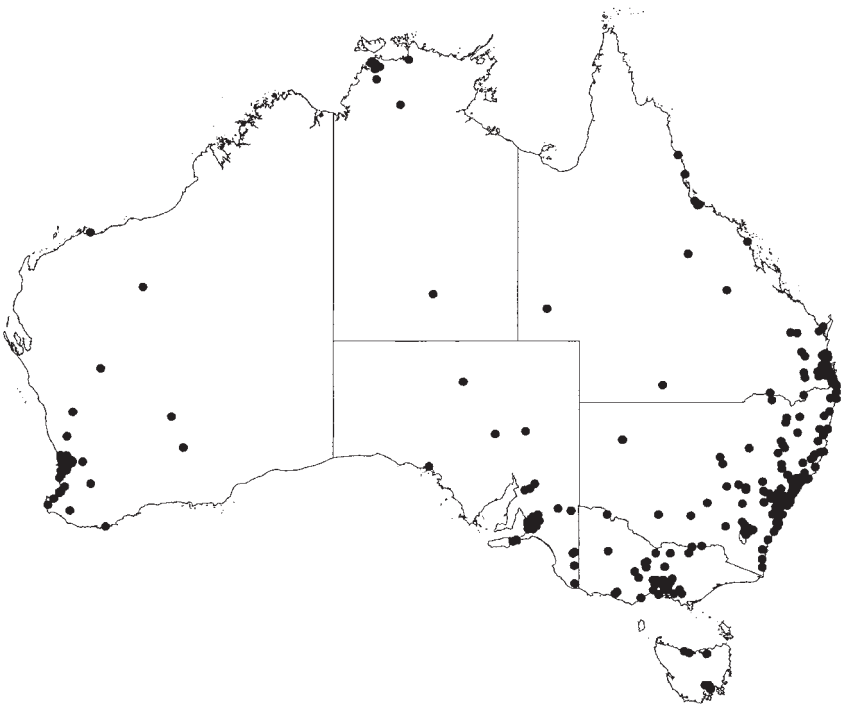

Figure 2. Geographical distribution of spider bites in the study.

Of 750 definite spider bites, there were 16 cases where there was both a bite and a contact reaction to the spider. Of the 19 cases of definite contact reactions to the spider, 17 were caused by large spiders from the Sparassidae and Araneidae families. In 12 cases, these reactions may have been due to leg spines of the spiders, but this was only confirmed in one case by examination of the spines from the wound.

Discussion

Spiders are feared by a large proportion of the population, and this combined with the lack of good clinical studies has created many myths about spider bite.[1,2,10,14,17,18] This has meant that there have been undue fears of many spider groups, and misattribution of effects to them. This is unlikely to change without well-designed observational cohort

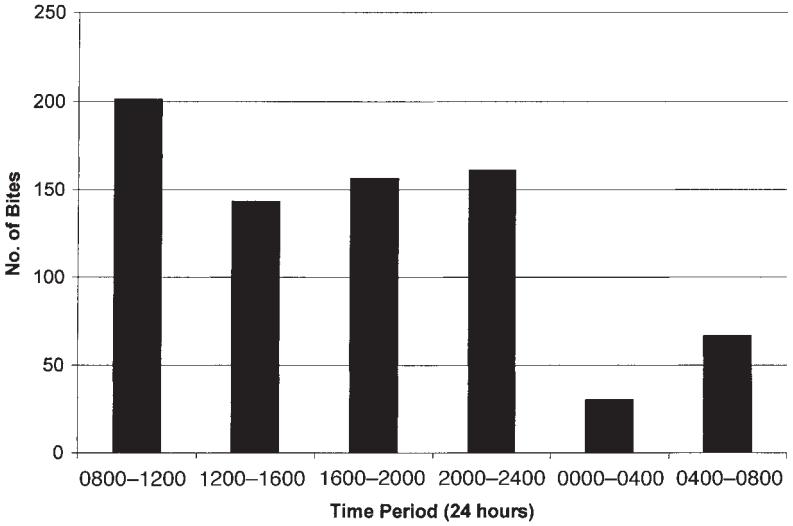

Figure 3. Number of spider bites occurring at different times of the day divided into four hour blocks. Information about the time of the bite was unavailable in 3 patients.

