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Change of Temperature at Sting Site by Scorpion in León, Guanajuato

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Abstract

Introduction: Being Mexico one of the countries with the highest diversity in species of scorpions, their population is at a greater risk of being poisoned by scorpion sting. The objective of this study was to analyze the change in temperature at the sting site and describe the clinical evolution of patients treated between May and September 2017.

Methods: Descriptive, longitudinal, prospective study realized in the Red Cross Antialacran Center of Leon, Guanajuato in patients older than 6 years requiring specific treatment for scorpion sting. The variables of study are presented descriptively while baseline temperature in sting site and temperature after leaving the center were compared with t student's test. Additionally we performed a *post hoc* comparison analysis between antivenom treatments available during the time of this evaluation.

Results: One seventy four cases were analyzed, 51.1% were men, average age of 31.8 years, and 44.2% were classified as poisoning grade I; 48.9% as grade II and 6.9% as grade III. The reported mortality was zero. The average temperature at Sting site prior to treatment was 35.83°C and in contralateral site of 36.24°C. Hospital discharge mean temperature was 36.22°C at the sting site while in contralateral site was 36.37°C.

Conclusion: It was observed a significant difference between the baseline temperature at sting site and at contralateral limb, which represents a sign that could support the diagnosis of envenomation. There was also a trend to normalization in the temperature of the sting site, which could be considered to evaluate the response to treatment. Antivenom therapy demonstrated to be safe and effective in therapy for this group of patients. The post-hoc analysis concluded that the dose for two types of treatment was different this must be confirmed in another study.

Keywords: Scorpion stings; Arthropod venoms; Antivenins; Body temperature

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Introduction

Mexico is considered a megadiverse country since it is one of the 6 countries worldwide where all orders of Arachnids are present; specifically, scorpions are accountable for 7 families, 23 genera and 280 species and subspecies recorded, of which 16 are of medical importance; last ones corresponding to the family *Buthidae*, genus *Centruroides*, whose members are present from the South to Northern South America; in Mexico they are distributed in 30.3% of the national territory, so that 36.8% of the Mexican population is at risk of suffering poisoning by scorpion sting [1-7].

Taxonomic research in Mexico on these arachnids began in The 1930s. Scorpions *Centruroides* of medical importance identified in Mexico are: *Centruroides noxius* (considered the most toxic in the country) found mainly in the State of Nayarit; *Centruroides limpidus* in Guerrero, Morelos and Michoacan; *C. infamatus* in Guanajuato and Mexico State; *C. elegans* in Jalisco; *C. tecomanus* in Colima; *C. suffusus* in Durango and *C. sculpturatus* in Sonora. In addition, Mexico is still giving description of new species of the genus *Centruroides*; with type locality in Jalisco, Colima, Balsas depression, among others in recent years, providing important information which results in a better understanding and control of the epidemiologic phenomenon [3,4,6,8-17].

The poisoning by sting of scorpion poisoning is located within the 20 major health problems in Mexico, affecting mainly children and adults older than 65 years, in rural areas and in recent years increasing in urban areas as a consequence of the invasion of natural habitats; considering that

approximately 300,000 poisonings occur within a year in national territory. The only specific treatment for the treatment of this pathology is antivenom [1-4,8,18,19].

Most frequently affected sites are the upper and lower extremities. The rapid establishment of treatment is important and will have a direct impact on the prognosis for the patient. Symptoms occur within 20 min to 40 min after the sting [2].

The signs and symptoms described are: pain at site of sting (97%), paresthesia (97%), sensation of foreign body in pharynx (40%), sialorrhea (40%), nasal pruritus (40%), pharyngeal itching (40%), tongue twitching (40%), nystagmus (38%), abdominal distention (38%), high blood pressure (35%), priapism (30%), hesitant march (30%) and diaphoresis (30%) [20,21].

According to national guidelines and also mentioned in the Manual of Procedures for Epidemiological Surveillance of Poisoning by Scorpion sting of the Ministry of Health, the clinical picture is classified according to its severity and taking into account the major local and systemic manifestations [8,22].

