ORIGINAL RESEARCH

Evaluation of Scorpion Envenomation by *Tityus trivittatus* in Adults: An Analysis of Variables Related to Severity of Clinical Presentation

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Introduction—In Argentina, the scorpion species *Tityus trivittatus* has been the species most commonly associated with serious injury and death.

Methods—We performed a retrospective study of cases of *T trivittatus* envenomation that presented to the emergency department at an infectious disease hospital in Cordoba, Argentina, between December 2014 and February 2015. All cases were taxonomically confirmed using criteria established in the Argentine Ministry of Health national guidelines. The primary outcome was classification of clinical presentation (mild/moderate/severe). Classification of clinical presentation was performed in a post hoc fashion using the national guidelines and compared to the classification of clinical presentation given to patients at the time of diagnosis in the emergency department.

Results—We included 450 individuals with *T trivittatus* envenomation. The median age of was 36 y (interquartile range 25–52), and 57% were female. In the emergency department, only 5 patients (<1%) were diagnosed as moderate cases and received antivenom; all other cases were diagnosed as mild. Conversely, in our post hoc classification of clinical presentations, 280 patients had mild presentations, 170 had moderate presentations, and no patients had severe presentations. In our cohort, there were no deaths, no inpatient hospital admissions, and no requirements for continuous cardiac monitoring. We found that age >50 y, (odds ratio [OR] 2.5, $P<0.001$), time from sting to presentation >120 min (OR 2.6, $P=0.02$), and pre-existing hypertension (OR=3.9, $P<0.001$) were all independently associated with worse post hoc classification severity.

Conclusions—Our study exposed factors associated with moderate presentations of scorpion envenomation and proposes the option of conservative treatment for affected adults.

Keywords: *T trivittatus*, scorpionism, scorpion sting

Introduction

Scorpion envenomation is a public health concern in many regions of the world and is responsible for over 3200 annual deaths globally.^{1,2} In South America, scorpions of the genus *Tityus* have been the most commonly associated with serious injury and death.^{3–7} In Argentina, an estimated 6871 scorpionism cases per year were reported between 2005 and 2009, and 74% of these were

attributed to scorpion species of clinical significance. Among the 45 native species of scorpions in Argentina, *Tityus trivittatus* is of the most clinical significance.^{8,9} The mechanism of *T trivittatus* venom is thought to primarily involve Na⁺ channel modulation and has activity similar to other beta-type sodium scorpion toxins.^{10,11} Although the overall risk of mortality per envenomation is relatively low, the wide distribution and the synanthropic behavior of these arthropods make them a significant public health risk.^{12,13}

Classification of clinical presentation differs widely among scorpion species, based on the endemic areas in which guidelines are published. Although global consensus guidelines have been published in an attempt to

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Submitted for publication November 2018.

Accepted for publication May 2019.

standardize diagnosis and treatment of scorpionism, differences in clinical presentation limit their use, and the use of these guidelines by global providers remains unknown.^{14–16}

In 2011, the Argentine Ministry of Health published national guidelines for the diagnosis and treatment of scorpion envenomation (Table 1).⁸ This classification, based on clinical presentation, is important because it provides guidance on how to manage patients who first present to a healthcare facility. However, since the release of the Argentine national guidelines, there have been no large studies reporting the relative prevalence of each clinical classification (ie, mild, moderate, severe). In the current study we aimed to assess diagnostic and treatment patterns related to clinical classification of *T trivittatus* envenomation and to characterize clinical variables associated with envenomation severity to better define clinical practice and future treatment guidelines.

Methods

We performed a retrospective cohort study of *T trivittatus* envenomation cases seen in the emergency department (ED) of a public infectious disease hospital in Cordoba, Argentina. We evaluated the medical records of all cases seen between December 8, 2014 and February 11, 2015 (66 d). We included patients who were aged ≥ 14 y, who were stung by *T trivittatus*, and who brought the scorpion to the ED for species confirmation. Because of national health regulations, our institution is unable to care for children aged <14 y because these patients are assigned to pediatric centers. The species

was taxonomically confirmed by ED providers per the Argentine Ministry of Health national guidelines, which helps differentiate *T trivittatus* from other endemic scorpions such as *Bothriurus bonariensis*.⁸ The primary endpoint was classification of clinical presentation (mild/moderate/severe). Although classification of clinical presentation was recorded at the time of diagnosis by the physician in the ED, because of ambiguities in the national guidelines, we performed an additional post hoc classification of clinical presentation. We then compared the clinical classification made at the time of diagnosis with the post hoc classification. Secondary endpoints included treatment and resolution of vital sign abnormalities at subsequent 2-h follow-up.

