

Preliminary assessment of antivenom availability and management in the public health system of Costa Rica: An analysis based on a survey to pharmacists in public health facilities

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ABSTRACT

Availability and accessibility of safe and effective antivenoms are key elements for the successful treatment of snakebite envenoming (SBE). This study provides a preliminary analysis on the way antivenoms are managed by the public health system in Costa Rica and on the role played by pharmacists in the overall management of antivenoms. This was an observational, cross-sectional study based on an online survey sent to pharmacists working at *Caja Costarricense de Seguro Social* (Costa Rican Social Security System; CCSS) in different locations in Costa Rica. Characteristics and location of health facilities, as well as antivenom availability and management details, were analyzed. Responses from a total of 96 pharmacists, corresponding to 55 different healthcare facilities, were included in this study. Most respondents worked at pharmacies located in urban communities (69.0%) and in the secondary level of care, which includes clinics, and regional and peripheral hospitals (55.2%). Overall, participants reported antivenom availability at all levels of care and in centers having various operating schedules, although they were not available in some facilities in regions where SBE is uncommon or do not attend SBE cases because of the proximity of more complex health centers. On average, the stocks of anticor and polyvalent antivenoms per health facility were compatible with the dose of antivenom required for treating a SBE case. More than half of participants reported knowing the availability of protocols for the management of SBE and the correct use of antivenom at their healthcare facilities. Of the total respondents, 49% agreed on possessing all the resources needed for the correct management of these medicines at their facilities, and 65.6% indicated that they know the procedures for antivenom storage and management. Our findings provide a first description of the availability of antivenoms in the public health system of Costa Rica, including the primary care level. Results also underscore the perceived role of participating pharmacists in the management of these life-saving drugs and the need to improve their knowledge on this topic.

1. Introduction

Neglected tropical diseases (NTD) have a devastating impact on the poorest populations in the world, increasing the social and economic burden of these vulnerable groups (World Health Organization, 2019). In 2017, snakebite envenoming (SBE) was included as a category A NTD by the World Health Organization (WHO) owing to its heavy impact on a

global basis, especially in impoverished rural settings of sub-Saharan Africa, Asia, and Latin America (Gutiérrez, 2021a).

SBE is responsible not only for more than 100,000 deaths every year but also leaves hundreds of thousands of people with permanent physical and psychological sequelae, and multiple effects in their lives (Gutiérrez et al., 2017). However, complications and deaths associated with SBE are potentially preventable through adequate public health

Abbreviations: SBE, Snakebite envenoming; CCSS, Costa Rican Social Security System (Caja Costarricense de Seguro Social); EBAIS, Basic Provision Units of Integrated Healthcare (Equipos Básicos de Atención Integral en Salud).

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interventions. These include, among others, continuing education for communities and healthcare professionals, the introduction of effective first aid interventions, access to adequate treatment, and management of the associated disabilities as key elements to provide the best care to those affected (World Health Organization, 2019).

The WHO strategy for prevention and control of SBE is based on four main pillars, one of which is the provision of safe and effective treatments (World Health Organization, 2019). The mainstay in the therapy of SBE is the administration of animal-derived antivenoms (Gutiérrez et al., 2017). However, the availability and accessibility of these life-saving products are limited, for diverse reasons, in many developing countries (Potet et al., 2021).

Costa Rica is a 51,000 km² upper-middle-income country (The World Bank, 2022) located in Central America, with a population of over 5 million (Instituto Nacional de Estadística y Censos, 2022), a snakebite incidence of 10.76 snakebites per 100,000 inhabitants in 2014 (Sasa and Segura Cano, 2020), and a mortality rate due to SBE of 0.06 per 100,000 inhabitants in 2015 (Ministerio de Salud, 2016). The viperid species *Bothrops asper* is responsible for the vast majority of cases, especially in rural communities located in humid lowland areas (Gutiérrez et al., 2021; Hansson et al., 2013; Sasa and Segura Cano, 2020). The number of snakebite cases has remained stable in this country over the years, although the incidence has shown a steady decrease (Sasa and Vazquez, 2003; Sasa and Segura Cano, 2020). Mortality has also dropped significantly over the years owing to sustained public health development, local production of antivenoms, and training of healthcare staff in the management of these accidents, among other factors (Fernández and Gutiérrez, 2008; Rojas et al., 1997). However, there are still regions of greater vulnerability to SBE in this country (Arroyo et al., 1999; Hansson et al., 2013).

