Original article

Primary Hospital Management of Snakebites in Morona Santiago, Ecuador: A Clinical-Epidemiological Study

Manejo hospitalario primario de las mordeduras de serpiente en Morona Santiago, Ecuador: un estudio clínico-epidemiológico

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ABSTRACT

Introduction: Snakebites in Ecuador mainly affect isolated low-income rural communities, leading to delayed treatment and underreporting of cases.

Objective: This study aimed to determine the clinical-epidemiological characteristics of snakebites attended in a primary hospital in Morona Santiago, Ecuador.

Methods: A descriptive study analyzed 66 cases reported as "Toxic effect of snake venom" (code T63.0) according to the International Classification of Diseases (ICD-10). Patient medical records were obtained from the hospital's Electronic Health Record system. Descriptive statistics were calculated for variables on the sociodemographic characteristics of patients, seasonality, diagnosis, and treatment of snakebites.

Results: Snake bites were more common in men (57.58%) and adults (63.64%). The Shuar indigenous population was the most affected (63.64%). The prevalence of snake bites peaked in the first half of the year, particularly in January, February, and April. *Bothrocophias microphthalmus* and *Bothrops atrox* species represented 75.76% of cases. Most cases were mild (59.09%) and lacked complications (71.21%). The mean time from the bite to the administration of antiophidic serum was 3.12 hours (SD ± 3.98 hours; range: 0.25-27.50 hours).

Conclusions: Snakebites significantly impact indigenous communities in Ecuador with limited healthcare access. Addressing delayed treatment and underreporting cases requires improving rural healthcare accessibility and educating patients and professionals. Local studies are the first step to understanding local reality and adapting the national guidelines to its context.

Keywords: snake bites; snakebite envenomation; Viperidae, antivenom.

RESUMEN

Introducción: Las mordeduras de serpiente en Ecuador principalmente afectan a comunidades rurales aisladas de bajos ingresos, lo que conlleva un retraso en el tratamiento y un subregistro de casos.

Objetivo: Determinar las características clínico-epidemiológicas de las mordeduras de serpiente, atendidas en un hospital básico en Morona Santiago, Ecuador.

Métodos: En un estudio descriptivo se analizaron 66 casos reportados como "efecto tóxico de veneno de serpiente" con código (T630), según la Clasificación Internacional de Enfermedades (CIE-10). Las historias clínicas de los pacientes se obtuvieron del sistema de historia clínica electrónica del hospital. Se calcularon estadísticas descriptivas para las variables relativas a las características sociodemográficas de los pacientes, la estacionalidad, el diagnóstico, y el tratamiento de las mordeduras de serpiente.

Resultados: Las mordeduras de serpiente resultaron más frecuentes en hombres (57,58 %) y adultos (63,64 %). La población indígena Shuar fue la más afectada (63,64 %). La prevalencia de mordeduras de serpiente alcanzó su máximo en el primer semestre del año, particularmente en enero, febrero y abril. Las especies *Bothrocophias microphthalmus* y *Bothrops atrox* representaron el 75,76 % de los casos. La mayoría de los casos fueron leves (59,09 %) y carecieron de complicaciones (71,21 %). El tiempo medio transcurrido desde la mordedura hasta la administración de suero antiofídico fue de 3,12 horas (DE ± 3,98 horas; rango: 0,25-27,50 horas).

Conclusiones: Las mordeduras de serpiente afectan, significativamente, a las comunidades indígenas del Ecuador con acceso limitado a la atención sanitaria. Para hacer frente al retraso en el tratamiento y al subregistro de casos es necesario mejorar la accesibilidad de la atención sanitaria rural y educar a pacientes y profesionales. Los estudios locales son el primer paso para comprender la realidad local y adaptar las directrices nacionales a su contexto.

Palabras clave: mordeduras de serpientes; envenenamiento por mordedura de serpiente; Viperidae; antiveneno.

