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BACTERIAL INFECTION SECONDARY TO SNAKEBITE

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ABSTRACT

Objective: This study aims to describe the symptoms, epidemiological profile, laboratory abnormalities, and antibiotics used in patients with wound infection secondary to snakebite. Methods: This is a retrospective study with secondary data, which analyzed 211 medical records, of which 60 (28.4%) patients were included. Results: there was a higher prevalence of cases in rural areas, with predominantly male involvement and in lower limb topography. The main local manifestations were pain and edema. All patients received antibiotics and the most used was clindamycin. Thirty-one patients (51.7 %) developed abscess or necrosis and required surgery. Conclusion: Further studies are needed to identify predictors of infection and diagnostic criteria that facilitate its detection. From the knowledge of the determinants of the infection, it will be possible to establish the appropriate therapy, prevent complications and reduce treatment costs.

Keywords: Epidemiology. Infection of the wounds. Snake bites. Venomous snakes.

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INTRODUCTION

Among the causes of human poisoning, accidents by venomous animals are considered one of the main etiologies. However, despite the known socioeconomic impact, this condition has been neglected (FEITOSA et al., 2015; KASTURIRATNE et al., 2008). This fact can be proven, since snake envenomation is part of the World Health Organization (WHO) list of neglected tropical diseases (THE LANCET, 2017). It is estimated that there are at least 421,000 cases of poisoning in the world annually, and this number may reach up to 1,800,000 cases. A large portion of bites occur in Central and South America, Asia and Sub-Saharan Africa (KASTURIRATNE et al., 2008; LONGBOTTOM et al., 2018). And, even though there are species of snakes in the most varied habitats of the globe, envenomation is more important in the tropics (KASTURIRATNE et al., 2017), possibly due to climatic and socioeconomic factors. Rainfall and temperature, for example, are strong influencers of agricultural activity, which imposes greater exposure of workers, having a direct correlation with the higher rate of bites in this period (GUTIÉRREZ et al., 2006). In addition to reflecting the precariousness of services, there is a lack of use, incentive and knowledge of adequate protective equipment for rural workers, associated with economic factors of the workers.

In the years 2020-2022, 811,820 accidents with venomous animals were reported in Brazil and 14,490 in the state of Tocantins (DATASUS, 2020). The incidence and prevalence data released by the surveys are still estimated and the real incidence of cases remains unknown, since few countries invest and propose to carry out adequate epidemiological control (KASTURIRATNE et al., 2008; LONGBOTTOM et al., 2018; WEN et al., 2015). In Brazil, venomous snakes of medical importance belong to the genera *Bothrops, Crotalus, Lachesis and Micrurus*. However, the genus *Bothrops* is responsible for almost all cases in the Americas and also in Brazil (OTERO-PATIÑO, 2009; PATIÑO et al., 2023). Local and systemic clinical manifestations are a consequence of proteolytic, coagulant, hemorrhagic, neurotoxic and/or myotoxic action. Among the local signs and symptoms, pain, edema, erythema, ecchymosis, bleeding, blisters, paresthesia and lymph node infarction stand out (MINISTRY OF HEALTH, 2001).

Knowledge about infection secondary to snakebite is scarce and conflicting, especially with regard to microbial profile, effective antibiotic therapy, and susceptibility profile. The institution of an inappropriate therapy can lead to the evolution of the infectious process, side effects, induction of resistance and high costs to public-private services

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(FEITOSA et al., 2015; SENTHILKUMARAN et al., 2023). It is assumed that infection is determined not only by the microbiota of the oral cavity of snakes, but by the individual's skin flora and factors such as wound manipulation (SACHETT et al., 2017). Pre-hospital therapeutic measures can influence the evolution of the disease in a positive or negative way. The use of tourniquets, application of homemade products, suction of venom and any type of wound manipulation is known to be erroneous (MICHAEL et al., 2011).

The first published work that experimentally tested the occurrence of bacterial infection as a consequence of the changes induced by the venom, concluded that the role of the venom in susceptibility to infection has not yet been fully understood. However, it is postulated that the toxic effect of the venom on the vasculature and tissues favors the ability of pathogenic bacteria to infect the tissue (OTTEN et al., 2007). The main local signs and symptoms are pain, edema, erythema, local heat, vesicles, blisters, petechiae, ecchymoses, lymphangitis, and lymphadenitis (STEVENS et al., 2014). The infected wound can progress to abscess, tissue necrosis, osteoarticular complications, and impacts of the surgical approach (BALAJI et al., 2015; BONASSO et al., 2015; CHATTOPADHYAY et al., 2004), which leads to increased hospital costs and morbidity and mortality.