In Costa Rica, the treatment of SBE includes two equine-derived antivenoms, i.e., polyvalent and anticoral, manufactured by Instituto Clodomiro Picado (University of Costa Rica) (Gutiérrez, 2021b). The former is used in the treatment of envenoming by snakes of the family Viperidae, while the latter is effective in cases inflicted by species of coral snakes (genus *Micrurus*, family Elapidae). Antibiotics, analgesics, steroids, adrenaline, and antihistamines are also part of the standard treatment protocol at the *Caja Costarricense de Seguro Social* (Costa Rican Social Security System; CCSS) (Dirección de Farmacoepidemiología, 2008; Gutiérrez, 2021b; Sasa and Segura Cano, 2020). This institution provides most health care services in Costa Rica through a widespread national network of clinics, hospitals, and primary care centers known as *Equipos Básicos de Atención Integral en Salud* (Basic Provision Units of Integrated Healthcare, EBAIS), the basic unit of healthcare in this country. The healthcare staff of EBAIS includes a general physician, a nurse, and technical personnel (Caja Costarricense de Seguro Social, 2021). Pharmacists are generally not included in the basic staff of EBAIS, although some of these units have a pharmacist. When this professional is not available at the primary care level, prescriptions are processed by a pharmacist at a secondary level of care. Antivenoms are included in the national medicines lists under the biological, vaccine, toxoids, and antitoxins therapeutic group, being authorized for administration in health establishments at all levels of care (Caja Costarricense de Seguro Social, 2022).

Availability and accessibility of safe and effective antivenoms are key elements for the effective treatment of SBE (Potet et al., 2021). Assuring real access to these medications on a timely basis demands a series of concerted efforts by the public health system, including an active role of public health authorities in the provision of these medicines, the use of innovative strategies to overcome budget restrictions, distribution based on sound epidemiological data, adequate management of the cold chain, permanent training programs aimed at health professionals in charge of managing SBE, and raising awareness through community engagement in regions of a high incidence of snakebites (Gutiérrez et al., 2010).

Effective attention to SBE should involve the collaborative work of various health professionals, including physicians, nurses, pharmacists,

and microbiologists in charge of laboratory diagnosis. Pharmacists play an important role in antivenom management, overseeing the dispensing of antivenoms and keeping adequate stocks of these immunobiologicals in health facilities. Nevertheless, information regarding their role in the SBE therapeutic journey is rather limited.

This study presents a preliminary assessment of the availability and management of antivenoms in the public health system of Costa Rica, based on a survey submitted to pharmacists. In addition, information regarding pharmacists' perceptions, knowledge, and practices on aspects of antivenom management was assessed.

2. Materials and methods

This was an observational, cross-sectional study based on a survey sent to pharmacists working at CCSS in different locations in Costa Rica. The survey was previously validated by three pharmacists and an expert on SBE from Instituto Clodomiro Picado, University of Costa Rica. The Human Subjects Committee of the University of Costa Rica approved the study protocol and issued an exemption for the use of the informed consent form (approval number CEC # 419–2021).

Participants were pharmacists currently working at CCSS, at the primary (EBAIS), secondary (clinics and regional and peripheral hospitals), and tertiary (national and specialized hospitals) levels of care. An online-based survey was developed using the Google Forms platform and sent via email by the Costa Rican Pharmacists Association to all pharmacy professionals described above; reminders were sent seven and fifteen days after the initial communication. Participation was voluntary, and no incentives were offered to those willing to fill out the survey. The survey was anonymous and did not collect personal identifiers from respondents. Responses were collected over 30 days, from August to September 2021. We present data for a total of 22 items included in the survey related to pharmacists' responses and perceptions of antivenom availability and management at worksites.

Worksites were categorized according to operating hours, level of healthcare attention, and geographical setting. Healthcare facility operating hours ranged from regular schedules (8 h of care), extended operating hours (between 8 and 12 h of care), and 24-h services. Healthcare attention level was indicated by participants according to the level of complexity of attention provided at their workplace as a primary, secondary, or tertiary level of care. Also, depending on the location of every center they were classified as rural or urban, based on the classification of the Costa Rican National Institute of Statistics and Censuses (Instituto Nacional de Estadística y Censos, 2016). Finally, the percentage of antivenom availability was obtained grouping responses by healthcare facility.