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Introduction

According to the World Health Organization (WHO), around 5.4 million snake bites occur worldwide yearly, and up to 50% cause envenomation. From the envenomation cases, 3 to 5% lead to death and up to 15% to amputations or other permanent disabilities.[1] Snakebite is a neglected disease mainly affecting tropical and subtropical countries in Africa, Asia, and Latin America, where low-income rural communities suffer the most significant impact.[1]

Ecuador is a megadiverse country, with 70% of its territory providing favorable conditions for the development of venomous snake species.[2,3] As a result, Ecuador has one of the world's highest species counts of venomous snakes.[4] Of the 230 snake species, 35 are venomous; 17 belong to the *Viperidae* family, and 18 to the *Elapidae* family.[2,5]

The risk of snakebite in Ecuador shows a geographic pattern, where the Andean region has a low to medium risk, and the Coast and Amazon regions have a medium to high risk.[4] The species *Bothrops Asper*, in the Coast, and *Bothrops Atrox*, in the Amazon, are responsible for 70 to 80% of the envenomations nationwide.[2] Depending on the genus of the snake, the envenomation is classified into three types: bothropic, lachesic, and elapidic. The bothropic envenomation, produced by snakes of the *Viperidae* family, is the most frequent in the country.[2]

Snakebite envenomation can generate diverse clinical manifestations, mainly after the first two hours of the accident. From local inflammatory and tissular destruction signs to systemic effects such as coagulation alterations, hypovolemia, myotoxicity, acute renal injury, respiratory and neurological disorders, and death.[2] The severity of snakebite envenomation is influenced by multiple factors associated with the patient and the snake.[2] Staging the envenomation's severity is based on clinical and laboratory parameters established by national guidelines. Accurately and rapidly assessing the severity of the envenomation is crucial for determining the appropriate treatment and improving the patient's clinical evolution.[6]

Part of the knowledge on treating snake envenomation's in Central and South America comes from accumulated clinical experience since controlled studies on these treatments are scarce.[7] The only scientifically validated treatment is the administration of antiophidic serum.[6,7,8] Unfortunately, there is no national production of antiophidic serum, so they must be imported.[2,9] The Clodomiro Picado Institute in Costa Rica produces several types of sera. One of them, the polyvalent antiophidic serum (Anti-Bothropic, Anti-Crotalic, and Anti-Lachesic), is widely used at the national level against envenomations produced for snakebites of the *Viperidae* family.[10] The dose of antiophidic serum depends on the severity of the bite, the type of ophidian accident, and the type of antiophidic serum.[7] Therefore, it should be adjusted to the guidelines of the manufacturing laboratory and the guidelines generated in each country.

The complications after a snakebite depend on several factors. Inadequate first aid practices and delayed treatment are important limiting factors at the national level.[11] Additionally, underreporting cases in hard-to-reach rural communities has prevented a clear understanding of the extent of the snakebite problem in Ecuador.[2] The current national situation makes it imperative the study and report cases at a local scale and the establishment of standardized measures for diagnosing and treating this pathology. Therefore, the present study aims to determine the clinical-epidemiological characteristics of snakebites attended in a primary hospital in Morona Santiago, Ecuador.

Methods

A descriptive study was conducted to analyze all snakebite cases attended in a primary hospital in Morona Santiago, Ecuador, from January 2019 to January 2021. Patient medical records were obtained from the hospital's Electronic Health Record system. All cases admitted with the diagnosis of "Toxic effect of snake venom" with the International Classification of Diseases (ICD-10) code T63.0 were included.[12]

The universe consisted of 66 patients, classified according to age group and ethnic group (white, mestizo, and indigenous). Within the indigenous group, the Shuar nationality was included.[13] Other sociodemographic variables and variables related to the clinical picture and treatment were considered. In addition, the time delay in medical care was calculated.

For the severity staging and treatment, the protocol for the clinical management of envenomation by venomous snakebites and scorpion stings issued by the Ministry of Public Health of Ecuador was exclusively followed.[2] Data processing and analysis were performed using SPSS Version 22.0. Frequencies and percentages were calculated for categorical variables, and averages and standard deviation for the quantitative variables.

The Teaching Department of the Hospital authorized this study, and all information collected was treated with absolute confidentiality and in compliance with the ethical principles of the Declaration of Helsinki.[14]

Results

Table 1 presents the sociodemographic variables examined in 66 patients. Snakebites were more common in adults (63.64%) and males (57.58%). The mean age of the patients was 34.95 years, with an SD of ± 19.35 years. The predominant ethnicity was indigenous-Shuar (63.64%), and most patients resided in rural areas (57.58%). The prevalence of snakebites was higher during the first half of the year, which coincides with the rainy season (fig. 1).