In addition to the lack of clinical research with high methodological rigor, there is also a need for observational-descriptive studies, since they serve as a basis for clinical trials. Medical propaedeutics in the face of clinical situations has a heterogeneous and controversial aspect in its practice. Therefore, it is vitally important to characterize accidents and to question, in the face of the scientific method, the conduct carried out, especially in specialized centers (WEN et al., 2015). This study aims to characterize the clinical and epidemiological profile of accidents treated at the Hospital for Tropical Diseases, focusing on cases such as wound infection, the most prevalent pathogenic microorganisms, and empirical antimicrobial therapy.

METHODOLOGY

A cross-sectional and descriptive study was carried out with secondary data from the medical records of snakebite patients treated at the Hospital for Tropical Diseases of the Federal University of Northern Tocantins (HDT-UFNT), from 2020 to 2022. The HDT-UFNT is the first University Hospital in the State of Tocantins and is located in Araguaína. The city represents the second largest economic center in the state, mainly due to commerce and

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agriculture. The Hospital is a reference for the entire North region in the care of infectious diseases, accidents with venomous animals and bite victims.

The data analyzed were gender, age, area of occurrence of the accident (rural or urban), time of year, snake species, body region, first aid, time between the bite and hospital care, previous comorbidities, local signs and symptoms, use of antivenom, complications, admission laboratory tests and surgical approach. Data such as education, occupational activity, operational classification of the case (mild, moderate and severe) were not available in most of the medical records.

The diagnosis of pyoderma was based on the classification criteria of cellulitis, erysipelas and/or abscesses. Signs of local inflammation (pain, edema, erythema, and heat), fever, leukocytosis, and lymphadenitis were considered diagnostic of cellulitis and erysipelas, in the absence of other hypotheses and clinical data. A fluctuating lesion associated with signs of local inflammation, with or without drainage of purulent secretion, was characterized as an abscess. The diagnosis of acute kidney failure/injury was based on the KDIGO (*Kidney Disease: Improving Global Outcomes*) criteria (KDIGO, 2012) for serum creatinine and urine output values. The reference values of the biochemical tests were established based on the standards of the laboratories that provided services to the hospital.

Among the 219 cases reported and treated during the period, 7 were excluded due to insufficient data and 1 was excluded from this analysis because he had received previous antibiotic therapy at another health unit. For this review, 211 cases were considered, 60 of whom were diagnosed with secondary infection. The data were analyzed using the Jamovi software, version 2.3.28, and presented in the form of absolute count, percentage, mean, median, standard deviation, minimum value, and maximum value.

RESULTS

A total of 211 medical records were analyzed, and 60 patients (28.4%) received a clinical diagnosis of secondary bacterial infection. Men accounted for the largest share of the total (76.8%) and cases of pyoderma (80%). The mean age ± SD (standard deviation) was 37.4 ± 20.5 years, with the youngest patient being 4 years old and the oldest being 80 years old. Of these, 46 (76.6%) were in the age group considered productive (15-64 years). Accidents occurred predominantly in rural areas (93.3%). All 60 patients were hospitalized, of whom 58 (96.7%) remained in the ward and 2 (3.3%) in semi-intensive care. Thirty-nine

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(65%) patients were admitted to the service for urgency and emergency, while 21 (35%) were transferred from other units on the same day of the accident. The mean time between the accident and care at the referral hospital was 9.9 ± 24.4 hours, median of 3 hours, minimum of 0.5 hours (30 minutes) and maximum of 168 hours (7 days). The length of hospital stay was 8.3 days ± 5.8, median of 6, minimum of 2 days, and maximum of 29 days. Regarding the type of discharge from the service, 59 (98.3%) patients were discharged with total resolution of the case and 1 (1.6%) patient was transferred to a more complex service. Only 17 (28.3%) patients reported previous comorbidities (1 patient with unspecified arrhythmia, 1 history of stroke, 1 non-status leprosy, 1 epilepsy, 11 systemic arterial hypertension, 2 type 2 diabetes mellitus, 1 major depressive disorder, 1 hepatitis B of unknown status, and 1 history of melanoma). However, only 10 (58.8%) reported the use of continuous medications: four antihypertensives, one antiarrhythmic and two psychotropic drugs. Only one patient had an axillary temperature considered febrile (≥ 37.8ºC) at the time of admission. The mean value was 36.2ºC ± 0.7ºC, with a minimum of 33.6ºC and a maximum of 37.8ºC. The most affected body region was the lower limbs, with 54 cases (90%).