Table 3 Clinical effects of bites by spiders from the most frequently biting taxa, excluding cases of contact only ($n = 8$) or unclear cases ($n = 3$)

Family	Fang marks or blood (%)	Severe pain (%)	Duration of pain (min)	Distal limb bites (%)	Total duration (h)	Systemic effects (%)
Sparassidae (169)	54	27	5	83	1	5
Araneidae (157)	32	17	5	36	2	11
Lamponidae (122)	19	28	5	25	24	9
Theridiidae (82)	10	46	1440	45	48	28
L. hasselti (56)	7	57	2160	48	48	32
Lycosidae (43)	35	26	10	72	1	7
Salticidae (37)	30	11	20	24	2	8
Desidae (26)	23	31	5	42	2	15
Corinnidae (16)	19	6	9	25	3	19
Zodariidae (15)	40	40	45	13	8	20
Clubionidae (13)	8	46	60	38	4	23
Mygalomorphae (38)	61	50	20	92	3	32
Hexathelidae (8)	75	50	63	75	1	38

Duration of pain and effects is given as a median because data were not normally distributed.

Table 4 Examples of diagnostic use of different circumstances and early clinical effects of spider bites in identifying the spider involved

Spider group	Diagnostic feature	Sensitivity	Specificity	PPV	NPV	LR	*p*
Araneidae	Washing-related	85%	76%	0.97	0.38	3.49	<0.0001
Araneidae	Dressing	82%	41%	0.89	0.29	1.40	<0.0001
Theridiidae	Putting on shoes	91%	31%	0.95	0.21	1.33	<0.0001
Theridiidae	Increasing pain	94%	86%	0.99	0.46	6.88	<0.0001
Latrodectus	Increasing pain	97%	70%	0.98	0.55	3.27	<0.0001
Sparassidae	Bite occurred when catching the spider	80%	73%	0.98	0.16	2.95	<0.0001
Mygalomorph	Puncture *or* blood	97%	94%	0.69	0.61	1.07	0.0005
Mygalomorph	Gardening	96%	28%	0.95	0.27	1.23	<0.0001

PPV, positive predictive value; NPV, negative predictive value; LR, likelihood ratio. 95%CIs are not reported but can be obtained from the authors. Mygalomorphs = large spiders, potentially funnelweb spiders.

Figure 4. Immature male Heteropoda sp. (Sparassidae) or tropical huntsman spider; Darwin, Northern Territory, Australia (Photograph G. Isbister).

studies, with expert identification of the spiders, showing that the majority of spider bites are medically insignificant.

This is the only large study of spider bite with prospective data collection, follow-up and expert identification of spiders, and so provides the most accurate information on spider bite published to date. It gives comprehensive information on Australian spider bite as well as on the clinical effects and circumstances of bites by important groups of spiders that also occur worldwide.[2] The analysis was done on 750 definite bites with expert spider identification. All cases were followed up for at least one week to define clearly the time course of the clinical effects. Although a number of biases were introduced in the recruitment of definite cases, the sample is a good representation of the majority of cases of spider bite presenting to health care facilities in Australia. Figure 2 demonstrates that cases were recruited from all over Australia and correspond to human population density. Comparison of subjects with definite bites with and without the spider shows that the only significant differences were in subject age and the number of daytime bites (Table 1). Neither of these is likely to be clinically significant.