Table 1 - Sociodemographic characteristics of snakebites attended in a primary hospital in Morona Santiago, Ecuador

Variable	Frequency (percentage)
Age (n = 66) *	
Older adult (≥ 65)	6 (9.09)
Adult (20-64)	42 (63.64)
Adolescent (10-19)	15 (22.73)
Child (0-9)	3 (4.55)
Sex (n = 66)	
Male	38 (57.58)
Female	28 (42.42)
Ethnicity (n = 66)	
White	1 (1.52)
Mestizo	23 (34.85)
Indigenous (Shuar)	42 (63.64)
Place of residence (n = 66)	
Rural	38 (57.58)
Urban	28 (42.42)
Geographic location of the bite (n = 66)	
Road/Street	9 (13.64)
Near the river	3 (4.55)
Farm/Field	40 (60.61)
Housing	14 (21.21)

Legend: *$\bar{x}$ = 34.95 years; SD = ± 19.35 years.

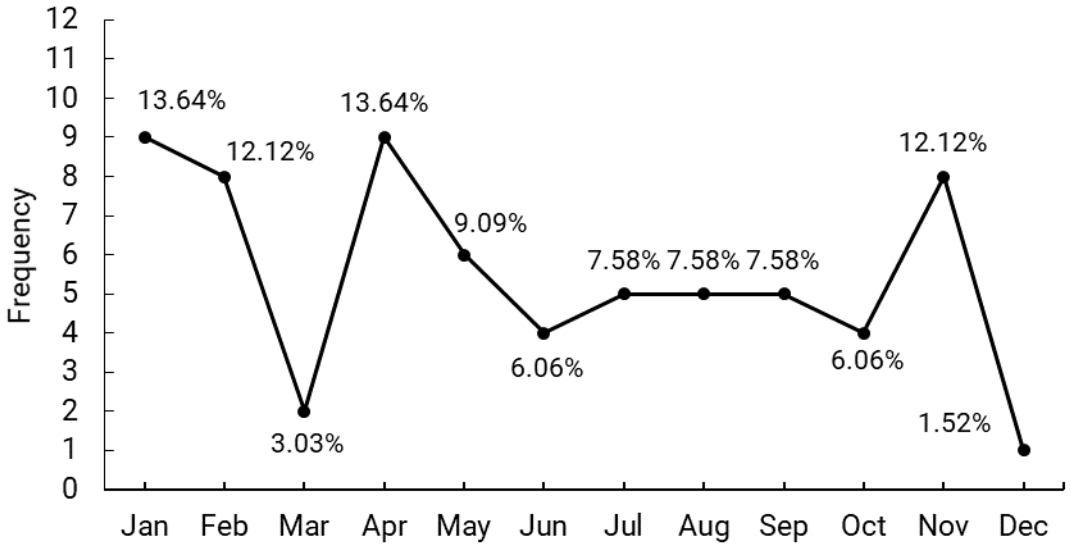

Fig. 1 – Seasonality of snakebites attended in a primary hospital in Morona Santiago, Ecuador.

The clinical picture is detailed in table 2. The type of snake was identified in 78.79% of the cases; 75.76% as venomous and 3.03% as non-venomous. However, in 21.21% of the cases, this characteristic remained undetermined. Among venomous snakes, *Bothrocophias microphthalmus*, known as "*Rotten Leaf*", caused the majority of envenomation.

According to the severity scale of the Ministry of Public Health of Ecuador,[2] 59.09% of the cases were mild envenomations. The bites mainly occurred in a single anatomical segment (92.42%) and the lower extremities (56.06%). Complications were observed in 28.79% of cases, with cellulitis being the most frequent (22.73%).

The mean hospitalization time was 4.7 days with an SD of ± 5.6 days. All patients were discharged alive, and only one case was referred to a higher level of complexity (tertiary hospital). The initial coagulation test was negative in more than half of the cases (57.58%), i.e., the sample coagulated after 20 minutes.

Table 2 - Clinical picture of snakebites attended in a primary hospital in Morona Santiago, Ecuador

Variable	Frequency (Percentage)
Snake type (n = 66)	
Venomous	50 (75.76)
Non-venomous	2 (3.03)
Not identified	14 (21.21)
Snake species (n = 66)	
Bothrocophias microphthalmus	41 (62.12)
Bothrops atrox	9 (13.64)
Epicrates cenchria	1 (1.52)
Bothrops taeniatus	1 (1.52)
Non identified	14 (21.21)
Number of affected anatomical segments (n = 66)	
1	61 (92.42)
2 or more	5 (7.58)
Anatomical location of the bite (n = 66)	
Lower extremities	37 (56.06)
Upper extremities	29 (43.94)
Bite severity (n = 66)	
Non-envenomation	2 (3.03)
Mild	39 (59.09)
Moderate	17 (25.76)
Severe	8 (12.12)
Complications (n = 66)	

None	47 (71.21)
Abscess	3 (4.55)
Cellulitis	15 (22.73)
Compartment syndrome	1 (1.52)
Clot test (n = 66)*	
Positive	28 (42.42)
Negative	38 (57.58)
Hospitalization (n = 66)**	
0 to 7 days	51 (77.27)
8 to 14 days	10 (15.15)
15 to 21 days	3 (4.55)
22 or more days	2 (3.03)

Legend: *Positive clot test: after 20 minutes, the sample does not clot; Negative clot test: after 20 minutes, the sample clots; ** $\bar{x}$ = 4.7 days; SD = ± 5.6 days.

