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Accidents and poisoning caused by arachnids on domestic felines and canines: a review

[*Acidentes e intoxicações causadas por aracnídeos em felinos e caninos domésticos: uma revisão*]

"Review/Revisão"

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Abstract
Poisoning by spiders' bites and scorpions' stings domestic canines and felines seems to be frequent, considering the biology and behavior of these animals. However, little is known about this relationship. In the present review, we compiled the available information concerning this topic by focusing on arachnids that can cause accidents, reported cases in the scientific literature, and epidemiological and clinical aspects of accidents with domestic canines and felines. Arachnids of medical importance are distributed worldwide, but the cases described in the literature are episodic, and some report animals' death. Each taxon has specific venom toxicity that can affect organisms differently. Thus, the diagnosis and clinical treatment must be based on the individual that caused the accident. Knowledge on the occurrence of arachnids of medical importance, their biology, and venom toxicity must be deepened and publicized to avoid accidents.

Keywords: Arachnida; companion animal; epidemiology; Loxoscelism; Phoneutrism.

Resumo
Envenenamento pela picada de aranhas e escorpiões em caninos e felinos domésticos parece ser comum, considerando a biologia e comportamento desses animais. Entretanto, pouco se sabe sobre esta relação. Na presente revisão, nós compilamos o pouco que se conhece sobre esta relação, focando nos potenciais aracnídeos que podem causar acidentes, nos casos registrados na literatura científica e nos aspectos epidemiológicos e clínicos de acidentes em caninos e felinos domésticos. Existem aracnídeos de importância médica em quase todo o mundo, mas os casos registrados na literatura são episódicos e alguns relatam morte dos animais. Na clínica, a diagnose e tratamento devem ser baseados na observação do aracnídeo que causou o acidente, pois cada táxon possui veneno com efeito diferente no organismo. Portanto, chama atenção a necessidade de aprofundar o conhecimento sobre este tema, além da divulgação da ocorrência dos aracnídeos de importância médica em cada localidade, sua biologia e toxicidade do veneno.

Keywords: Arachnida; animal de companhia; epidemiologia; Loxoscelismo; Foneutrismo.

Introduction

Spiders (Araneae) and scorpions (Scorpiones) are venomous arachnids that can cause severe poisoning accidents with animals. Spiders are adapted to all types of terrestrial habitats and currently present over 50900 species described worldwide (Platnick, 1999; WSC, 2023). Scorpiones are less diverse and abundant than spiders, presenting over 2750 species described, although some important species live abundantly in synanthropic environments (Scorpion Files, 2023).

Although most spiders and scorpions can inoculate venom, few taxa are of medical importance, representing a major danger in human and veterinary medicine due to their toxicological potential and preference for urban environments (Mullen, 2002). The venom of these arachnids can affect several animals, potentially leading to

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significant economic losses associated with premature death, reduced functioning during recovery, lost potential productivity and the cost of treatment (Dehghani et al., 2020).

Considering felines, the progression of clinical signs can easily lead to death (Peterson, 2006). In addition, animal diagnoses are often made erroneously due to the absence of reliable clinical-epidemiological descriptions (Brazil and Porto, 2011). Lonny and Vetter (2009) highlight the difficulty of obtaining a definitive diagnosis for arachnid bites or stings, specifically considering the *Loxosceles* spider. Doctors and veterinarians need to rely on geographic criteria, collateral clinical findings, and often turn to arachnid specialists for further clarification. In addition, specific laboratory tests that would facilitate the histopathological diagnosis and provide the correct treatment are not usually found (Furbee et al., 2006). Reports considering accidents with canines are helpful in loxoscelism cases, but literature on the clinical manifestation and treatment involving felines is almost inexistent (Duarte et al., 2018).

Using the same drugs as definitive therapy for canines and felines is not always effective due to differences in their physiologies. Thus, it is important to understand their behavioural differences to determine adequate treatments to allow their survival (Roder, 2003). For example, dogs present a natural exploratory personality, which makes them more likely to be exposed since they usually live in localities adequate for the occurrence of several arachnid taxa (Sakate, 2008). In this way, accidental encounters will occur even when subjected to strictly indoor breeding.