Clinical data related to scorpionism symptomology were collected using standardized intake forms, with checkboxes for each local or systemic sign or symptom, at the time of initial ED evaluation. Vital signs were recorded at the time of presentation and during a subsequent 2-h follow-up period. Systemic symptoms (ie, nausea, diaphoresis) were not recorded at subsequent 2-h follow-up. Other variables collected included demographic information, age, sex, site of venom inoculation, time of sting, time of medical treatment, and treatment administered. Although Argentine national guidelines recommend at least a 6-h observation period, it has been the clinical practice of the institution to observe patients every 2 h after presentation until symptoms resolve and vital signs stabilize and then discharge patients to home with instructions to return if new symptoms emerge.⁸ Patients diagnosed with moderate presentations in the ED were treated with a specific divalent, equine-derived immunoglobulin antivenom [F(ab')₂], produced by the Argentine National Institute for the Production of Biologics.

Summary statistics were performed and stratified by clinical presentation (mild vs moderate). Continuous variables were expressed as medians and interquartile ranges (IQRs), and categorical variables were expressed as percentages and proportions. The Fisher exact test and Mann-Whitney U test were used to compare categorical and continuous variables, respectively. Categorical variables thought to most plausibly affect classification of clinical presentation underwent univariate analysis with the Fisher exact test. Variables trending with a *P* value <0.1 on univariate analysis underwent multivariate analysis using maximum likelihood dichotomous logistic regression models. A *P* value ≤ 0.05 was taken as the criterion for statistical significance. Statistical analysis was performed using STATA v14.2 (Statacorp, College Station, TX).

This study was approved by the commission for the regulation and assessment of scientific studies of the Hospital Rawson.

Table 1. Argentine national guidelines for classification of *T trivittatus* envenomation

Clinical classification	Definition
Mild	<ul style="list-style-type: none"> • Local signs and symptoms at the site of inoculation only
Moderate	<ul style="list-style-type: none"> • Local signs and symptoms • Systemic symptoms (ie, diaphoresis, nausea/vomiting) without significant hemodynamic/respiratory compromise
Severe	<ul style="list-style-type: none"> • Local signs and symptoms • Systemic symptoms that include but are not limited to altered mental status with psychomotor agitation, tachycardia progressing to bradycardia, early-onset hypersalivation, rhinorrhea and excessive lacrimation, hypothermia, paleness, cold extremities, bradypnea, and diaphoretic crisis

Results

ALL SCORPION STINGS

During the specified study period, 694 cases of scorpion envenomation presented to our institution's ED. The scorpion specimen was brought to the ED by the patient for species confirmation in 516 cases (74%). Of these, 450 (87%) were attributed to *T trivittatus* and 66 (13%) were attributed to *B bonariensis*.

CONFIRMED T TRIVITTATUS STINGS

The median age of individuals was 36 y (IQR 25–52), and 57% (n=259) of affected patients were female (Table 2). Hypertension was the most common vital sign abnormality at presentation (27%, n=122), followed by tachycardia (7%, n=31). Thirty-seven percent of patients presenting with hypertension had a pre-existing diagnosis of chronic hypertension. Patients with known chronic hypertension were more likely to present to the ED with hypertension (66 vs 20%; $P<0.001$). Headache (2%, n=9) and nausea/vomiting (2%, n=8) were the most common systemic symptoms at the time of presentation. Other systemic symptoms present in >1% of cases included dizziness, diaphoresis, and myalgias. Patients with a time from sting to presentation >120 min were more likely to be treated with antivenom (13 vs 0.2%; $P<0.001$), steroids (20 vs 0.2%; $P<0.001$), antihistamine (13 vs 4%; $P=0.048$), and tetanus booster (7 vs 0.5%; $P=0.025$).

Clinical classifications made by providers at the time of ED presentation revealed 445 (99%) patients with a mild presentation, 5 patients with a moderate presentation (1%), and no patients with a severe presentation. All 5 patients with moderate classifications diagnosed at the time of ED presentation were treated with antivenom. (Clinical presentation of these 5 patients is described in Table 3.)