Regarding the recognition of the species that caused the accident, one patient (1.6%) took a photo of the animal, which was identified as belonging to the genus *Bothrops*. Twelve patients stated that they recognized the snake as bothrops (10), crotalic (1) and non-venomous (1), while the other medical records did not provide any information. Antivenom was administered to 58 patients (96.6%), and SAB (anti-bothrops serum) was administered to 47 patients (81%), SAC (anti-crotalic serum) to 8 (13.8%), SABL (anti-botropic-lachetic serum) to 2 (3.4%) and SABC (anti-botropic-crotalic serum) to 1 (1.7%). Of those who received specific serum therapy, two (3.4%) had a reaction and the infusion was interrupted. The number of ampoules prescribed is shown in Table 1.

Only four patients (6.7 %) denied complaints at the site of the bite. Among the local manifestations, the most reported were pain and edema (Table 1). None of the patients with secondary infection had skin blisters or compartment syndrome. Approximately eight patients (13.3%) met criteria for acute renal failure during the hospitalization period. Thirty-one (51.7%) patients underwent a surgical procedure, and skin abscess drainage was the most common intervention (67.7%).

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Table 1: Clinical-epidemiological data

Variable	N (%)
Gender	
Female	12 (20)
Male	48 (80)
Body region	
Lower limbs	54 (90)
Upper limbs	5 (8.3)
Multiple locations	1 (1.7)
Occurrence zone	
Rural	56 (93.3)
Urban	3 (5)
Accident-care time	
< 6 am	40 (66.6)
6 – 11:59 am	13 (21.6)
12 - 11:59 pm	1 (1.6)
≥ 24h	5 (8.3)
Local events	
Yes	56 (93.3)
No	4 (6.7)
Nature of the local event	
Pain	55 (91.7)
Oedema	49 (81.7)
Abscess	2 (3.3)
Necrosis	2 (3.3)
Hyperemia	5 (8.3)
Bruise	5 (8.3)
Paresthesia	5 (8.3)
Itch	1 (1.7)
Bleeding	9 (15)
Antivenom	
Yes	58 (96.7)
No	2 (3.3)
No. of ampoules	
2-4	7 (11.6)
5-8	32 (53.3)
> 9	19 (31.6)
Surgical approach	
Tissue debridement	5 (16.1)
Abscess drainage	21 (67.7)
Drainage + debridement	4 (12.9)
Fasciotomy	1 (3.2)

All patients received antibiotic therapy. The antibiotics prescribed alone were: oxacillin (3), amoxicillin (6), cefazolin (1), cephalothin (1), ceftriaxone (26), ciprofloxacin (25), clindamycin (47), meropenem (2) and vancomycin (2). The regimen of antibiotics prescribed is shown in Table 2. Regarding non-pharmacological measures, it was recommended that the affected limb remain, most of the time, elevated in 38 cases (63.3%), lowered in 1 case (1.7%) and in a neutral position (0º) in 4 cases (6.7%). Hot compresses were prescribed in 51 cases (85%).

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Table 2: Antibiotics Prescribed

Prescription	N (%)
Amoxicillin-clavulanate PO 875mg + 125mg 12/12h or 500mg + 125mg 8/8h	5 (8.3)
Cefazolin IV 1g 8/8h	1 (1.6)
Ceftriaxone IV 1g 12/12h	2 (3.3)
Ciprofloxacin VO 500mg 12/12h	1 (1.6)
Clindamycin IV 600mg 8/8h	2 (3.3)
Ceftriaxone + clindamycin IV 1g 12/12h + 600mg 8/8h	20 (33.3)
Ceftriaxone + Ciprofloxacin IV 1g 12/12h + 400mg 12/12h	1 (1.6)
Ceftriaxone + oxacillin IV 1g 12/12h + 1g 4/4h	3 (5)
Ciprofloxacin + clindamycin IV 400mg 12/12h + 600mg 8/8h	23 (38.3)
Clindamycin + Cephalothin IV 600mg 8/8h + 500mg 6/6h	1 (1.6)
Clindamycin + Amoxicillin VO 450mg 8/8h + 500mg 8/8h	1 (1.6)
Meropenem + vancomycin* IV 500mg 6/6h + 15mg/kg/dose 12/12h	2 (3.3)
*Staggered ATB of prescription ceftriaxone + clindamycin and ceftriaxone + oxacillin IV (intravenous); oral route.	