For all responses including a clear location, and the name of the healthcare facility, maps were constructed using Google Maps 2022 (maps.google.com). Each place was categorized depending on whether it was urban or rural, the level of care, and whether antivenom stocks were reported as available at the time of the survey.

Using a five-point Likert scale, participants were asked to indicate whether they agreed or not with statements evaluating having all resources needed to adequately manage these medications at their workplace and having general knowledge of the procedures for antivenom storage.

To describe the antivenom management process at every health facility, pharmacists were presented with seven tasks related to antivenom management: availability requests to the distribution center, expiration date review, distribution of antivenom to EBAIS and clinics, cold chain review, education of other health care professionals, and destruction of expired or damaged antivenom. For each action, participants were asked to indicate which of the following professionals were in charge: pharmacists, pharmacy technicians, nurses, nursing assistants, physicians, technical assistants of primary health care, or administrative staff.

All statistical analyses were performed with the R 4.1 and R studio 2022.07.1 programs and the R Commander version 2.8 package. For the

analysis of the results, descriptive parameters were obtained, and participants' responses were analyzed using the Levine test for homoscedasticity, as well as the Shapiro-Wilks test to check the normal distribution of the data. Since the data did not follow a normal distribution, the Chi-square test was used to assess the significance of the differences between groups, with a significance level of 0.05 for each data set.

3. Results

The Costa Rican Pharmacists Association sent emails with the survey link to 936 pharmacists working at primary, secondary, and tertiary levels of care at CCSS all over the country. Nearly half of them ($n = 395$, 42.2%) opened the email and one of every four completed the survey ($n = 101$, 25.6%). Five participants were excluded from the analysis due to ambiguous responses to the question "level of care of the site you work at". Thus, responses from 96 pharmacists, corresponding to 55 healthcare facilities were included in the analysis.

Overall, most respondents work at pharmacies located in urban communities. In addition, when considering all centers (urban and rural) more than 80% of centers reported antivenom availability. As shown in Table 1, responses came mainly from the secondary level of care (55.2%), followed by the primary and tertiary levels (21.9% and 22.9%, respectively). Regarding the schedule of attention, all centers having a 24-h shift corresponded to the secondary and tertiary levels, whereas the regular 8-h shift was reported mostly at the primary and secondary levels (Table 1). Antivenoms were available at all levels of care, particularly in those at the tertiary (100.0%) and secondary levels (85.7%), while 81.3% of centers at the primary level reported having a stock of antivenom. Considering the existence of antivenoms *vis-a-vis* the schedule of attention, more than 90% of centers having a 24-h schedule or extending operating schedules (between 8 and 12 h) reported having antivenom stocks, while in the case of centers operating in an 8-h schedule antivenom stocks were reported in 80.0% of them (Table 1). No statistically significant differences were observed when comparing antivenom availability according to geographical location ($p = 0.665$), level of care ($p = 0.199$), and health facility schedule ($p = 0.1844$). Fig. 1 presents the geographical distribution of health facilities included in this study, their antivenom availability, and the level of health care.

Table 1
Antivenom availability reported by pharmacists at different health care centers in Costa Rica.

Characteristics of health centers ^a	Participants n (%)	Percentage of antivenom availability ^{b,c}
Location		
Rural	27 (31.0)	87.0
Urban	60 (69.0)	84.4
Level of care		
Primary	21 (21.9)	81.3
Secondary	53 (55.2)	85.7
Tertiary	22 (22.9)	100.0
Consultation hours		
Regular schedule (8 h)	38 (39.6)	80.0
Primary level	18 (85.7)	
Secondary level	19 (35.8)	
Tertiary level	1 (4.5)	
Extended operating hours	10 (10.4)	100.0
Primary level	3 (14.3)	
Secondary level	6 (11.3)	
Tertiary level	1 (4.5)	
24-h shift	48 (50.0)	93.5
Primary level	0	
Secondary level	28 (52.8)	
Tertiary level	20 (90.9)	

^a $n = 87$ for rural/urban classification and $n = 96$ for the other parameters.