- Slight - Pain at sting site, local paresthesia, restlessness, mild pruritus.
- Moderate - Most of slight symptoms and: persistent crying in children under 5 years, anxiety, headache, epiphora, eye redness, itchy nose, mouth and throat, sneezing, hypersalivation, sensation of foreign body in the pharynx, dysphagia, lingual twitching, xerostomia, tachycardia, dyspnea, abdominal distention, abdominal and muscle pain, priapism, pruritus vulvae.
- Severe - Moderate symptoms and: hypertension or hypotension, fever or hypothermia, miosis, mydriasis, photophobia, nystagmus, dyslalia, perioral cyanosis, convulsions, temporary amaurosis, bradycardia, arrhythmias, retrosternal, oliguria, unconsciousness, multiple organic failure, coma, death.

This classification is important because it is used to decide the specific treatment dosage. In Mexico there are two antivenoms available for the treatment of intoxication by scorpion sting: one manufactured by Laboratorios de Reactivos y Biológicos de México, S.A. de C.V. (Birmex) and the other one named Alacramyn® manufactured by Instituto Bioclon, S.A. de C.V. Both antivenoms are obtained from serum of hyperimmunized horses with a mixture of poisons of the most poisonous species in Mexico: *Centruroides noxius*, *Centruroides limpidus* and *Centruroides suffusus*. Both products have the ability to neutralize 150 LD_{50} per vial [8,15,17,23-25].

While the systemic effects of Scorpion venom are well described, local signs and symptoms are less known [26]. Clinical experience suggests that there are changes in temperature within the general symptoms secondary to scorpion poisoning in the sting site; however, to the date of this publication there is no specific publication about this signs [19].

In a study carried out in 1996 in the Red Cross of Nuevo Leon, incidence in general population is 109/10,000 inhabitants (Sting/town cases), with a growing tendency which makes it a public health problem [27].

The primary objective of this study was to examine changes in temperature at the sting site and the contralateral limb prior to the start of treatment and hospital discharge. As secondary objectives, changes in vital signs (blood pressure, heart rate and respiratory rate), time between sting and home health care, degree of intoxication, specific treatment type used, as well as length of hospital stay were evaluated and described.

Methods

Descriptive, prospective, longitudinal study in patients of both genders, older than 6 years and treated with specific pharmacological therapy in the Red Cross Antialacran Center of Leon, Guanajuato from May to September 2017.

Included subjects should present history of scorpion sting and symptoms compatible with poisoning with less than 2 hours of evolution. Subjects were not included in the study if they had a history of cardiovascular, neuropathic or kidney disease, as well as those who had used home treatments prior to arrival to the emergency room or that did not required specific treatment during hospitalization stay. The Protocol was approved by the Committee of Ethics of the Mexican Red Cross I.A.P. Leon Guanajuato.

The degree of intoxication was established by medical criteria, considering the suggestions established in national regulation (NOM SSA2-033-2011). Patients were treated with polyvalent antivenom for scorpion sting by prescription and according to availability in hospital pharmacy.

General procedure

After signing informed consent, demographic general data such as age, gender, degree of intoxication, anatomic region, and time of stinging, time of hospital admission for initiation of treatment as well as types of antivenom administered were obtained and registered. The study variables: temperature of the sting site and the contralateral anatomic site (Beurer laser thermometer, model FT90) and vital signs, were analyzed prior to the start of treatment and hospital discharge of the patient. Additionally, the initial dose and total antivenom doses needed at the end of treatment as well as hospitalization time were recorded.

Statistical analysis

Demographic and clinical variables that were categorical were presented as frequency and percentage. Quantitative variables were displayed with average, minimum-maximum, Standard Deviation (SD) and Confidence Interval (CI) when appropriate.

Test t of Student for related samples or Mann-Whitney U test was used to test changes between baseline and final evaluations. In the exploratory analysis, groups were compared using the univariate ANOVA test, showing average and confidence intervals. Considered a p-value <0.05 as significant, estimating the confidence intervals as 95% and using program SPSS version 25.