Using the Argentine National guidelines, our post hoc classification of clinical presentation revealed that 280 patients (62%) were classified as having a mild clinical presentation, 170 (38%) were classified as having a moderate presentation, and no patients were classified as having a severe presentation. Most patients (72%, n=122) with moderate presentations had a single systemic sign or symptom. Among these patients, most had an isolated vital sign abnormality without the presence of other systemic symptoms, with hypertension and tachycardia being the most common. In our cohort, there were no patient deaths, no inpatient hospital admissions, and no requirements for continuous cardiac monitoring. One patient returned to the ED after discharge for headache

Table 2. Patient characteristics of all 450 cases of *T trivittatus* envenomation

Parameter	Median (IQR)(n) or percentage (proportion)
Selected clinical data	
Median age (y)	36.5 (25–52)(450)
Female sex	58% (259/450)
Median minutes from sting to presentation	33 (23–60)(435)
Presented with ≥ 2 stings	8% (34/441)
Site of envenomation	
Upper extremity	40% (182/450)
Lower extremity	45% (203/450)
Trunk	8% (37/450)
Head/Neck	3% (13/450)
Comorbidities	
≥ 1 comorbidity	3% (30%)
Diabetes	4% (19/450)
Hypertension	15% (68/450)
Cardiovascular disease	1% (5/450)
Signs and symptoms	
Local pain	80% (358/450)
Local erythema	37% (166/450)
Local hypoesthesia	14% (65/450)
Local edema	10% (45/450)
Any systemic symptoms or VS abnormalities	39% (177/450)
Treatment	
Any treatment	6% (25/450)
Steroids	2% (7/450)
Antihistamines	1% (4/450)
Antivenom	1% (5/450)
Tetanus booster	5% (22/450)

IQR, interquartile range; VS, vital sign.

and tinnitus; the patients was monitored for 4 h before being re-discharged home without any complications.

The 2-h follow-up data were available for 72 patients (16%) (Table 4). Patients with isolated systolic

Table 3. Clinical characteristics of ED-diagnosed moderate cases

Patient	Sex	Age (y)	Clinical signs/symptoms
1	F	66	Tachycardia (100 beats·min ⁻¹)
2	F	25	Diaphoresis, N/V, headache, myalgia, tachycardia (100 beats·min ⁻¹)
3	M	30	Tremors, tachycardia (130 beats·min ⁻¹)
4	F	47	N/V
5	M	40	Diaphoresis, pallor, headache, tremors, tachycardia (126 beats·min ⁻¹)

ED, emergency department; F, female; M, male; N/V, nausea/vomiting.

Table 4. Vital sign abnormalities at presentation and at 2-h follow-up in the emergency department

VS abnormalities	Patients with VS abnormality at presentation	Patients with resolution of VS abnormality at 2 h
HTN	27% (122/450)	24% (17/72)
Mixed HTN	53% (65/122)	13% (5/40)
Systolic-only HTN	30% (36/122)	38% (12/32)
Diastolic-only HTN	17% (21/122)	29% (6/21)
Tachycardia	7% (31/450)	46% (6/13)
Tachypnea	4% (16/450)	80% (8/10)
Bradycardia	1% (6/450)	No data
Hypotension	0.4% (2/450)	No data
Fever or hypothermia	0% (0/450)	n/a

VS, vital sign; HTN, hypertension; n/a, not applicable.

hypertension were more likely to return to normal blood pressure when compared to those with mixed systolic/diastolic hypertension (50 vs 12%; $P=0.003$). A similar trend was found between isolated diastolic hypertension and mixed hypertension (46 vs 12%; $P=0.01$).

Univariate analysis revealed that individuals with a post hoc clinical classification of moderate were significantly older (median 49 [IQR 31–64] vs 33 y [IQR 23–44]; $P<0.001$), had higher rates of pre-existing hypertension (29 vs 6%; $P=0.001$), and were more likely to experience a sting-to-presentation time of >120 min (11 vs 4%; $P=0.01$) (Table 5) compared with those with mild clinical presentations. Patients with a post hoc classification of moderate were also more likely to be treated with steroids (4 vs 0.3%; $P=0.013$) and antivenom (3 vs 0%; $P=0.007$). Multivariate analysis revealed that age >50 y, time from sting to presentation >120 min, and

pre-existing hypertension were independently associated with a post hoc clinical classification of moderate (Table 6).