Accidents involving spiders of the species of *Loxosceles* and *Phoneutria* are the most common in the veterinary clinical practice (Brescovit et al., 2011), and there is no consensus among veterinarians for treating bites beyond the provision of supportive care, including several protocols to mitigate poisoning symptoms (Lonny and Vetter, 2009). The biology and geographic distribution of the arachnids responsible for the accidents are poorly reported, making identification difficult or prone to error (Cacy and Mold, 1999). This lack of knowledge makes it difficult the development of public health policies, veterinary diagnosis, and adequate treatment of the venom effects in dogs and cats (Peterson and McNalley, 2006). The present study reviews the epidemiological and clinical aspects of medical and veterinary interest, and the potential arachnids that cause more severe and common accidents on domestic canines and felines and the potential arachnids that cause more severe and common accidents to these animals.

Development

Arachnids of Medical Importance

In the class Arachnida, the species of medical and veterinary importance due to venom inoculation belong to the orders Araneae (spiders) and Scorpiones (scorpions). However, few species are considered of medical importance by causing severe accidents and health impacts in humans (Arêa et al., 2018) and are distributed differently around the globe (Figure 1). Here, we consider that those taxa that most impact human health would also be the most relevant for dogs and cats.

Spiders

The spiders (Araneae, Arachnida) use their chelicerae to inoculate venom into their prey or defend themselves from potential predators. Most spiders present a gland in each chelicera that produces toxins with different compositions that have different effects on the victims (Foelix, 2011). However, few species are of medical importance among more than 50 thousand spiders described (WSC, 2023). Relevant factors to be considered are their venom effect, the frequency of accidents in humans and domestic animals, and the animals' size since most spiders are tiny and cannot penetrate a mammal skin with their fangs (Foelix, 2011). *Loxosceles, Latrodectus* and *Phoneutria* are the spider taxa with the most medical importance worldwide (Foelix, 2011).

Loxosceles Heineken and Lowe, 1832 (family Sicariidae) (Figure 2A) is a genus with 141 species with cryptic, sedentary, and nonaggressive behaviour (Lopes et al., 2020; WSC, 2023). They are known as brown-spiders or recluse-spiders, occurring mainly in tropical regions and marginally in the temperate areas of America, Africa, Asia (widespread), Europe, and Australia. They are usually found living in burrows under rocks and resting inside their tangled cotton-like webs. However, some species are synanthropic and invasive into many countries, living inside houses, hiding in furniture, clothes, and shoes, thus causing many human accidents. Their bites are painless, but their venom has a substantial dermonecrotic effect. It can lead to hemolysis with systemic implications that can cause deaths (Lopes et al., 2020).

Latrodectus Walckenaer, 1805 (family Theridiidae) is a genus with 32 species from all continents, with some invasive species (WSC, 2023). Among them, *L. mactans* (Fabricius, 1775), the black widow, and *L. geometricus* C.L. Koch, 1841, the brown widow (Figure 2B), are the most important species due to their synanthropic habitat, living in shrubs and peridomestic areas, as in walls or other angular constructions that allow the building of their irregular webs (Garb et al., 2004; Peterson, 2006). Like most Theridiidae species, they are not aggressive and live resting pending on their webs, where they stay waiting for prey. *Latrodectus geometricus* has been considered a cosmopolitan spider because of its recent introductions in many continents and oceanic islands caused by human activities (Garb et al., 2004). Their venom has vertebrate-specific toxins since their diet includes small vertebrates (Peterson, 2006).

