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Epidemiological and clinical aspects of scorpionism by *Tityus trivittatus* in Argentina

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Abstract

This is a descriptive study of epidemiological and clinical aspects of stings caused by the scorpion *Tityus trivittatus* in Argentina. We analyzed 511 cases recorded from different health centers in 22 provinces. Most accidents took place during the period November–April (76%), in or nearby houses (86%). Over 50% of the accidents involved children and teenagers. Envenomation by *T. trivittatus* was mainly characterized by local symptoms: pain (85%), edema (26.6%), burning sensation (24.7%), erythema (20.7%), local hyperthermia (13.1%), paresthesia (9.8%) and general manifestations such as vomiting (25%), paleness (18.8%), headache (11.4%) and sweating (8.2%). Neurological, cardiovascular and respiratory disorders were uncommon. Almost 90% of the injured people got treated with specific antivenom within 2 h, 6% were treated 2–h after the accident and only 2 people were treated 12 or more hours after being stung. The global mortality recorded was 6 per 1000 cases. Scorpionism in Argentina is a public health problem under control due to the relatively low incidence and the accessibility of specific antivenom.

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1. Introduction

Scorpions are one of the animals most commonly implicated in human envenomation through America, Asia and Africa. However, the sting of few species can produce severe envenomation: only about 25 out of almost 1500 species described around the world are dangerous to humans.

Envenomation by scorpions depends on several factors, both from the scorpions and from the victims. Among those from the scorpions, it can be mentioned species, size of

the scorpion, content of the venom glands and status of the venom ducts of the telson, number of stings and quantity of venom injected (Dehesa-Dávila and Possani, 1994). Among those from the human, there must be considered the anatomical location of the sting as well as the age, weight and health status of the victim. Children and old people are more susceptible and, in general, people suffering some risky condition, such as diabetes, hypertension or heart disease (Dehesa-Dávila and Possani, 1994; Freire-Maia et al., 1994; Ministerio de Saúde, 1999).

The symptoms and clinical signs of scorpion envenomation are traditionally explained as the result of the alterations produced by venom toxins acting on excitable tissues, i.e. nerves and muscles. The toxins contained in *Tityus* venoms can block or modulate different types of ionic channels

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(Becerril et al., 1997), principally in the autonomous nervous system. At the nerve terminals of the autonomic nervous system, scorpion venom induces the uncoordinated release of acetylcholine and/or noradrenaline leading to severe syndromes which causes respiratory and circulatory damages that may lead to death (Dehesa-Dávila and Possani, 1994; Freire-Maia, 1990; Freire-Maia et al., 1994; Ministerio de Saúde, 1999).

The scorpions of sanitary importance in America belong to the Buthidae family, which is represented by *Centruroides* genus in North America and *Tityus* genus in South America (Bucherl, 1971). Among more than 100 different species and subspecies of scorpions belonging to the families *Bothriuridae* and *Buthidae* described in Argentina (Maury, 1997), the only species identified so far as dangerous for humans is *Tityus(T.) trivittatus* Kraepelin 1898, from the *Buthidae* Family. *T. trivittatus* is distributed through all South America excepting Chile. In Argentina, this scorpion can be frequently found in the provinces North to 36° South Latitude, where it has invaded buildings and old houses, becoming adapted to a synanthropic way of life (Salomon and De Roodt, 2001).

The bibliography on accidents caused by *T. trivittatus* in Argentina is scarce, limited to some few reports with low number of cases registered in different health centers, including some severe cases leading to the death of the victim (Martino et al., 1979; Tomassone, 1994; Del Valle Luna and Luna, 1997; Gordillo et al., 2000; Peirano et al., 2000).

Since the first report, presented by Sancón in 1928 (Maury, 1997), it is known that the main clinical features of scorpionism are localized reactions that occur in almost all affected people. Severe systemic manifestations (e.g. sweating, hypertension, vomiting) as well as more severe organ/tissue dysfunction (e.g. cardiorespiratory manifestations) are uncommon. Thus, scorpionism by *T. trivittatus*, being a problem of public health with no definitive solution, constitutes a risk that deserves better attention in order to diminish the mortality and morbidity as much as possible.