Discussion

Scorpion envenomation is a public health concern in Argentina and around the world. It is estimated that about 10 to 30% of scorpion stings worldwide result in systemic toxicity requiring emergency consultation.^{14,15,17} Whereas ED providers at our institution diagnosed just 1% of taxonomically confirmed *T trivittatus* cases as moderate, our post hoc classification found that 38% of cases warranted a classification of moderate, per Argentine National guideline criteria. Because the results of our post hoc classification would represent the highest reported percentage of moderate cases of scorpion envenomation in the world, this is less likely to be due to the high toxicity of *T trivittatus* and more likely the result of the methods used to classify cases. The large discrepancy between ED classification and the post hoc classification of envenomation severity suggests that current guidelines may be too liberal or local providers may be too conservative, or both. In our study, most post hoc classifications of moderate were due to a single isolated vital sign abnormality (without other systemic symptoms) at the time of presentation, of which hypertension was the most common. However, true systemic envenomation should affect multiple organ systems, leading to multiple systemic signs and symptoms; thus, isolated vital sign abnormalities are unlikely to be related to scorpion envenomation.¹²

Multivariate analysis revealed that pre-existing hypertension was independently associated with a post hoc classification of moderate. However, because hypertension represents a systemic sign, this automatically yields a moderate classification regardless of pre-existing hypertension; the Argentine national guidelines do not

Table 5. Univariate analysis of variables associated with post hoc clinical classification

Selected variables	Classification of presentation		P
	Mild (n=280)	Moderate (n=170)	
Age >50 y	16% (46/280)	44% (74/170)	<0.001
Female sex	56% (158/280)	59% (101/170)	0.556
>120 min from sting to presentation	4% (12/273)	11% (18/162)	0.01
Presented with ≥ 2 stings	9% (25/274)	5% (9/167)	0.198
Diabetes	3% (8/280)	7% (11/170)	0.089
Pre-existing hypertension	6% (18/280)	29% (50/170)	<0.001
Cardiovascular disease	0.4% (1/280)	2% (4/170)	0.07

Variables expressed as % (proportion). P values derived using Fisher's exact test.

Table 6. Multivariate analysis of factors independently associated with a post-hoc clinical classification of moderate

Trending variables	OR (95% CI)	P
Age >50 y	2.5 (1.5–4.2)	<0.001
>120 min from sting to presentation	2.6 (1.2–5.9)	0.021
Diabetes	0.8 (0.3–2.4)	0.698
Pre-existing hypertension	3.9 (2.0–7.4)	<0.001
Cardiovascular disease	1.8 (0.2–17.6)	0.634

OR, odds ratio.

Dependent variables were analyzed by maximum likelihood dichotomous logistic regression, and outputs are displayed as odds ratios (95% CI).

discriminate between patients with this comorbidity. In fact, 45 patients with hypertension at presentation (and no other systemic signs or symptoms) were likely defined as “moderate” simply because of poor control of their documented chronic hypertension and not because of any pathophysiological effect of scorpion envenomation. Likewise, the presence of isolated tachycardia, tachypnea, nausea, or other nonspecific systemic signs and symptoms all warranted “moderate” classifications, although most of these signs and symptoms can be explained by benign etiologies in some patients. Perhaps that is why other countries in the region, such as Colombia, do not consider mild gastrointestinal symptoms (nausea, diarrhea) to be part of a moderate presentation.¹⁸ Argentine guidelines do not provide any assistance in differentiating between sympathetic symptoms stemming from envenomation and those related to anxiety or pain.⁸ The ambiguity created by these cases makes the management of these patients difficult because guidelines may recommend treatment with antivenom in patients whose systemic signs and symptoms may be unrelated to scorpion envenomation (Table 6).

Explaining the difference between ED classification and post hoc classification of envenomation severity is important because the clinical classification is used to inform patient treatment with scorpion antivenom.⁸ In our study, 97% of moderate cases (as defined by our post-hoc analysis) were treated conservatively, without the delivery of antivenom, continuous cardiac monitoring, or in-patient admission. Among these patients, there were no fatalities or severe complications. A single patient had to return to the ED, but the chief symptoms of headache and tinnitus were unlikely related to scorpion envenomation. These data suggest that conservative treatment of select adult patients with moderate presentations can help preserve clinical resources without compromising patient safety. However, because follow-up data were limited in our cohort, it is unclear whether the clinical presentation may have continued to

evolve and whether this would have changed the patients’ clinical classification and need for antivenom. Moreover, because our study classified the clinical presentation in a post hoc fashion, it is difficult to assess which patients should or should not have received more aggressive treatment because it is impossible to recreate an individual provider’s clinical reasoning using retrospective data.