Results

In total, 184 patients agreed to participate and signed informed consent; of them, 10 were excluded from the analysis for not requiring specific treatment. Of the 174 cases, 89 were men (51.1%) and 85 women (48.9%); average age of 31.85 ± 16.7 years (range: 3 years to 82 years). Scorpion was identified in 161 cases.

During the period in which data was collected both antivenoms were available in hospital pharmacy making it possible to divide patients into two treatment groups. A *post-hoc* analysis was performed for this reason and the data is presented for total population and then for type of specific treatment used (A=Alacramyn®; Instituto Bioclon, Batch B-6G-31, expiration date July 2018; B=Birmex®, Laboratorios

Table 1: Baseline and Demographic Characteristics.

Gender	Treatment A (n=63)	Treatment B (n=111)	Total (n=174)	Sig.*(*p*)
Female, n (%)	30 (48)	55 (49.5)	85 (48.9)	NS
Male, n (%)	33 (52)	56 (50.5)	89 (51.1)	
Age, Mean ± SD	34.49 ± 15.35	30.35 ± 17.42	31.85 ± 16.77	NS
Sting-medical attention interval mean ± SD (CI 95%)	1:00 ± 1:04 (0:43 - 1:16)	1:12 ± 1:29 (0:55 -1:29)	1:07 ± 1:21 (0:55 - 1:20)	NS
Anatomical site of sting[&]				
Inferior extremities, n (%)	8 (12.7)	25 (22.5)	33 (19.1)	NS
Superior extremities, n (%)	54 (85.7)	68 (61.3)	122 (70.1)	NS
Torax, n (%)	1 (1.6)	9 (8.1)	10 (5.7)	NS
Back, n (%)	0	2 (1.8)	2 (1.1)	NS
Head and Neck, n (%)	0	7 (6.3)	7 (4)	NS
Intoxication degree[&]				
Grade I, n (%)	24 (38)	53 (48)	77 (44.2)	NS
Grade II, n (%)	36 (57)	49 (44)	85 (48.9)	
Grade III, n (%)	3 (5)	9 (8)	12 (6.9)	
Vital signs				
BSBP, Mean ± SD (IC 95%)	133.59 ± 25.58 (127.14-140.03)	117.93 ± 12.51 (115.57-120.28)	123.6 ± 19.77 (120.64-126.56)	<0.001
BDBP, Mean ± SD (IC 95%)	87.38 ± 17.47 (82.98-91.78)	75.14 ± 9.52 (73.34-76.93)	79.57 ± 14.21 (77.44-81.70)	<0.001
BHT, Mean ± SD (IC 95%)	81.89 ± 15.85 (77.90-85.88)	81.34 ± 14.21 (78.67-84.02)	81.54 ± 14.78 (79.33 – 83.75)	NS
Temperature at Sting Site Mean ± SD (IC 95%)	35.11 ± 2.06 (34.59 -35.63)	36.25 ± 0.59 (36.13-36.36)	35.83 ± 1.43 (35.62-36.05)	<0.001
Temperature at Contralateral Site Mean ± SD (IC 95%)	35.47 ± 1.31 (35.14-35.80)	36.67 ± 0.30 (36.61-36.73)	36.24 ± 1.00 (36.09-36.39)	<0.001

Treatment A: Alacramyn®; NS: Non Significative; SD: Standard deviation; Treatment B: Birmex®; BSBP: Baseline Systolic Blood Pressure; IC: Confidence Interval; *p: Univariable ANOVA between treatment groups; BDBP: Baseline Diastolic Blood Pressure; Sig: Statistical Significance; [&]p: U Mann-Whitney test, comparison of distribution between groups; BHR: Basal Heart Rate; n: Sample size

de Reactivos y Biológicos de México, Batch FA010-AE, expiration date January 2018).

Baseline demographic and clinical results are shown in Table 1 and the data of the clinical variables evaluated at hospital discharge, in Table 2.

All subjects completed the study, however not all complete data for vital signs, therefore, the final analysis had only considers data from subjects who had baseline and final data complete.