^b Responses grouped by healthcare facility, $n = 55$.

^c No significant differences regarding antivenom availability were observed when comparing rural and urban centers, level of care, and consultation hours.

Nearly all pharmacists reported managing a stock of both anticorral and polyvalent antivenoms in their health centers. On average, the reported stock of anticorral antivenom was 16.9 vials (SD = 11.2; range: 5–50), with seven sites reporting having less than ten vials on stock (four rural and three urban) and 16 sites with 20 or more vials available. On the other hand, polyvalent antivenom availability per health facility was 21.6 (SD = 18.7; range: 5–100), with 10 reports of a stock of 25 vials or more (four rural and six urban).

This medicine was not available in eight healthcare centers located at primary and secondary levels of care (three and five centers, respectively). Two main reasons given by pharmacists for the lack of availability were: close proximity to more complex health centers, and the low number of cases of SBE in the community.

The existence of antivenom stock according to the time needed to transfer patients to the next level of care was also investigated. Fourteen out of the 17 health facilities that do not transfer SBE patients reported having antivenom stocks. In cases where patient transfer takes 1 h or more, all centers reported having antivenom stock, whereas 15% of those in which the transfer takes less than 1 h reported not having antivenom (Table 2). In these facilities, in the event of an SBE, antivenoms can be requested from nearby health centers. In particular, centers where patient mobilization to more specialized healthcare centers takes more than 2 h correspond to rural settings, some of which are known for their difficult access for some populations, specifically in Coto Brus (province of Puntarenas) and Turrialba (province of Cartago). All these healthcare facilities reported having both types of antivenoms in stock for the attention of SBE.

In terms of the existence of protocols for the management of SBE and the correct use of antivenom at their healthcare facilities, half of the participants (52.1%) reported knowing the availability of such protocols at their workplace. In contrast, a fifth of participants did not know whether this document was available, and 15.6% thought that it was not available at all. When presented with different statements related to resources needed for the adequate management of antivenoms, almost half of the participants agreed as having all the resources needed for the correct management of antivenoms at their health facilities (49%) and 65.6% indicated that they know the procedures for antivenom storage and management.

Pharmacists recognized their role in activities related to the adequate management of antivenoms such as: securing availability (86.5%), requesting antivenoms to the distribution center at CCSS (66.7%), reviewing expiration date checkout (79.2%), guaranteeing distribution of antivenom to EBAS and clinics (60.4%), maintaining the cold chain (84.4%), providing information to other healthcare professionals (78.1%), and knowing the procedures for proper destruction of expired or damage antivenom (81.3%).

In addition, nearly 40% of responding pharmacists considered that pharmacy technicians are involved in activities related to securing availability and requesting antivenoms to the distribution center at CCSS. Pharmacy technicians were also related to guaranteeing distribution of antivenom to primary health care centers and clinics (42.7%), maintaining the cold chain (42.7%), and reviewing expiration date checkout (49.0%). Furthermore, participants considered that physicians (34.4%) and nurses (19.8%) play an important role in educating other healthcare professionals on antivenom use.

4. Discussion

This study presents a preliminary overview on the availability of antivenoms in the public health system of Costa Rica and on the role that pharmacists play in their management. In the sample analyzed, it was found that antivenoms are available in health facilities located in urban and rural settings, at the three levels of health care and in centers having various schedules of attention. Despite their preliminary nature, our observations provide novel information on various aspects of antivenom availability and management in the country.