Some 82% of bites were caused by six major families of spiders, five of these having worldwide distribution and previously being responsible for bites outside Australia.[14,18–23] The majority of bites caused only minor effects, and did not require treatment in a health care facility. The exceptions were 44 (6%) medically significant bites, the majority (37) by the Australian redback spider (*L. hasselti*) (see cover), which is a widow spider. Although only 11% of redback spider bites were treated with antivenom and only 34% presented to hospital, it is of concern that almost two-thirds of patients had significant pain lasting 24 h or longer. This appears to be a combination of patients not seeking appropriate medical attention, and health professionals not giving antivenom.

The commonest family to cause bites was that of the huntsman spiders (Sparassidae) (Figure 4) that occur in many parts of the world, mainly in tropical and temperate regions. *Heteropoda venetoria*, a member of the huntsman family, has been reported to cause bites in many countries,[23] and this study suggests these bites are not medically significant. Other important families were wolf-spiders (Lycosidae), which have been implicated in necrotic arachnidism[14] and jumping spiders (Salticidae).[2]

The study provides firm evidence that in Australia, necrotic ulcers are unlikely to be the result of a spider bite, with no cases of necrotic lesions in the study (99%CI 0.67%). The many previous case reports of necrotic arachnidism are more likely to be a result of misattribution[17,24] to spider bites, and to be due to other clinical conditions, such as mycobacterial and fungal infections and, systemic diseases such as pyoderma gangrenosum.[17] This may also suggest that many families of spiders worldwide, known to bite humans, are unlikely to cause necrotic lesions. This does not include *Loxosceles* spp., which have been shown to cause necrotic arachnidism. Although introduced to a small part of Australia,[25] there were no bites by *Loxosceles* spp. in this study. Thus, excepting *Loxosceles* spp., these data suggest that spider bites are an extremely uncommon cause of necrotic or cytotoxic lesions, and other diagnoses should be considered first.

In this study there were no cases of early allergic reactions, providing evidence that spider bites rarely cause hypersensitivity reactions. This is consistent with the absence of previous confirmed reports.[26] There were delayed reactions in a small number of bites, but it was unclear exactly what caused them. Allergic reactions to spiders appear to occur almost exclusively following contact with them, and usually with body hairs.[27] Secondary infection was also rare in this study, with less than 1% of cases presenting features consistent with local infection and no severe or prolonged effects.

There are few arachnologists, and the lengthy process required to identify spiders means that spiders cannot be identified for every patient at the time of the bite. Other methods are required to

allow rapid identification of the type of spider. This is even more important if the patient saw the spider, but did not catch it, or when there is a suspected bite. The study confirmed the investigators' initial clinical impression that different groups of spiders were associated with characteristic circumstances and clinical effects of their bites. Table 4 quantifies the diagnostic value of a number of initial features of bites, and shows that these can be used to predict the spider type. More detailed multivariate analysis of these data may allow diagnostic algorithms to be developed to identify spiders rapidly, and thereby provide patients with immediate advice. Although these data are most applicable to Australia, with appropriate observational data collection, the technique could be applied in other regions of the world.

There were a number of limitations of this study. The first was the bias created by the recruitment of patients, in that they had to have caught the spider and then be willing to send it (in 720 cases) to the investigators. This is less biased than sampling from only a population of hospital admissions, which would exclude the majority of minor bites, and is unlikely to be a problem because the results are applicable to health professionals managing spider bites, which is what the study represents. There was also bound to be some bias because of fear of particular types of spiders, but this is only likely to bias the proportion of different spiders, leaving the important conclusions of this study unaffected. The study focussed on the correlation between taxonomic identification of spiders and the effects and circumstances of their bites.

Spider bite is a common problem for many health professionals, and it is important that there is evidence-based information on the effects of definite spider bites. Rapid identification of the spider involved, whether caught by the patient or not, and correlation with known effects of that spider group would allow appropriate early advice to patients, whether over the phone, or by staff of an emergency department. From our data, the majority of spider bites are likely to be of minor importance and subjects would be rapidly discharged from medical care, reducing pressure on health care resources. On the other hand, medically important bites, such as those of the widow spider, need to be identified early and given appropriate treatment.

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