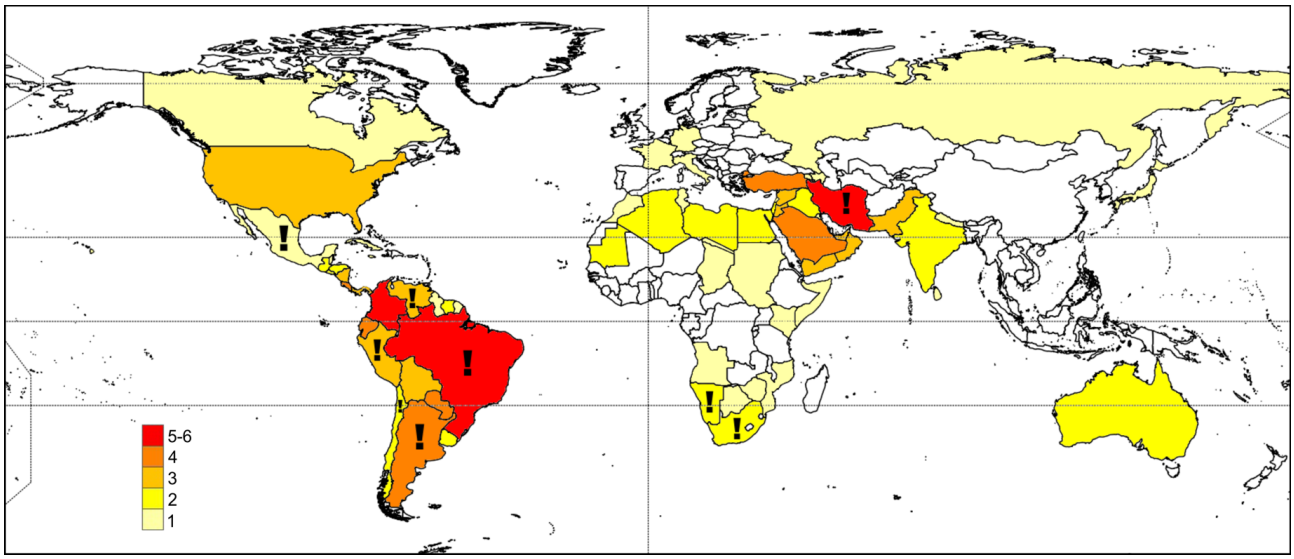

Figure 1. Map showing occurrence of medical importance taxa of arachnids per country, cited in the present work. In colours, the number of genera – except for *Loxosceles* and *Latrodectus*, because they are considered cosmopolitan taxa. Exclamation points represent countries with five or more species of arachnids of at least one of those genera. Data from Ward et al. (2018) and WSC (2023).

Phoneutria Perty, 1833 (family Ctenidae) is a small genus with seven species of large spiders, known as "armadeiras" (Brazilian Portuguese), Brazilian wandering spiders, or banana spiders. The genus is restricted to forested areas in Central and South Americas, and it is composed of very aggressive spiders which behave arming against potential threats lifting their anterior legs, erecting their bodies, and exposing their fangs (Bucaretchi et al., 2008; Foelix, 2011; WSC, 2023). They cause many human accidents due to their aggressive and wandering behaviour, mainly in Brazil, where some species have a synanthropic habitat. This spider has a neurotoxic venom which can cause severe symptoms (Bucaretchi et al., 2008). So, *Phoneutria* is considered one of the most medically important spiders globally (Foelix, 2011).

In addition, the following taxa are also of medical importance:

Atrax Pickard-Cambridge, 1877 (three species), a funnel-web spider with records of deaths in humans, but restricted to southeastern Australia (Foelix, 2011).

Tarantulas (Theraphosidae). Although they do not cause severe accidents in humans due to their relatively innocuous venom, their urticant hair (used for defense) can cause injuries (Foelix, 2011). In addition, there are records of bites by *Heteroscodra* (Africa), *Poecilotheria* (Asia), *Acanthoscurria and Vitalius* (South America), and *Phlogiellus* and *Selenocosmia* (Australia) (Vetter, 2018).

Lycosa erythrognatha Lucas, 1836, a Neotropical wolf spider, causes many accidents due to its wandering and aggressive behaviour, although its venom only causes mild symptoms (Foelix, 2011).