The clinical management is summarized in table 3. All cases in this study were treated with polyvalent antiophidic serum, except those classified as non-envenomations. The median (Me) number of antiophidic sera was four, with a mean of 6.18 sera and an SD of ± 3.45 sera. Combined analgesic therapy predominated over simple one (60.61%); the combination of Paracetamol and Tramadol was the most used (45.45%). 33.33% of patients received combined antibiotic therapy. The Ceftriaxone plus Clindamycin regimen was the treatment of choice in more than half of these cases. In addition, tetanus toxoid was administered during hospitalization in 45.45% of cases.

Table 3 - Clinical management of snakebites attended in a primary hospital in Morona Santiago, Ecuador

Variable	Frequency (Percentage)
Number of sera administered (n = 66)*	
0	2 (3.03)
4	37 (56.06)
8	18 (27.27)
12	8 (12.12)
20	1 (1.52)
Tetanus immunization (n = 66)	
No	36 (54.54)
Yes	30 (45.45)
Analgesic therapy (n = 66)	
Paracetamol	13 (19.70)
Tramadol	13 (19.70)
Paracetamol + Tramadol	30 (45.45)
Paracetamol + Tramadol + NSAIDs	9 (13.64)
Paracetamol + Tramadol + Morphine	1 (1.52)
Antibiotic therapy (n = 66)	
None	38 (57.58)
Monotherapy	6 (9.09)
Combined Therapy	22 (33.33)

Legend: *Me = 4 sera, $\bar{x}$ = 6.18 sera, SD = ± 3.45 sera; Polyvalent antiophidic serum (Anti-Bothropic, Anti-Crotalic and Anti-Lachesic) was used in all cases.

Figure 2 shows the time distribution in three scenarios, as explained below. The mean time from the snakebite to the patient´s arrival at the Emergency Department was 2.96 hours (SD ± 3.73 hours; range: 0.23-19.75 hours). From the patient´s arrival at the Emergency Department to administering antiophidic serum, an average of 0.38 hours (SD ± 1.14 hours) elapsed. Finally, the average time between the bite and the administration of antiophidic serum was 3.12 hours (SD ± 3.98 hours; range: 0.25-27.50 hours).