In the late seventies a Federal Program for Ophidism (Programa Nacional de Ofidismo, PNO) was set up by the Ministry of Health of Argentina. The PNO takes care of the surveillance of human accidents involving venomous animals (snakes, spiders and scorpions) through a system for surveillance of accidents and for the distribution of antiscorpion antivenom free of charge, to 565 health centers along 22 provinces over the country (De Titto et al., 1999). In order to enforce the system in the first years of the PNO in health centers that received the antivenom, the subsequent provision of antivenom was conditioned to the deposition of a written report, according to a data sheet form distributed to the medical centers.

The objective of the present work was to characterize the accidents by *T. trivittatus* in Argentina both epidemiologically and clinically, including information on their geographical distribution, age, sex and clinical signs of people

stung as well as on the time elapsed between the accident and the application of antivenom.

2. Materials and methods

Patients. A total of 511 cases of scorpionism by *T. trivittatus* were considered. Most data ($n = 499$) were recorded from the PNO files after reported from health centers located in 8 provinces, 7 at the central and West parts of the country (Santa Fe, Córdoba, Santiago del Estero, Tucumán, Catamarca, La Rioja and Mendoza) and 1 from the Patagonia (Chubut). The remaining provinces have not reported cases of scorpionism to the PNO during the period of study (1993–1999). Included are also 12 cases from the Hospital for Infectious Diseases ‘Dr F. J. Muñiz’, a national clinical center of reference for accidents by venomous animals, which is located in the city of Buenos Aires and receives patients from both the city and its urban areas, but does not report to the PNO.

Use of antivenom. Most patients included in the present study (468 out of the 511), received scorpion antivenom therapy. During the period here reported, two different antivenoms were used. Until 1996 antivenom therapy was carried out with the antiarachnidic antivenom from the Butantan Institute (Sao Paulo, Brazil), which is produced by injecting the horses with venom from *T. serrulatus*, *Loxosceles gaucho* and *Phoneutria nigriventer*. This antivenom cross-react with the venom of *T. trivittatus* with a good neutralizing ability (De Roodt et al., 2001). Since 1997 the specific antivenom is produced by the Instituto Nacional de Producción de Biológicos (I.N.P.B.)-A.N.L.I.S. ‘Dr Carlos G. Malbrán’, through the immunization of horses with *T. trivittatus* venom. Specific treatment was carried out using 2 ml ampoules containing a dilution of F(ab’)₂ fraction of equine immunoglobulins obtained after double saline precipitation and pepsin digestion (Antiscorpion serum, I.N.P.B.). The mean protein content of the antivenoms from the batches used during the period considered was 8.0 ± 3.0 g/dl with a neutralizing ability of 104 ± 65 LD₅₀ per ml.

Data recorded. The data used for the present study were: information on the province where the accident was recorded, the date and occasion of the accident (inside or outside home, at work, etc.), the anatomical site where the scorpion stung, as well as the age and sex of stung people and the signs and/or symptoms recorded at the time of medical attention. It was also recorded the time between the sting and the application of the antivenom and the amount of antivenom given to each patient.

Statistics. In order to compare proportions, chi-square test was used; differences were considered significant with less than 0.01 associated probabilities.