Sicarius Walckenaer, 1847 (21 species), in South America, and *Hexophthalma* Karsch, 1879 (eight species), in Africa. These are two close-related genera of wandering spiders that live buried in the sand. They present less medical importance since their habitat has little contact with humans. However, their venom is more dangerous than *Loxosceles* (Lopes et al., 2021).

Cheiracanthium C. L. Koch, 1839 (214 species) is a genus widespread in many continents (WSC, 2023). Accidents with humans were recorded for some species, mainly in Europe and North America. Besides the synanthropic habitats of a few species, the venom causes mild symptoms (Vetter et al., 2006).

Steatoda Sundevall, 1833 (121 species) is a widespread genus (WSC, 2023). Some accidents with humans were also reported, especially with *S. nobilis* (Thorell, 1875), considered an invasive species found in synanthropic habitats on many continents. Its venom is similar to *Latrodectus* (the same family, Theridiidae) but causes milder symptoms (Dunbar et al., 2021).

Scorpions

Scorpions (Scorpiones, Arachnida) present around 2750 species worldwide (Scorpion Files, 2023). They use a sting with an internal gland located in their last metasoma segment (the "tail") to inoculate venom in their prey or a potential attacker. However, like spiders, few species can cause severe symptoms or death in humans. About 36 confirmed scorpion species are implicated in severe incidents with humans, most belonging to the family Buthidae (Figure 2C), but also to Hemiscorpiidae and Diplocentridae (Ward et al., 2018).

The main scorpions' genera related to severe accidents with humans worldwide are listed in Table 1. In opposition to the diversity of spiders' venoms, the scorpions' venoms are somewhat conservative and affect cell ion (Na+ and K+) channels, often rendering neurotoxic symptoms. However, specific toxins adapted to different prey, such as mammals or insects, were also described (Simard and Watt, 1990). The scorpions' behaviour and habitats are more conservative than in spiders. They live near the ground, generally hidden below rocks, trunks, barks, and similar objects in urban areas, with wandering behavior but with little mobility (Polis, 1990). Some species have biological traits leading to higher importance in public health, such as synanthropic habitat and populations with parthenogenetic reproduction (females reproduce without male partners). A very illustrative example is *Tityus serrulatus* Lutz and Mello, 1922, a species in rapid expansion in urban areas in southern and central Brazil, leading to thousands of stings and some deaths per year, mainly children (Cologna et al., 2009).

Case Records

There is no systematic recording of accidents involving arachnids and domestic felines and canines, but episodic cases were recorded in the literature and are concentrated in a few countries. Below is a description of these records.

Australia

Isbister et al. (2003) recovered arachnid accidents between 1978 and 2002 in Northern Queensland, Australia. Seven dogs were bitten and evolved into a fatal condition among the recovered cases. The stings were recorded all day, and only one spider was found indoors. The spider collection by the owner was paramount for the identification in all cases, where the prevalence of accidents involved *Phlogiellus* sp. and *Selenoscomia* sp. Queensland presents a history of multiple fatalities involving canine and feline deaths following tarantula bites (Raven, 2000). Their venom demonstrated extreme toxicity in several animals, including cats and dogs (Bucherl, 1971). An accident in Darwin caused by *Selenocosmia* sp. is also described in the literature (Robinson and Griffin, 1985).

Brazil

Despite the significant lack of information from responsible departments, case reports predominantly focus on *Loxosceles* sp. The literature is scarce for felines, and the specific treatment indication lacks more detailed attention. Duarte et al. (2018) described a case of dermonecrotic lesion related to *Loxosceles* sp. in Caxias do Sul, Rio Grande do Sul, where the cat was two years old, weighed 4.3 kg, and non-defined breed. The lesion was associated with *Loxosceles* by capturing the spider close to the animal and excluding other etiologies through clinical analysis.