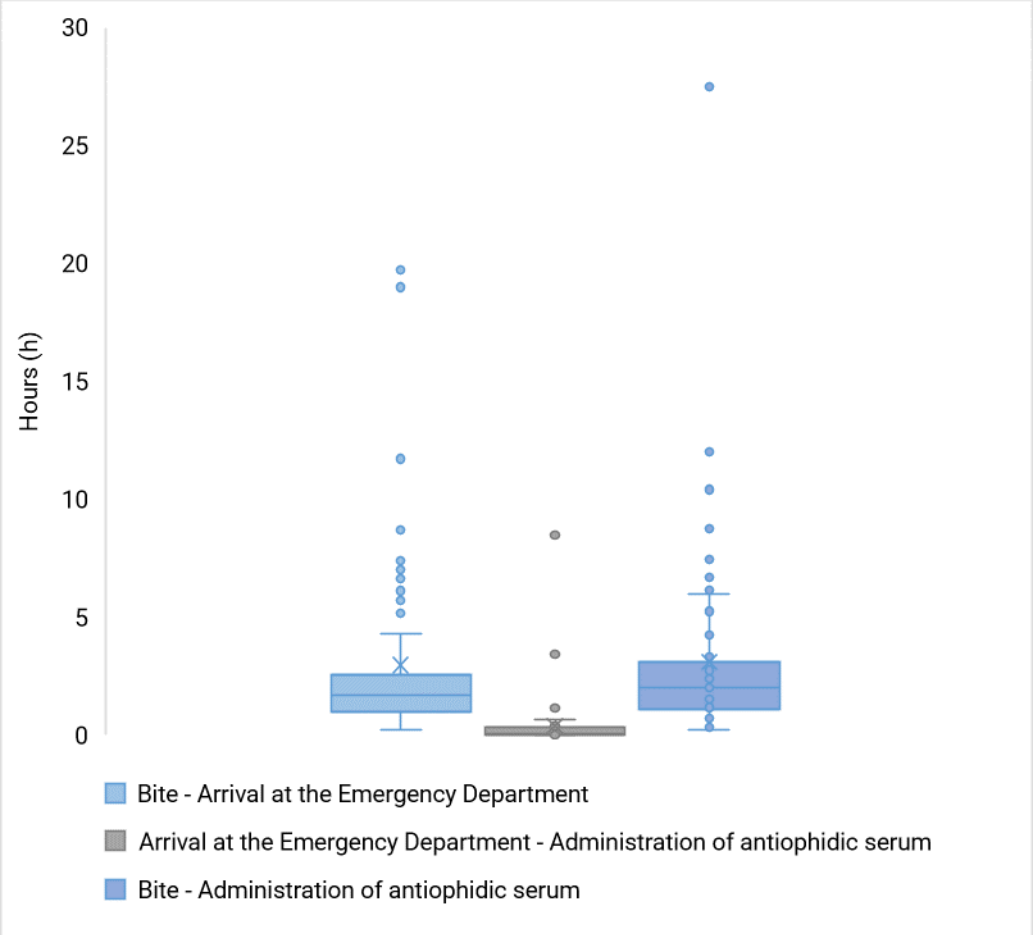

Fig. 2 – Distribution of time between snakebite, arrival at the Emergency Department, and administration of antiophidic serum in patients attended in a primary hospital in Morona Santiago, Ecuador.

Discussion

Ecuador has the climatological and geographical characteristics for the development of numerous species of snakes.[3] In 2021 there were 1556 cases of snake bite envenomations, most of them reported in the province of Morona Santiago.[5] In this context, the present study aims to identify the clinical-epidemiological characteristics of snakebites attended in a primary hospital in this location as a first step in developing preventive strategies.

Snake bites affected predominantly the Shuar population, a widely distributed ethnic group in Morona Santiago.[15] National studies performed in other places in

the Amazon reported higher prevalences.[16,17] The high prevalence in this ethnic group is strongly related to their living and work conditions that involve direct contact with nature in fields, rivers, and crops.[18] Due to its close relationship with work activity, snakebites were mainly located in the lower extremities (56.06%). These results coincide with local and international studies.[17,19,20,21]

As documented in other national studies, snakebites were more frequent in young adult men.[5,16,17,19] In contrast, snakebites in women are less common, although their participation in the agricultural sector has increased in recent years.[22] The reality in other Latin American countries is similar, where men are at higher risk of snake bites due to occupational exposure.[20,23]

According to national statistics, snake bites occur mainly during the rainy season.[5,24] Consistent with this data, the prevalence of snakebite envenomations in this study was higher in the first half of the year, with peaks in January, February, and April.

Snakes of the genus *Bothrops* from the *Viperidae* family cause 70 to 80% of the cases nationwide.[2,3,4,24] Their aggressiveness, ability to adapt to environmental changes, and ecological plasticity have ensured their wide distribution in Latin America.[20] In concordance with those above, this study found that species *Bothrocophias microphthalmus* and *Bothrops atrox* caused 75.76% of the envenomations. However, in 21.21% of cases, the snake species were not identified. Identifying snake species is crucial for accurate diagnosis and treatment, but it is often impossible. People in rural areas rely on practical experience rather than scientific knowledge for identifying venomous snakes. Consequently, cases are often diagnosed and treated based on symptoms and patient testimony without identifying the specific snake species. This challenge is also observed in other studies with a similar non-identification rate.[17,20,23]

Two cases were treated as non-envenomation, 59.09% as mild and only 12.12% as severe. National statistics show a similar trend as in 2021; 51.48% of the cases at the national level were mild, 33.10% moderate, and 15.42% severe.[5] Other national studies agree with these values; however, in some, different severity staging scales were used (Audebert and Russel), and in others, it was not mentioned.[16,19] The

absence of standardized severity scales poses a significant challenge at the national level. The lack of unanimity in diagnosis and treatment may affect the accuracy of national statistics and future studies.