The clinical severity of scorpionism is known to be related to patient age.^{13,19–23} Although mortality risk from *T trivittatus* is estimated to be 6 per 1000 cases, all documented fatalities have been in children.¹³ The exclusion of children <14 y in our study helps explain the lack of mortality in our cohort. Although increased morbidity has been associated with advanced age in cases of envenomation from other species of scorpions, to our knowledge, our study is the first to demonstrate this trend in cases of *T trivittatus* envenomation.^{19,21} Unsurprisingly, patients aged >50 y were more likely to have diabetes, pre-existing hypertension, and cardiovascular disease; however, when correcting for these variables, age remained an independently significant risk factor for moderate presentation. These findings suggest that older patients may be more susceptible to the pathophysiological effects of scorpion envenomation for reasons incompletely explained by a higher proportion of comorbidities.

A time from sting to antivenom administration of <120 min has been previously associated with improved clinical prognosis.^{8,9} Our study found that a time from sting to presentation >120 min was independently associated with a moderate clinical presentation. Additionally, these same patients were more likely to receive treatment with antivenom, steroids, antihistamine, and tetanus booster. These results suggest that a prolonged time from sting to presentation may negatively affect patient outcomes, as these individuals likely require more aggressive treatment.

Patients presenting with isolated systolic hypertension were more likely to have resolution of their hypertension at 2-h follow-up, and this same trend was seen in patients presenting with isolated diastolic hypertension. In these select groups of patients in whom hypertension resolved, it is likely that the elevation in blood pressure was related to anxiety or pain rather than the toxic effects of envenomation. These results suggest that isolated systolic or diastolic hypertension may be a positive prognostic indicator for a favorable clinical course.

This study is limited by its retrospective design. Because we performed a post hoc determination of clinical severity, there is a risk of misclassifying patients because errors in data collection could give an incomplete clinical picture. Furthermore, our institution’s inability to care for children also limits this study; it is well known that pediatric patients are at increased risk of

systemic symptoms and death when compared to adults. Our series did not contain any patients with a severe presentation, and therefore we cannot comment on this pattern. Because 2-h follow-up data were only available in 16% of patients, this limits our ability to draw any definitive conclusions regarding resolution of vital sign abnormalities and prognosis. Because the time frame of our study was just 2 mo, we cannot comment on seasonal patterns of scorpion stings. Other large prospective studies that include children are needed to explore the broad applicability of these findings.

In summary, our report found that age >50 y, pre-existing hypertension, and time from sting to presentation >120 min were independently associated with a moderate presentation, and patients with isolated systolic or diastolic hypertension were more likely to return to normal blood pressure when compared to patients with mixed systolic/diastolic hypertension. No adverse events were observed after conservative management of patients with a post hoc clinical presentation of moderate; however, because follow-up data were limited, the safety of this practice remains unclear. We believe that our findings provide an updated contribution to the evaluation and management of *T. trivittatus* envenomation and should be considered in future revisions of national treatment guidelines and by providers caring for these patients.

Author Contributions: NF and JF contributed equally to this work and share first authorship. Study design (NF, DV, AB, LM); data collection (NF, DV, AB, LM); data analysis (JF); writing of manuscript (JF, JD); critical revisions (NF, JF, DV, AB, JD, LM).

Financial/Material Support: This work was supported in part by the Doris Duke Charitable Foundation through a grant supporting the Doris Duke International Clinical Research Fellows Program (Grant number 2016176) at the University of Minnesota. James Leathers is a Doris Duke Fellow.

Disclosures: None.