Machado et al. (2009) described dermonecrotic lesions caused by *Loxosceles* sp. in a Poodle breed dog, admitted to the São Paulo State University (UNESP), in Botucatu, São Paulo. The correct anamnesis, the histopathological study of the necrotic tissue, and the clinic correlated the findings with loxoscelism. Another accident involving *Loxosceles* sp. and a female dog (non-defined breed, nine years old) was reported at the Tuiuti do Paraná University, Paraná state (Souza et al., 2015). The lesion was initially attributed to a tumor, but the final diagnosis was suggestive of

poisoning by *Loxosceles* sp. bite due to the observed symptoms pattern (Souza et al., 2015).

At the State University of Londrina Veterinary Hospital, Paraná, a Pitbull dog presented a ventral dermonecrotic lesion compatible with a bite by *Loxosceles* sp. and cervical oedema (Collacico et al., 2008). The diagnosis was also based on correct anamnesis and clinical and laboratory findings (Collacico et al., 2008). Branco et al. (2014) treated a Poodle with a lesion in the right forelimb compatible with the necrotic lesion obtained after a *Loxosceles* sp. bite. The animal died due to the clinical condition severity (Branco et al., 2014). During the necropsy, an extensive area of hemorrhagic muscle necrosis was found with the presence of fibrin, characterizing a reasonable time between the bite and the treatment (Branco et al., 2014).

Figure 2. Photographs of common arachnids of medical importance. (A) *Loxosceles* sp., the brown-spider (courtesy of Christian G. Menezes). (B) *Latrodectus geometricus*, the brown-widow (courtesy of Jane C. Vieira). (C) *Tityus stigmurus*, the yellow-scorpion (courtesy of Ricardo Pinto-da-Rocha).

Table 1. Scorpion taxa of medical importance, with the number of confirmed species involved in severe incidents (Ward et al., 2018) and geographic occurrence of those species.

Taxon	Number of species	Geographic occurrence
Buthidae		
Androctonus Ehrenberg, 1828	3	Northern Africa and Middle East
Centruroides Marx, 1890	7	Tropical and sub-tropical North America, Central America and the Caribbean, and northern South America.
Hottentotta Birula, 1808	3	Northern Africa, Middle East, and Southeastern Asia.
Leiurus Ehrenberg, 1828	2	Middle East
Mesobuthus Vachon, 1950	1	Iran and Turkey
Odontobuthus Vachon, 1950	1	Iran
Parabuthus Pocock, 1890	2	Southern Africa
Tityus Koch, 1836	15	South and Central America
Hemiscorpiidae		
Hemiscorpius Peters, 1861	2	Middle East and Iran
Diplocentridae		
Nebo Simon, 1878	1	Middle East and Egypt

The poisoning of a two-year-old dog by *P. nigriventer* was described at the Veterinary Hospital of UNESP – Botucatu (Fernandes et al., 2002). The animal presented limb spasms, dyspnea, sialorrhea, and hypothermia (Fernandes et al., 2002). The spider was found in an attack position near the animal, allowing the species identification by the university's Center for the Study of Poisons and Poisonous Animals (CEVAP) (Fernandes et al., 2002).

Regarding cases involving scorpion stings, the Brazilian literature is scarce for canines and absent for felines (Tanajura et al., 2013). Cardoso (2002) reported a unique case of the poisoning of a three-year-old Terrier, admitted to the UNESP Veterinary Hospital – Botucatu. The treatment occurred shortly after direct contact with *Tityus bahiensis*, a species identified by CEVAP (Cardoso 2002).

Colombia

In Manizales, Colombia, Echeverry and Salgado (2019) indicated the lack of published information on cases of scorpionism in Colombia. Between 2009 and 2018, such cases were reported for 11 dogs and a one cat. Eight scorpions were collected by the tutor and then identified as *Centruroides gracilis* females. The morphological parameters described for Centruroides were used for taxonomic determination (Armas et al., 2012).