Elapsed time from stinging to hospital admission

The average of elapsed time between the sting of the scorpion and the admission to hospital for all subjects was 1:07 ± 1:21 hr; 1:00 ± 1:04 hr for treatment A and 1:12 ± 1:29 hr for treatment B. Univariate comparative analysis did not show statistically significant difference between groups (p=0.348).

Sting site

Anatomical distribution (arm, leg and chest) was statistically similar between groups (test of U Mann-Whitney, p=1.000). Only in the group treated with Birmex® cases in back, head and neck were presented. Percentages of cases by anatomical site and treatment group are presented in Table 1.

Degree of intoxication

All of the subjects included in the study were classified as follows: 77 cases (44.2%) classified as grade I, 85 (48.9%) as grade II and 12 (6.9%) as grade III. The frequency for treatment A was: 24 cases (38%) classified as grade I, 36 (57%) as grade II and 3 (5%) as grade III; for treatment B: 53 cases (48%) were classified as grade I, 49 (44%) as grade II and 9 (8%) as grade III. The distribution of intoxication degree was statistically similar between groups (test of U Mann-Whitney, p=0.382).

Vital signs

For study population the average for Baseline Systolic Blood Pressure (BSBP) was 123.60 ± 19.7 mmHg. For group of treatment A the BSBP average was 133.1 ± 25.5 mmHg and 114.77 ± 10.88 mmHg for treatment B. The average for Baseline Diastolic Blood Pressure (BDBP) was 79.57 ± 14.21 mmHg. For treatment A, the BDBP average was 87.38 ± 17.47 mmHg and 75.14 ± 9.52 mmHg for treatment B.

Statistically significant differences between groups were found regarding BSBP and BDBP (p<0.001), however in both cases, the values are within the clinical normal range.

The study population average for Hospital Discharge Systolic Blood Pressure (HDSBP) was 116.27 ± 13.4 mmHg, the average of HDSBP for treatment A was 120.24 ± 15.27 mmHg and 110.68 ± 7.28 mmHg for treatment B.

The average of Hospital Discharge Diastolic Blood Pressure (HDDBP) for study population was 77.15 ± 9.32 mmHg. For treatment A, the average was 79.16 ± 10.74 mmHg and 74.32 ± 5.86 mmHg for treatment B. The basal difference observed was maintained during the study ($p \leq 0.005$).

When comparing values prior to the start of treatment *versus* values of hospital discharge in the study population, a statistically significant difference is observed for systolic blood pressure (p=0.016) and for diastolic blood pressure (p=0.003).

Table 2: Final Clinical Characteristics.

	Treatment A (n=63)	Treatment B (n=111)	Total (n=174)	Sig.* (*p*)
Vital Signs&				
HPSBR, Mean ± SD (IC 95%)	120.24 ± 15.27 (116.36-124.12)	110.68 ± 7.28 (108.4-112.90)	116.27 ± 13.40 (113.69-118.85)	<0.001
HDDBP, Mean ± SD (IC 95%)	79.16 ± 10.74 (76.43-81.89)	74.32 ± 5.86 (72.53-76.10)	77.15 ± 9.32 (75.36-78.95)	0.005
HDHR, Mean ± SD (IC 95%)	76.10 ± 11.55 (73.16-79.03)	79.82 ± 8.11 (77.35-82.29)	77.64 ± 10.38 (77.64-79.64)	0.033
Temperature at Sting Site Mean ± SD (IC 95%)	35.91 ± 1.42 (35.55-36.27)	36.66 ± 0.26 (36.58 – 36.75)	36.22 ± 1.16 (36-36.45)	0.001
Number of vials used for Initial dose, Mean ± SD (IC 95%)	1.78 ± 0.83 (1.57-1.99)	2.55 ± 1.47 (2.27-2.83)	2.27 ± 1.33 (2.07-2.47)	<0.001
Total number of vials used, Mean ± SD (IC 95%)	1.92 ± 0.95 (1.68-2.16)	3.95 ± 3.25 (3.34-4.57)	3.22 ± 2.83 (2.79-3.64)	<0.001
Time of hospitalization	1:51 ± 0:43 (1:40-2:02)	2:00 ± 0:51 (1:51-2:10)	1:57 ± 0:48 (1:50-2:04)	NS