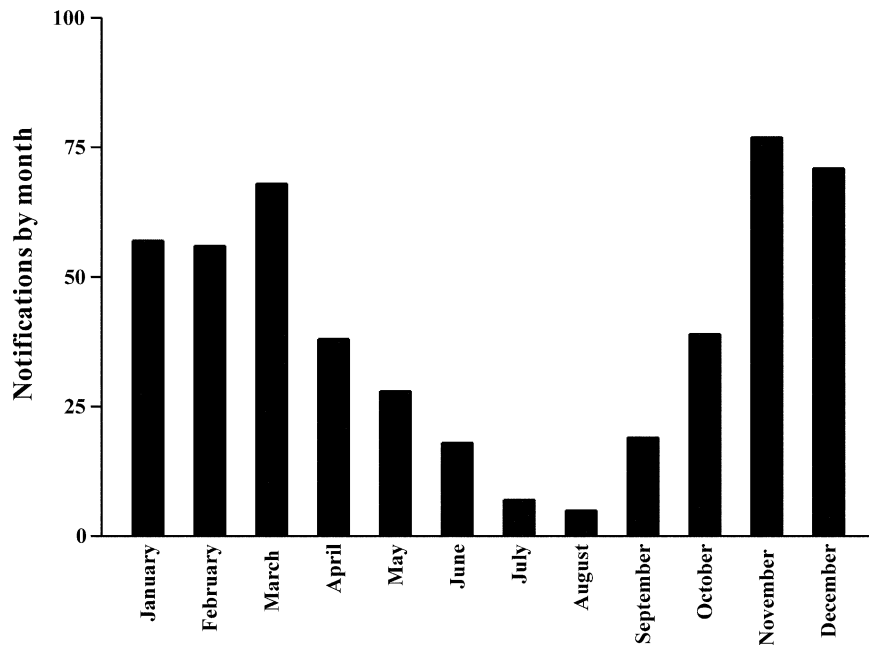


Fig. 1. Notification by month of people stung by *Tityus trivittatus* in Argentina. The numbers in the Y axis indicate the number of accidents recorded each month during the period of study.

3. Results

Almost 98% of the 511 cases of scorpionism reported were collected in the period 1993–1999, after the modifications of the PNO conditions, described above.

Apart from the 12 cases registered in the city of Buenos Aires, the accidents were reported in other 7 provinces located between latitude 26 and 36 degrees South, with the exception of 2 cases reported in the Patagonian province of Chubut. However, 85.6% of the reports came from only two provinces, Córdoba and Santiago del Estero, coincident with the *T. trivittatus* hyper endemic area. Moreover, 12.8% of the cases were from Robles Department, Santiago del Estero, with an estimated incidence of 2.8 cases per year per 10.000 inhabitants.

It is interesting to note that accidents occurred all the year around. As shown in Fig. 1, 84% of the accidents took place in the warmest months (October–April). However, although scarce, there were cases (2.5%) even during the season of lower scorpion activity (July/August).

Around 86% of the people stung suffered the accident indoors, which is in accordance with the synanthropic behavior of this scorpion.

There were no significant differences between sexes (52% male, 48% female) across all ages (10 years age groups).

Taking into consideration the age distribution of the population in the provinces with cases of scorpionism, the proportion of accidents reported from children up to 10

years old was significantly higher than those from the groups between 11 and 50 years old ($P = 0.0017$), and the latter were higher than the reports from 51 to 89 years old. The age of person stung was missing in 20 reports out 511 (Fig. 2).

The frequency of stings in feet (40%) and hands (32%) was clearly different from those in arms (11%) and legs (10%), without difference between upper and lower limbs.

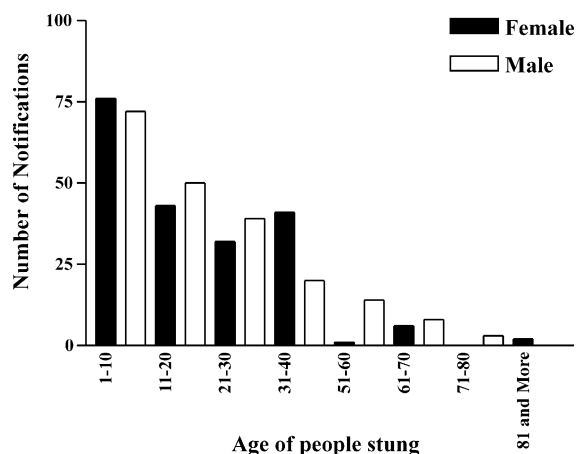


Fig. 2. Sex and age of people stung by *Tityus trivittatus*. The numbers in the Y axis indicate the number of stung people during the period of study. The age groups are indicated under each pair of bars. The sex is indicated by the type of bar (black: female, white: male).