Porras-Villamil et al. (2020), in Córdoba, Colombia, attended a mixed breed dog that, according to its owner, had ingested a *Latrodectus* sp. or *Steatoda* sp. The identification was dubious due to the owner's description and insistence on not bringing the specimens to the hospital (Porras-Villamil et al., 2020). The animal presented vomiting, abdominal discomfort, muscle weakness, sialorrhea, and asthenia, but the clinical picture gradually improved until complete recovery (Porras-Villamil et al., 2020).

The United States

At the University of Iowa, Taylor and Greve (1985) reported a case of a six-year-old Brittany spaniel female hospitalized with muscle swelling in the left lateral portion. Laboratory tests indicated a systemic inflammatory response. A differential diagnosis by attempted loxoscelism was made due to ulcer formation in the center of the edematous region, lesion progression, and correlated clinical signs (Taylor and Greve, 1985). In Tucson, Arizona, information collected on scorpion accidents by *Centruroids sculpturatus* indicated that 71% of felines and 39% of canines in the region had a previous clinical bite history (Hovda et al., 2016).

In Colorado, United States, a 14-year-old mixed breed cat was admitted to the University Hospital of Veterinary Medicine with pain and stiff muscles, followed by constant spasms (Twedt et al., 1999). Due to the enzymatic and physical clinical findings performed over the hospitalization days, the diagnosis was considered intoxication by *Latrodectus* sp. (Twedt et al., 1999). The animal had a favorable prognosis, with almost no neuromotor sequelae at 38 days (Twedt et al., 1999).

Clinical Protocols

Since treatments will vary according to the arachnid identification, the veterinarian treating arachnid accidents should initially focus on the etiological diagnosis, seeking the animals' morphological description and the symptomatic signs (Chagas et al., 2010). The condition should be classified into mild, moderate and severe according to the symptoms.

Loxoscelism

Loxoscelism is the cutaneous-systemic syndrome associated with the brown spider bite (*Loxosceles* sp.). The lesion progression level varies according to the amount of venom injected during the bite and how the animal immune system will react to the presence of the toxin. The loxoscelic venom is mainly composed of a protease called sphingomyelinase D, which causes platelet aggregation by inducing the chemotactic factor. Thus, severe lesions can present intravascular coagulation and dermal necrosis (Sakate, 2008).

Clinical signs are late after the bite, and a specific diagnosis is not available. Differential diagnosis should exclude secondary infections, decubitus ulcers, and clinically severe burns. Clinical pathology should seek to prevent hemolytic anemia, immune-mediated diseases, and zinc or onion poisoning as options for laboratory abnormalities (Peterson and McNalley, 2006). The cutaneous-necrotic lesion has a necrotic center corresponding to the spider bite site, progressing to edge necrosis and ulceration, characteristic inflammatory signs, ecchymosis, and exanthema (Dallegrave and Sebben, 2008). The leading death cause in small animals is acute kidney injury caused by poisoning. Thus, fluid therapy is indicated as adjuvant therapy to avoid overload and renal failure.

Latrodectism

The *Latrodectus* or black widow spiders can control the amount of venom injected during the bite using body muscles (Peterson, 2006). The poisoning can vary according to the spider and victim size. The lesion is painful, and the site remains with initial tactile sensitivity, followed by hyperesthesia, marked muscle pain and fasciculitis.

Small species, especially felines, are vulnerable to venom, and almost every bite leads to death or an unfavorable prognosis. Maretic (1951) conducted a study where 20 of 22 cats died within hours of being bitten by the black widow spider. The animals demonstrated exacerbated clinical symptoms due to their small body size. In a short time, all individuals presented complete paralysis, extreme pain characterized by excessive vocalization and drooling. Death occurs because of respiratory mismatch due to final physical atony.

There are no differential tests for *Lactrodectus* bites, and the diagnosis occurs by exclusion. The literature demonstrates that, when ingested by cats, they are usually visible among the debris of the natural vomiting induction, facilitating symptomatic knowledge (Peterson, 2006). However, early identification is difficult since the animal already shows severe symptoms characteristic of neurotoxins when arriving at the veterinary hospital.