Due to the possible complications of the bite, laboratory tests should be requested at hospital admission and during therapeutic follow-up, such as blood count, coagulogram, CRP, renal function, and electrolytes. At the time of hospital admission, C-reactive protein (CRP) was requested in only 5 cases (8.3%), with a mean value of 35.5 ± 61.9, median of 12.1, minimum of 0.8, and maximum of 146. Other laboratory parameters are presented in Table 3. On admission, 41 patients (68.3%) had abnormalities in leukocyte counts, 14 (23.3%) in creatinine, 12 (20%) in urea, 7 (13.4%) in serum sodium, 9 (16.9%) in serum potassium, 37 (69.8%) in coagulation time, 6 (11.7%) in bleeding time, and 31 (67.3%) in prothrombin activation time. Among the 53 patients in whom the test was requested, coagulation time was considered incoagulable in 29 cases (54.7%).

Table 3: Admission laboratory tests

	Average ± SD	Median	Minimum value	Maximum value
Hemoglobin	13.8 ± 1.7	14.1	7.90	17.4
Haematocrit	41.5 ± 4.9	42	26.6	50.3
Leukocytes	12. 519 ± 4,536	11.780	3.580	25.950
Creatinine	0.9 ± 0.3	0.9	0.3	2
Urea	35.1 ± 15.1	33	13	101
Serum potassium1	3.9 ± 0.5	4	2.8	5.6
Serum sodium2	140 ± 3.5	140	132	149
Coagulation time1	14.6 ± 6.4	Coagulable	3	Coagulable
Bleeding time3	1.4 ± 0.5	1.3	0.3	2.3

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TAP/INR4	2.9 ± 2	1.8	0.9	8.3
Unsolicited test in 7 cases1, 8 cases2, 9 cases3 and 14 cases4. **Laboratory reference values:** Hemoglobin (g/dL): > 12-15 in females and > 13-17 in males. Hematocrit: 35-45% in women and 40-50% in men. Leukocytes: 5,000-10,000/mm^3. Creatinine (mg/dL): 0.6-1.2 in women and 0.7-1.3 in men. Urea (mg/dL): 15-50 in adults and 10-30 in children. Serum potassium (mEq/L): 3.5-5.5. Serum sodium (mEq/L): 135-145. Coagulation time: 5-10 minutes. Bleeding time: 1-5 minutes. TAP/INR: < 1.2.				

DISCUSSION

It is known that socioeconomic vulnerability, male gender, and rural areas are important risk factors for the occurrence of snakebites and envenomation (BOCHNER; STRUCHINER, 2003). Harrison (2009) cross-referenced data on mortality, GDP (Gross Domestic Product) and other indicators to obtain maps of vulnerable locations from a social and economic perspective. When relating these regions to the map of mortality from snake accidents, he observed that there is a positive correlation. In addition, it is reinforced that rural agriculture, especially subsistence agriculture, is an important risk factor. These facts corroborate the data present in this and other studies, which identified a greater share of accidents in rural areas (MISE; SILVA; CARVALHO, 2007; BERNARDE; GOMES, 2012; FILE; FIELDS; RIBEIRO, 2009; ALKAABI et al., 2011; CHEN et al., 2011). In addition, 76.6% of the individuals were in the age group of 15 to 64 years and men represented 80% of the total, in line with other locations (SENTHILKUMARAN, 2023; BERTOLOZZI et al., 2015; NICOLETI, 2010; HOUCKE et al., 2022; RUHA et al., 2017), and only in one study did the number of women surpass that of men (50.4% x 49.6%) (OKUMU et al., 2019) and the pediatric population (≤ 15 years) predominated over the adult population (WAGENER et al., 2017). Possibly, children were the most affected because, in the rural African communities where the study was conducted, the bites occurred predominantly at night, and children usually sleep on the floor (WAGENER et al., 2017).