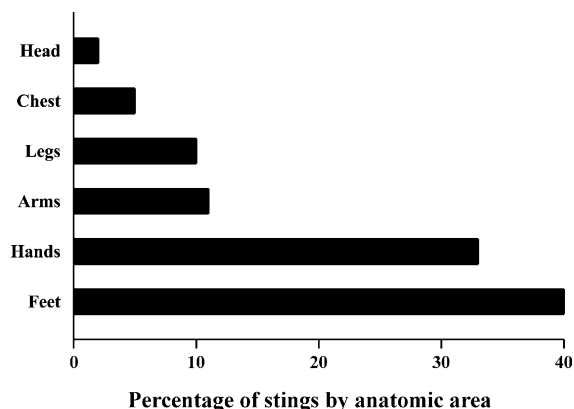


Fig. 3. Anatomic site of the sting by *Tityus trivittatus*. In the X axis are showed the percentage of stings in different anatomical parts.

Only occasionally, the stings were located on the chest (5%) and the head (2%) (Fig. 3).

Clinical signs and/or symptoms were reported in 94% ($n = 480$) of the accidents. Local symptoms were more frequent than systemic. The signs more frequently reported were pain (85%), edema (26.6%), burning (24.7%), erythema (20.7%) and hyperthermia (13.1%). Cardiovascular and circulatory symptoms more frequently found were paleness (18.8%) and tachycardia (18.2%). Neurological symptoms like cramps or tremors (4.1%) and paresthesia (9.8%) were also observed, while central symptoms like headache (11.4%), excitement (8.0%), sickness (4.9%) and dizziness (2.0%) were less frequently reported. Other symptoms reported were vomiting (25.0%), sweating (8.2%) and arthralgia (3.3%) (Fig. 4).

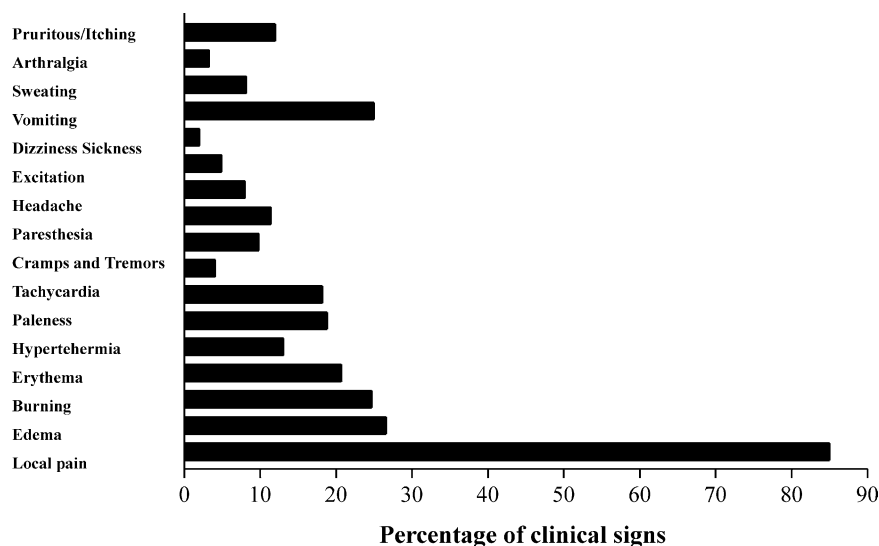


Fig. 4. Clinical signs of people stung by *Tityus trivittatus* in Argentina recorded during the period of study (1993–1999). The X axis indicates the percentage of occurrence for each clinical sign considered.

When the patients were grouped by age and the 0–10 years old group compared with those from 11 years old to older, the younger group presented higher proportion of cases with systemic signs (7% vs. 2%, $p = 0.0086$), vomiting (52% vs. 16%, $p = 1.1 \times 10^{-13}$), main cardiovascular and circulatory symptoms (34% vs. 22%, $p = 0.0043$) except for hypotension, and some neurological related symptoms as changes in behavior (excitement/depression) (23% vs. 7%, $p = 6.2 \times 10^{-7}$) and dyspnea (14% vs. 4%, $p = 0.00003$). Moreover, the presence of overall manifestations of systemic envenomation (tachycardia, vomiting, hypertension, hypotension, etc.) was more frequent among children below 10 years old than in the older people (70% vs. 47%, $p = 2.6 \times 10^{-6}$). On the other hand, the older group presented higher proportion than the younger in files with only local signs (43% vs. 25%, $p = 0.00017$), some neurological related symptoms as headache (15% vs. 6%, $p = 0.0055$) and paresthesia (18% vs. 5%, $p = 0.00011$), and arthralgia (5% vs. 3%, $p = 0.28$, non significant), while there were no differences between these groups on the other signs and symptoms.