Regarding complications, 28.8% of cases developed them, and as reported in the international literature, cellulitis and abscess were the most frequent complications.[20] The mean hospitalization time was 4.7 days with an SD of ± 5.6 days, and all patients were discharged alive. There is little information regarding hospitalization time in Latin America; however, two studies reported a maximum five-day hospitalization in most cases.[23,25]

The administration of antiophidic serum is the only scientifically validated treatment for snake envenomation.[6,7,8] In Ecuador, antivenoms are not manufactured but must be imported.[2,9] The Polyvalent antiophidic serum (Anti-Bothropic, Anti-Crotalic and Anti-Lachesic) produced by The Clodomiro Picado Institute in Costa Rica is widely used.[10] All envenoming cases in this study were treated with polyvalent antiophidic serum. The median number of antiophidic sera was four, with a mean of 6.18 sera and an SD of ± 3.45 sera. A national study reports a median number of antiophidic sera of eight, with an average of 9.78 sera and an SD of ± 4.20 sera.[25] The number of sera administered per patient depends on the criteria for stage severity, the type of protocol followed, the type of serum, and its neutralizing capacity. Hence, there are variations in serum dosage locally and internationally.

The combination of Tramadol with Paracetamol was the most frequently administered analgesic treatment. In patients with a hospital stay of more than one week, NSAIDs were used to treat pain associated with complications. A national study reports that Paracetamol was the most commonly used analgesic (83.3%), followed by Ketorolac (25.6%) and Tramadol (25.6%).[19] Despite the contraindication of using NSAIDs for snakebites,[2] they are still frequently used in Ecuador for this purpose. The lack of uniformity in treatment at the national level contributes to this problem. Therefore, continuous training of healthcare personnel and updating national protocols are essential.

Regarding antibiotic therapy, the national protocol advises against their use as prophylaxis.[2] In this study, 42.42% of cases received antibiotic therapy, and combined therapy predominated over monotherapy. Other studies reported the administration of antibiotics in more than 75% of the cases.[17,21] Following the national guidelines,[2] the combination of Ceftriaxone and Clindamycin was the treatment of choice, which coincides with a single national study conducted in the province of Napo.[17]

National guidelines recommend the administration of tetanus toxoid;[2] however, in this study, 54.54% of the cases did not receive it. Another national study reports lower coverage, with only 25.6% of patients immunized.[19] The Ministry of Public Health of Ecuador is in charge of vaccine supply at the national level; however, vaccination coverage is still limited in places with poor connectivity.[26]

The severity of snakebite envenomation and its associated complications are greatly influenced by the time between the bite and the administration of antiophidic serum. Delays in treatment are a pervasive problem worldwide, and contributing factors include a lack of connectivity in rural areas, limited availability of antiophidic serum, the use of non-recommended traditional practices, difficulties in identifying whether a patient is envenomed or not, and delays in transferring patients to specialized centres.[27,28]

In this study, the mean time from snakebite to the arrival at the Emergency Department was 2.96 hours (SD ± 3.73 hours; range: 0.23-19.75 hours). No national studies were found with this information; however, a study in Venezuela reported a time of 2 to 6 h in 53.54% of the cases.[23] In the Ecuadorian Amazon, many indigenous villages can only be reached by air or river.[29] Therefore, transporting patients from their communities to primary hospitals often involves hours of delay. In addition, practices such as incisions and the use of plasters and plant-based creams are still standing.[30] Another influential factor is the patient's perception; who can wait up to two hours for symptoms or worsening of the condition before seeking medical attention.[27]

From arrival at the Emergency Department to administering antiophidic serum, an average of 0.38 hours (SD ± 1.14 hours) elapsed, which includes the 20 minutes

needed for the clot test. Finally, the average time from the bite to the administration of antiophidic serum was 3.12 hours (SD ± 3.98 hours; range: 0.25-27.50 hours). Treatment with antiophidic serum is well-established for snake envenomation, even when administered with delay.[27,28] However, healthcare-dependent factors such as waiting for confirmatory symptoms or laboratory results delay the initiation of treatment.[27] Healthcare providers must weigh the potential benefits of administering antivenom as soon as possible against the risk of administering it to a non-poisoned patient.

Snakebite envenomation significantly affects indigenous communities in Ecuador, who face limited access to health care. The problem must be addressed from multiple angles to improve the current situation. First, improving the accessibility of small rural communities to the health system and promoting the national production of antiophidic serum. Second, developing a continuous training program for patients and health personnel in high-risk areas that promote harmonious integration between modern and traditional medicine. Finally, it is essential to carry out more local studies to design prevention strategies adapted to the community context.

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Conflict of interest

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