The most affected anatomical region found in almost all studies was the lower limbs (SACHETT et al., 2017; BERNARDE; GOMES, 2012; CHEW et al., 2011; MENDES et al., 2022). Possibly due to the fact that most accidents occur during work or on trails, when the individual has no vision of the animal. In the retrospective study by Ruha (2017) alone, 54.8% of accidents with men occurred in the upper extremity, and the lower limbs still predominated in the absolute count for both sexes. In addition, the time elapsed between the accident and specialized care is of vital importance, as it is desired to neutralize the local and systemic effects of the poison as quickly as possible. The relationship between this time lapse and the incidence of severe manifestations of envenomation (NICOLETI et

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al., 2010) and complications is already known. The studies that presented these data using the mean as a measure of central tendency had the following results: 2.75h (RUHA et al., 2017); 2.9 hours (ALKAABI et al., 2011); 4.5 hours (OKUMU et al., 2019); 9h (HOUCKE et al., 2022) and 10.8h (LIN et al., 2012), while the study in evidence obtained an average of 9.9 hours. In fact, it is verified that the time lapse is longer than that described in the literature, especially in rural regions far from health units and difficult to access. This fact highlights the importance of thinking about strategies and providing access to the health care network for rural populations and communities.

As for the species that caused the accident, its identification is not possible in a considerable percentage of cases. The recommendation to have a photograph of the snake or even the animal is controversial. Recognition by the patient is often unreliable, taking into account not only the level of education, but also the variety of names assigned by different populations within the same region. In fact, local and systemic manifestations may be more important to assist in this differentiation. Especially in underdeveloped countries, the diagnosis of snake envenomation is considered probable and classified as clinical-epidemiological, i.e., based on clinical presentation, geography, and incidence and prevalence figures. In Brazil, for example, adding the data on the prevalence of accidents with the genus Bothrops and the presence of characteristic manifestations, in the absence of neurological manifestations, it is possible to make the correct diagnosis with a good margin of safety or even institute combined serum therapy for more than one species. The species was not identified in 29.4% (MAO et al., 2016); 52.9% (CHEW et al., 2011); 100% (BERNARDE; GOMES, 2012); 54.7% (HOUCKE et al., 2022) and 88.2% (MORENO et al., 2005) of the cases, while in the study in question the rate was 98.4%.

As for local manifestations, there was a significant predominance of pain (91.7%) and edema (81.7%) over other symptoms, as observed in the literature (SACHETT et al., 2017; HOUCKE et al., 2022). However, ecchymosis was more important in other analyses than presented, with 49% (NICOLETI et al., 2010); 62% (RUHA et al., 2017) x 8.3% of cases. In contrast to our study, Chew (2011) reported compartment syndrome in six patients (2.3%), while there were no cases in our study, apart from 17 individuals with necrosis (6.5%), compared to 2 cases (3.3%) in our study.

Regarding the main abnormalities in hematological laboratory tests, coagulation time was abnormal in 59% of the patients (NICOLETI et al., 2010), compared to 69.8% in our study. And it was incoagulable in 57.5% (SACHETT et al., 2017), against 54.7% of the

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cases in our study. Regarding TAP/INR, a prospective cohort study (IRELAND et al., 2010), conducted with 478 patients, identified venom-induced consumption coagulopathy in 206 (43%) patients at admission, and the INR was abnormal (> 1.2) in 178 cases (86%), compared to 31 (67.3%) in our study.

The entire population of the present study was clinically diagnosed with secondary bacterial infection. The rate of individuals with this diagnosis varies considerably between studies (AUGUST et al., 2018; OTERO et al., 2002; LIN et al., 2020). The explanation for this seems to be related to different definitions of pyoderma (LARRÉCHÉ et al., 2023). In addition, there may be confusion between the manifestations of infection and poisoning. Thus, validated criteria are needed that can reliably differentiate these two conditions (RESIERE et al., 2020).

In the medical practice of the HDT-UFT, indicators of secondary infection include fever, the appearance of the wound (worsening or appearance of pain, erythema, edema, bad odor, abscess, necrosis), and laboratory parameters such as leukocytosis and CRP, similar to other studies (MAO et al., 2016; LIN et al., 2020). In this study, no case was confirmed by culture. In fact, in many locations, this diagnosis is made clinically, with microbiological tests being an exception (LIN et al., 2020). In the acute context of the bite and depending on the type of health service that provided care (primary or secondary), these resources are not available, especially in underdeveloped countries (BHAUMIK et al., 2022). Despite this, it is important to reinforce the need to request culture and antibiogram for patients with bacterial infection treated in hospital. In this way, it is possible to understand the profile served and adjust the health service.