Treatment A: Alacramyn®; Treatment B: Birmex®; *p: Univariate ANOVA between treatments; NS: Non significative; HPSBR: Hospital Discharge Systolic Blood Pressure; HDPBP: Hospital Discharge Diastolic Blood Pressure; HDHR: Hospital Discharge Heart Rate; &: Análisis con; n: 62; tratamiento A y n: 44, tratamiento B; SD: Standard Deviation; IC: Confidence Interval; Sig: Statistical Significance; n: Sample Size

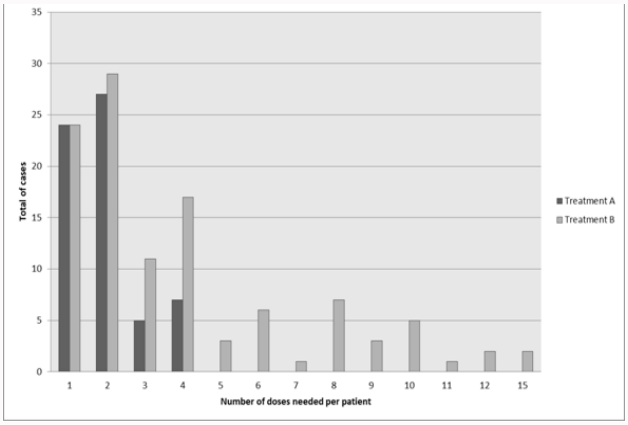

Figure 1: Cases according total number of doses needed. Treatment A: Alacramyn®, Treatment B: Birmex®.

The average heart rate prior to the initiation of treatment for the total sample was 81.54 ± 14.78 bpm and 77.64 ± 10.38 bpm at hospital discharge; being statistically significant the difference between this values (*p*=0.016), however it is not relevant since values are within clinically normal values.

For group of treatment A the average of heart rate prior to the start of treatment was 81.89 ± 15.85 and before hospital discharge 76.10 ± 11.55 bpm; for treatment B the average prior to hospitalization was 81.34 ± 14.21 lpm and before hospital discharge 79.82 ± 8.11 lpm (comparison between groups, basal *vs.* final: *p*=0.815 and *p*=0.033, respectively). Respiratory rate data were insufficient to carry out a comparative analysis.

Temperature at sting site and contralateral limb

The average temperature of the sting site in the evaluation prior to the initiation of treatment for the total sample was 35.83 ± 1.43°C and previous to hospital discharge was 36.22 ± 1.16°C ($p \leq 0.001$). For group of treatment A, prior to the start of treatment the average was 35.11 ± 2.06°C while for group of treatment B was 36.25 ± 0.59°C (*p*=0.000). At hospital discharge, the average for group of treatment A was 35.91 ± 1.42°C and 36.66 ± 0.26°C for group of treatment B (*p*=0.001).

The average temperature for contralateral member prior to the initiation of treatment for the total sample was 36.24 ± 1.00°C; at hospital discharge was 36.37 ± 0.80°C (*p*=0.000). In the group of treatment A, prior to the start of treatment temperature average was 35.47 ± 1.31°C and 36.67 ± 0.30°C in the group of treatment B (*p*=0.000). Contralateral temperature at hospital discharge for the group of treatment A average was 36.15+0.97°C and 36.68 ± 0.26°C for group of treatment *B* (*p*=0.001).

Analysis by type of treatment

The average for total vials used for all study population was 3.22 ± 2.83. For group of treatment A it was 1.92 ± 0.95, whereas for the group of treatment B was 3.95 ± 3.25. A statistically significant difference is observed between groups regarding the total number vials used before the hospital discharge (*p*=0.000). Figure 1 shows there is the relationship of cases by number of vials required.

Length of hospital stay

The average time of hospitalization for the total sample was 1:57 ± 0:48 hr; for patients in group of treatment A an average of 1:51 ± 0:43 hr and 2:00 ± 0:51 hr for patients in the group of treatment B. There were not statistically significant differences between groups (*p*=0.244).