Phoneutrism

Accidents by *Phoneutria* sp. can be monitored by leukocyte series and blood glucose laboratory tests that can avoid pathognomonic symptoms and close a diagnosis when added to a thorough anamnesis and clinical findings (Camplesi et al., 2014). Symptoms usually include deep pain (with confirmatory vocalization) at the bite site due to the neurotoxin injected into the musculature, sweating, prostration, muscle tremors, cardiac arrhythmia, arterial hypotension, pulmonary oedema, and respiratory arrest. The prognosis after the *Phoneutria* sp. bite is always reserved because the symptoms tend to progress to a neurogenic shock due to the systemic picture and the difficulty in using local anesthetic blockers.

According to Schvartsman (1992), canines are susceptible to the *Phoneutria* sp. bite and tend to progress to death. These animals are the most affected animals by *Phoneutria* sp. due to the association of the spider's habitat preferences when seeking shelter within urban areas and the natural curiosity of dogs to explore (Camplesi et al., 2014).

Scorpionism

Scorpion venom, despite its diversity, is neurotoxic and acts directly on nerve endings. It operates on the parasympathetic and sympathetic autonomic nervous system by causing the characteristic manifestations of the clinical pictures (Simard and Watt, 1990).

The scorpions of the genus *Tityus*, found in South and Central America, differ in the potential action. The lesions may be restricted to the bite site, varying in the degree of pain, regional paresthesia, and presence of an erythematous halo where the

toxin was inoculated (Ribeiro et al., 2009). Regarding systemic disorders, hypertension followed by arterial hypotension can be observed due to vascular permeability resulting from the inflammatory condition. The venom is cardiotoxic and can alter the heart rate and blood flow (Cupo, 2015). At the pulmonary level, oedema may reflect cardiogenic or non-cardiogenic changes. However, the increase in heart rate can lead to cardiorespiratory arrest (Cardoso et al., 2004; Melo and Silva-Junior, 2005). Ultimately, the gastrointestinal system is altered in glandular hypersecretion, which can cause imbalance and shock. All manifestations directly correlate to the amount of venom inoculated and whether the animal's immune system can neutralize the toxin.

The symptoms of *Centruroides gracilis* stings, a common scorpion in Colombia (Flórez, 2001), are also classified as less urgent, moderate, and severe. Less urgent cases present only local nociceptive reactions. As inflammatory symptoms, a moderate case will show profuse drooling, hyperglycemia, and hyperthermia. Finally, animals presenting severe symptoms will show all the previous signs, in addition to gastrointestinal systemic clinical findings, generalized complications and, mainly, respiratory problems (Echeverry and Salgado, 2019).

The most observed clinical signs in canines stung by a scorpion are related to the Central Nervous System. Thus, hyperactivity and hypermotility are observed due to adrenergic high doses release, disorientation, and blood pressure imbalance generating pulmonary oedema and convulsions. More severe cases may present hyperthermia, hypothermia, mydriasis, intense vocalization suggestive of pain, and aggressiveness. The symptomatologic variation depends on the interaction of the animal's organism with the scorpion toxin.

Conclusion

The lack of systematic information on accidents involving arachnids, felines and canines became evident in this review. This result is alarming since the finding of these animals is frequent, because the species coexist in synanthropic environments. Strategies for accidents prevention must be evaluated, considering the ecological characteristics of arachnids, their geographic range, local occurrence, and epidemiology.

By treating a possible poisoning by arachnids, the veterinarian must make a good anamnesis and search for common characteristics to the responsible sting/bite agent. The veterinarian cannot wait for the laboratory confirmation to start the therapeutic support treatment even without a conclusive diagnosis. Unfortunately, most arachnid venom serums are not available for animal treatment. Thus, the support treatment is the main main measure to be instituted, being possible to perform a blood transfusion in cases of severe hemolysis. Despite offering the recommended treatment, it is necessary to understand that the prognosis in accidents with arachnids is reserved due to the possibility of evolution to death due to systemic involvement.

Conflict of Interest

The authors declare that there is no conflict of interest.

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