Prophylaxis for secondary infection is still controversial, due to studies that recommend it or leave the question open (SHEK et al., 2009; NGO et al., 2020). In a study with electronic medical record data from 2,748 cases, prophylaxis was performed in 120 cases (4.4%), and only in 9 patients the culture result was positive (AUGUST et al., 2018), possibly due to collection after the start of the antimicrobial drug. In a randomized clinical trial whose objective was to test the efficacy of amoxicillin with clavulanic acid to prevent bacterial infection, it was observed that prophylactic therapy could delay the onset of the infectious condition, but was not able to prevent it (SACHETT et al., 2017). None of the patients in this study received prophylactic antibiotics.

It is already known the importance of knowing the cutaneous microorganisms with pathogenic potential in order to guide antimicrobial therapy until the results of

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microbiological research are available. However, knowledge about the oral microbiota of snakes does not seem to be considered in medical practice and guidelines. Certainly, by understanding that these microorganisms can be inoculated at the time of the bite, the action of the antibiotics routinely used against these bacteria is questioned. The most commonly prescribed antibiotics in the hospital of the present study were: clindamycin (n = 47), ceftriaxone (n = 26), ciprofloxacin (n = 25), and amoxicillin (n = 6). In the study by Mendes et al. (2022), clindamycin was also the most commonly used drug as initial therapy. In studies that performed bacterioscopy of the oral cavity of snakes of the genus Bothrops, along with susceptibility/resistance testing, it was found that there was resistance to amoxicillin/clavulanate, while there was sensitivity to meropenem and ciprofloxacin (LARRÉCHÉ et al., 2023). In addition, the author concluded that cefepime, piperacillin/tazobactam, or ciprofloxacin would be better options than ceftriaxone. In another study with snakes of the genus Bothrops, the most frequent bacteria were Salmonella, Citrobacter and Escherichia, with high rates of resistance to several classes of antibiotics, such as penicillins and cephalosporins (BASTOS et al., 2008). Another study, which performed culture and antibiogram of infected wounds, showed that gram-negative enterobacteria had 60% resistance to amoxicillin with clavulanate, while there was 100% sensitivity to ciprofloxacin and 97.1% to ceftriaxone (WAGENER et al., 2017). One of the few studies that isolated more gram-positive than gram-negative ones, demonstrated more than 88% sensitivity to ciprofloxacin and third-generation cephalosporins (GARG et al., 2009). Despite this, amoxicillin-clavulanate is the first-line treatment recommended by the American Society for Infectious Diseases Guideline (STEVENS et al., 2014) and one of the most prescribed drugs in several institutions (HOUCKE et al., 2022; HUANG et al., 2012). However, it is possible to note that, in the institution where this study was conducted, the prescription of amoxicillin was less frequent compared to clindamycin, ceftriaxone and ciprofloxacin, which are considered more effective drugs for infection secondary to snakebites. According to the studies analyzed, it seems to be more effective to start empiric therapy with ciprofloxacin, ceftriaxone (PANDA et al., 2018), piperacillin/tazobactam or amoxicillin/clavulanate, associated with ciprofloxacin or levofloxacin (HUANG et al., 2012; RÉSIÈRE et al., 2018).

Among the limitations of this study, the fact that the diagnosis of pyoderma was not confirmed by secretion or tissue culture. Factors that have an impact on the chance of infection, such as previous wound manipulation (suction, tourniquet, or topical

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preparations), were not considered. It was not possible to know the exact moment when the secondary infection was identified from the moment of admission, as well as the descriptive follow-up of the evolution of the wounds after the introduction of antimicrobials.

CONCLUSION

Bacterial infection secondary to snakebite is one of the main complications reported. However, it is still poorly understood, especially with regard to microbiology, antimicrobial drugs, and their resistance and susceptibility profiles. Further research is needed to look for predictors of infection and criteria to aid in the diagnosis of secondary bacterial infection. By considering all these factors, it is possible to institute appropriate therapy and prevent complications, such as abscesses, necrosis, fasciitis, amputation, induction of bacterial resistance, and increased costs in health services.

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