References

- Chippaux JP, Goyffon M. Epidemiology of scorpionism: a global appraisal. *Acta Trop*. 2008;107(2):71–9.
- Bawaskar HS, Bawaskar PH. Scorpion sting: update. *J Assoc Physicians India*. 2012;60(1):46–55.
- Becerril B, Marangoni S, Possani LD. Toxins and genes isolated from scorpions of the genus *Tityus*. *Toxicon*. 1997;35(6):821–35.
- De Sousa L, Bonoli S, Quiroga M, Parrilla P. Scorpion sting epidemiology in Montes Municipality of the State of Sucre, Venezuela: geographic distribution. *Rev Inst Med Trop Sao Paulo*. 1996;38(2):147–52.
- Pardal PP, Castro LC, Jennings E, Pardal JS, Monteiro MR. Epidemiological and clinical aspects of scorpion envenomation in the region of Santarem, Para, Brazil [in Portuguese]. *Rev Soc Bras Med Trop*. 2003;36(3):349–53.
- Otero R, Navio E, Cespedes FA, Nunez MJ, Lozano L, Moscoso ER, et al. Scorpion envenoming in two regions of Colombia: clinical, epidemiological and therapeutic aspects. *Trans R Soc Trop Med Hyg*. 2004;98(12):742–50.
- Chippaux JP, Galtier J, Lefait JF. Epidemiology of envenomation in French Guiana [in French]. *Bull Soc Pathol Exot Filiales*. 1984;77(2):206–15.
- Guía de Prevención, Diagnóstico, Tratamiento y Vigilancia Epidemiológica del Envenenamiento por Escorpiones. [Guide for Prevention, Diagnosis, Treatment and Epidemiological Record Keeping, for Scorpion Envenomation]: National Ministry of Health of Argentina; 2011.
- Saracco A, Dra. Cabrera A, García S. Envenenamiento por animales ponzoñosos. Escorpionismo. [Envenomation by poisonous animals. Scorpionism]. *Inform Bull Toxicol Soc Arg*. 2006;71:17–23.
- Coronas FI, Diego-Garcia E, Restano-Cassulini R, de Roodt AR, Possani LD. Biochemical and physiological characterization of a new Na(+)-channel specific peptide from the venom of the Argentinean scorpion *Tityus trivittatus*. *Peptides*. 2015;68(1):11–6.
- Ward MJ, Ellsworth SA, Nystrom GS. A global accounting of medically significant scorpions: epidemiology, major toxins, and comparative resources in harmless counterparts. *Toxicon*. 2018;151(1):137–55.
- de Roodt AR, Cornonas FI, Lago N, Gonzalez M, Laskowicz RD, Beltramino J, et al. General, biochemical and immunological characterization of the venom from the scorpion *Tityus trivittatus* of Argentina. *Toxicon*. 2010;55(2-3):307–19.
- de Roodt AR, Garcia SI, Salomón OD, Segre L, Dolab JA, Funes RF, et al. Epidemiological and clinical aspects of scorpionism by *Tityus trivittatus* in Argentina. *Toxicon*. 2003;41(8):971–7.
- Isbister GK, Bawaskar HS. Scorpion envenomation. *N Engl J Med*. 2014;371(5):457–63.
- Khattabi A, Soulaymani-Bencheikh R, Achour S, Salmi LR. Classification of clinical consequences of scorpion stings: consensus development. *Trans R Soc Trop Med Hyg*. 2011;105(7):364–9.
- Nouira S, Boukef R, Nciri N, Haguiga H, Elatrous S, Besbes L, et al. A clinical score predicting the need for hospitalization in scorpion envenomation. *Am J Emerg Med*. 2007;25(4):414–9.
- Chippaux JP. Emerging options for the management of scorpion stings. *Drug Des Devel Ther*. 2012;6(1):165–73.
- Bogota, Colombia: Ministry of Social Protection; 2008.
- Santos MS, Silva CG, Neto BS, Grangeiro Junior CR, Lopes VH, Teixeira Junior AG, et al. Clinical and epidemiological aspects of scorpionism in the world: a systematic review. *Wilderness Environ Med*. 2016;27(4):504–18.

20. Bucaretschi F, Baracat EC, Nogueira RJ, Chaves A, Zambone FA, Fonseca MR, et al. A comparative study of severe scorpion envenomation in children caused by *Tityus bahiensis* and *Tityus serrulatus*. *Rev Inst Med Trop Sao Paulo*. 1995;37(4):331–6.
21. Celis A, Gaxiola-Robles R, Sevilla-Godinez E, Orozco Valerio Mde J, Armas J. Trends in mortality from scorpion stings in Mexico, 1979–2003 [in Spanish]. *Rev Panam Salud Publica*. 2007;21(6):373–80.
22. Champetier De Ribes G, Jeddi HM. Anti-scorpionic control in the governorat of Sidi Bouzid, Tunisia. *Bull Soc Pathol Exot Filiales*. 1984;77(5):712–6.
23. Miranda Ruiz H. Scorpion stings [in Spanish]. *Rev Cubana Med Trop*. 1986;38(3):343–7.