Adverse events

No specific treatment-related adverse event was not reported and no subject died during hospitalization.

Discussion

Poisoning by sting of scorpion is a problem in Mexico that requires epidemiological approach in order to understand the real impact that has on the endemic areas; Leon, Guanajuato (place where this study was conducted) is nationwide leader of this problem. Being a medical condition that is usually presented in rural areas and therefore treated by first line practitioners (paramedics, general doctors, nursery), their training should be a priority to warranty an attention of quality and a better epidemiological knowledge of the condition.

The National Guideline for the treatment of sting by scorpion includes the clinical symptoms, diagnosis and treatment, which is widely described in various publications; however, to our knowledge, none mentions or describes the temperature at the sting site as intoxication.

The clinical manifestations are key elements to make a diagnosis in time to classify the degree of intoxication and start specific treatment in an optimal way to improve their prognosis. Having other signs, as lower temperature at the sting site in comparison to the contralateral limb can be a support tool in the diagnosis and the evolution of the patient.

As indicated in the National Guideline on Surveillance, Prevention and Control of the Poisoning by scorpion Sting, vital signs were monitored and all patients presented normal vital signs when discharged from hospital.

The initial temperature measurements at the sting site were discreetly minor in comparison with the contralateral limb, possibly due to local ischemia, however after initiating treatment they were regularized, being similar to hospital discharge.

The dosage of both treatments was different, being considerably higher in the group of patients treated with Birmex antivenom.

The present study had the following limitations: not being randomized and the size of the simple, situations; this may be considered in future studies.

The information presented here regarding local and systemic symptoms, as well as the types of treatment and its dosage, may be useful for the design of other studies.

Conclusion

The present study shows information from a hospital in which scorpion stings are common for medical practice, providing the description of local temperature decrease, identified in the daily practice but not previously documented.

This study reports a significant initial difference between the temperature of the sting site and the contralateral limb, which might help as a sign that supports de diagnosis of poisoning by scorpion sting. Trend to normalization of temperature was also recorded; this could be considered to evaluate the response to treatment.

Mexican health sector has two different treatment options, which led to different medical practices (dosage), making an impact in time of evolution of each case, which is reflected by the present study.

A difference was observed in the number of vials required for resolution of intoxication among available antivenoms, which was favorable for treatment A.

In this group of patients, both treatments had an expected efficacy and safety profile. The average time of hospitalization for treatments described in this study, were similar; No study treatment-related adverse events were reported.