The time between the scorpion sting and the application of the antivenom was available in 395 cases (84% of the 468 reports on treated patients). Specific antivenom therapy was provided within 2 h or less in 90% ($n = 355$) of the accidents, reaching 96% up to 4 h, 97% up to 6 h and 99.5% 12 h post accident. Only two out of the 395 cases required more than 12 h to be treated.

During the period analyzed three patients died after being stung by scorpions. Two cases (two girls, 6 and 10 years old) took place in the province of Santiago del Estero and one case (a girl 16 month old) in Santa Fe. All these patients received medical attention several hours after

the sting and when they arrived at the Sanitary Center, clinical manifestations of systemic envenomation were very clear. Antiscorpion antivenom was unsuccessfully administered in all three cases. All other patients treated with antivenom improved their health conditions, and finally recovery completely.

4. Discussion

In the period 1993–1999 a total of 511 accidents with scorpions, including three fatal cases, were reported to sanitary authorities in Argentina. Most accidents took place in the hyper endemic area of distribution of *T. trivittatus* (Maury, 1979; Acosta and Maury, 1979), the only species that produces severe envenomation symptoms in this country (Martino et al., 1979).

Most accidents with scorpions take place in houses or nearby areas (86%) especially during the warmer months (76%), when the activity of the scorpions increases (Maury, 1997) and so the probability of scorpion-human contact increases. Interestingly, over 51% of the accidents recorded were in children and teenagers. The fact that the population aged 14 or less in the seven reporting provinces accounts for 20.5% of the total population and register 38.5% of the accidents with scorpions, while those aged 65 and over, which account for 18.2% of the population, were involved in only 2.2% of the reported accidents suggest that the risk of suffering accidents with scorpions diminish with age.

It has also to be pointed out that our data show no difference in risk by sex at any age. Interestingly, previous reports on local cases in children at different provinces showed that boys were more frequently stung than girls: ratios were of 1.6: 1 (36 cases under 12 years old in Santiago del Estero, Del Valle Luna and Luna, 1997), 2.0: 1 (29 cases below 14 years old in Córdoba, Gordillo et al., 2000) and 2.6: 1 (11 cases under 11 years old in Santa Fe, Peirano et al., 2000). These differences could be due to a relatively low number of cases analyzed.

Feet and hands accounted for 72% of the stings, a frequency not very different from those reported by other authors in Argentina: 61% (Gordillo et al., 2000) and 86% (Del Valle Luna and Luna, 1997).

Local signs and symptoms were recorded in almost all files. Moreover, they were the unique clinical data reported in 37% of the cases, mainly among adults. The most frequent were pain (85%), edema (26.6%), burning (24.7%) and erythema (20.7%). Besides, some stung individuals (<12%) presented pruritus and itching, local neurological manifestations like paresthesia and the presence of cramps, excitation and headache.

The predominant signs involving the cardiovascular system were paleness (18.8%) and tachycardia (18.2%). Dyspnea, hypotension, arrhythmia, cyanosis, bradycardia

and precordial pain were rare (<5%). These symptoms together with the finding of hypothermia suggest an adrenergic autonomic disturb, involving specially the sympathetic system. On the other hand, there were also cases of vomiting, sweating and sickness, indicating cholinergic stimulation or the involvement of the parasympathetic system. That is in accordance with the presence of both autonomic stimulations in *Tityus* scorpion envenomation (Freire-Maia and Campos 1987; Freire-Maia, 1990; Freire-Maia et al., 1994) as well as in mice experimentally injected with venom of *T. trivittatus* (De Roodt et al., 2001).

Vomiting, cardiovascular involvement (except hypotension) and dyspnea were relative higher in children younger than 10 years old than in older people, while headache, paresthesia and arthralgia were lower. However, this data suggests that after the scorpion sting younger people have higher probability of showing at least one systemic symptom.