References

1. Secretaría de Salud. Intoxicación por picadura de alacrán. Ciudad de México, México. Secretaría de Salud, 2016 (reviewed on 10 September 2018).
2. Secretaría de Salud. Guía de Práctica Clínica. Prevención, diagnóstico, tratamiento y referencia de la intoxicación por veneno de alacrán. Consejo de Salubridad General. México. Catálogo maestro de guías de práctica clínica: SSA-148.08;2008. CENETEC, México, Secretaría de Salud, 2008;1-30.
3. Chávez A, Ortiz E. Scorpionism and Dangerous Species of Mexico. Toxicon. 2014;4(1):201-13.
4. Tay J, Díaz JG, Vega S, Castillo A, Ruíz D, Calderón L. Picaduras por alacranes y arañas ponzoñosas de México. Rev Fac Med UNAM. 2004;47(1):1-7.
5. Santibañez CE, Francke OF, Ureta C, Possani LD. Scorpions from Mexico: from species diversity to venom complexity. Toxins. 2015;8(1):1-18.
6. Armas LF, Frías EM, Estévez J. Lista anotada de las especies mexicanas del género Centruroides Marx, 1890 (Scorpiones, Buthidae). Revista Ibérica de Aracnología. 2003;8(1):93-8.
7. Francke OF. Biodiversidad de Arthropoda (Chelicerata: Arachnida ex. Acari) en México. Rev Mex Biodivers. 2014;85(1):408-18.
8. Comité Nacional de Vigilancia Epidemiológica (CONAVE). Manual de Procedimientos estandarizados para la vigilancia Epidemiológica de la Intoxicación por picadura de alacrán. Secretaría de Salud. 2012;1-60.
9. Quijano AF, Ponce J. A new species of scorpion of the genus Centruroides (Scorpiones: Buthidae) from the state of Michoacán. Mex Rev Mex Biodivers. 2016;87(1):49-61.
10. Baldazo JG, Ponce J, Flores M. A new scorpion species of medical importance of the genus Centruroides (Scorpiones: Buthidae) from the state of Guerrero, Mexico. Rev Mex Biodivers. 2013;84(1):100-16.
11. Teruel R, Ponce J, Quijano AF. Redescription of centruroides noxius and description of a closely related new species from western Mexico (Scorpiones: Buthidae). Rev Mex Biodivers. 2015;86(4): 896-911.
12. Ponce J, Francke OF. Una nueva especie de alacrán del género Centruroides Marx (1890) (Scorpiones: Buthidae) de la Depresión del Balsas, México. Acta Zoológica Mexicana. 2004;20(2):221-32.
13. Ponce J, Francke OF. Description of a new species of scorpion of medical importance of the genus Centruroides (Scorpiones: Buthidae) from the state of Colima, Mexico. Revista Mexicana de Biodiversidad. 2009;80(3):647-58.
14. Ponce J, Francke OF. A new scorpion species of the genus Centruroides (Scorpiones, Buthidae) from the state of Jalisco, Mexico. Revista Mexicana de Biodiversidad. 2011;82(2):465-74.
15. Ponce J, Francke OF. A new scorpion species of the genus Centruroides (Scorpiones: Buthidae) from the coast of the state of Jalisco, Mexico. Rev Mex Biodiv. 2011;82(4):1163-75.
16. Dehesa M, Ramírez AN, Zamudio FZ, Gurrola G, Lievano A, Darszon A, et al. Structural and functional comparison of toxins from the venom of the scorpions Centruroides infamatus infamatus, Centruroides limpidus limpidus and Centruroides noxius. Comp Biochem Physiol. 1996;113(2):331-9.
17. Camacho R, Sánchez H, Jaramillo R, Ávila R. Artículo de Revisión: Alacranismo. Arch Inv Ped Méx. 2007;10(1):21-25.
18. Riaño L, Rodrígues E, Santibañez C, Guereca L, Urbe S, Ramírez I, et. al. Updating knowledge on new medically important scorpion species in Mexico. Toxicon. 2017;138:130-7.
19. Espino GP, Riaño L, Becerril B, Possani LD. Antidotes against venomous animals: state of the art and prospectives. J. Proteom. 2009;72(2):183-99.
20. Osnaya N, Medina T, Flores S, León G. Clinical symptoms observed in children envenomed by scorpion stings, at the children's hospital from the State of Morelos, México. Toxicon. 2001;39(6):781-5.
21. Boyer L. Editorial: scorpion venom and antivenom. Toxicon, 2013;76:327.
22. Secretaría de Salud. Norma Oficial Mexicana NOM-033-SSA2-2011. Para la vigilancia, prevención y control de la intoxicación por picadura de alacrán. Diario Oficial de la Federación el 08 de diciembre de 2011.
23. Laboratorios de Biológicos y Reactivos de México. Ficha técnica Faboterápico Polivalente antialacrán. Birmex, 2015.
24. Instituto Bioclon. Ficha técnica Faboterápico Polivalente antialacrán, Alacramyn. Biodiagnósticos, 2015.
25. Osnaya N, Acosta L, Goytia R, Lares I, Basurto G, Pérez G, et al. Serum level of scorpion toxins, electrolytes and electrocardiogram alterations in Mexican children envenomed by scorpion sting. Toxicon. 2016;122:103-8.
26. Petricevich V. Scorpion Venom and the inflammatory response. Mediators Inflamm. 2010;2010:903295.
27. Castillo JE. Velázquez E, Ramírez E, Vargas E, Chávez A. Alacranismo en León, Guanajuato, perspectivas por áreas geoestadísticas básicas urbanas. Acta Universitaria. 2002;12(2):39-49.