The signs and symptoms observed in the present study are similar to those described in the envenomation by other American Buthidae scorpions, regarding both local and systemic levels (Dehesa-Dávila and Possani, 1994; Freire-Maia et al., 1987, 1990, 1994; Mazzei de Davila et al., 1997; Schenone and Fontecilla, 1998; Ministerio da Saúde, 1999; Lira da Silva et al., 2000). Our data support previous reports on *Tityus* envenomation (Freire-Maia et al., 1994) indicating that the symptoms of scorpion envenomation are very rich and sometimes with opposite effect complicating the medical management of this type of envenomation.

Time elapsed between the accident and the administration of specific antivenom appears critical because scorpion venom is distributed very fast, as shown on clinical and experimental reports (Ismail and Abd-Elsalam, 1988; Chávez Olortegui et al., 1994; De Rezende et al., 1995a; Santana et al., 1996; Krifi et al., 1998). According to our data, almost 90% of stung people in Argentina received the antivenom within the first 2 h after the accident, with good response. Such improvement of patients with severe envenomation after the administration of antivenom has been repeatedly documented (Tomassone et al., 1994; Gordillo et al., 2000; Peirano et al., 2000).

It is worth recalling that all fatalities recorded by the health authorities in Argentina and by some reports from local authors (Martino et al., 1979; Del Valle Luna and Luna 1997) refer to people stung that have not received antivenom properly. However, many stung people did not receive antivenom and survived the envenomation.

In addition, we did not observed any severe envenomation of people stung in the area of Buenos Aires City. The clinical symptoms recorded in the Hospital 'F.J. Muñoz' were only local. Similar situation seems to happen in the Province of Buenos Aires. Since the Province of Buenos Aires does not report to the PNO program the cases registered in this province were not included in the present statistical analysis. However,

the information available indicates that 127 scorpion accidents (without discrimination of species) occurred in the province of Buenos Aires during the period 1998/1999, including 5 showing moderate intoxication symptoms and 36 presenting only local pain (C.C. López, Centro Nacional de Intoxicaciones, Ministerio de Salud, personal communication). Based on the description of the scorpions, it is assumed that a high number of accidents in the Province of Buenos Aires, including all those that showed moderate intoxication, are due to *T. trivittatus*, since the other scorpion commonly found in the Province (*Bothriurus bonariensis* from Bothriuridae Family, which has a venom with low toxicity to mammals) is morphologically quite different of *T. trivittatus* (Salomon and De Roodt, 2001).

The appropriate treatment of scorpion envenoming remains controversial. While several authors consider that a correct clinical management on treatment of Buthidae envenomation makes unnecessary the use of specific antivenom (Gueron and Ovsyshcher, 1987; Gueron and Sofer, 1994; Sofer et al., 1994; Abrough et al., 1999), other authors do recommend the use of the scorpion antivenom (Freire-Maia and Campos, 1987; Freire-Maia, 1990; Freire-Maia et al., 1994; Dehesa-Dávila and Possani, 1994; Ismail, 1994; Sofer et al., 1994; Mazzei de Davila et al., 1997; Ghalim et al., 2000; Osnaya-Romero, 2001; Possani 2000). It is worth recalling that the severity of the envenomation in *Tityus* sting is directly related with the amount of venom inoculated and with the quantity of circulating venom (De Rezende et al., 1995a) and that the antivenom is capable to neutralize the circulating venom (De Rezende et al., 1995b). In this study, it has also been observed the efficacy of the available antivenom. Among our data deaths due to *T. trivittatus* stings, come from people in which the antivenom treatment was not properly applied.

In summary, most provinces in Argentina are endemic places for scorpions, and consequently involved in a hazardous public health problem. However, accidents with scorpions in Argentina are in general mild and with low lethality. Most human victims of scorpionism experience local pain or a mild burning sensation at the site of the sting but do not develop general envenomation.

As far as we know, the present is the first epidemiological study directed to establish the clinical features associated to envenoming with *T. trivittatus*, the southern species of *Tityus* that involves medical risk. We hope that the present report will contribute to build up a more clear criteria for diagnosis and treatment and will stimulate clinical research in order to establish dosage, route of administration and amount of antivenom to be used or even to decide whether mild cases, only reporting local symptoms, do really need to be treated or would solve the envenomation by themselves.

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