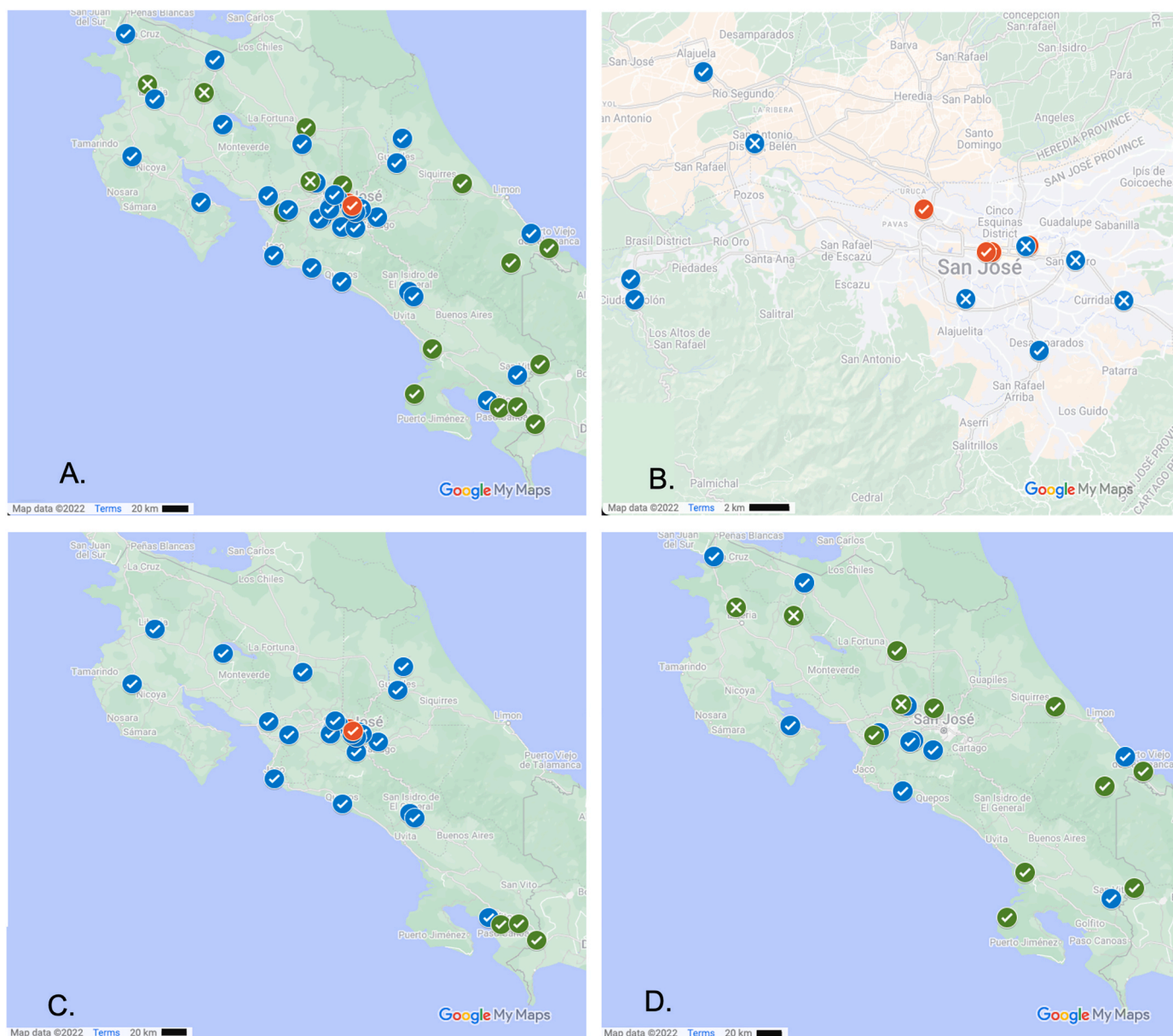


Fig. 1. Distribution of antivenoms according to the level of attention and location. (A) Antivenom availability in all health facilities in Costa Rica from which responses to the survey were obtained. (B) Close-up view of health facilities located in the central region of the country. (C) Antivenom availability in urban health facilities. (D) Antivenom availability in rural health facilities. Circles with check marks indicate antivenom availability whereas circles with “x” indicate facilities where antivenoms were not available. The color scale represents the level of attention of each center (Green: primary level, blue: secondary level, and red: tertiary level). Map scale A, C, and D: 20 km; B: 2 km. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

Table 2

Time required to transfer patients to the nearest healthcare facility.

Estimated patient transfer time to the next level of care	Number of centers	Antivenom availability (%)
Less than an hour	24	85.7
1–2 h	12	100.0
2–3 h	1	100.0
More than 3 h	1	100.0
Patients are not transferred	17	82.4

Antivenoms are the only accepted treatment for SBE (World Health Organization, 2017); therefore, guaranteeing the availability and accessibility of these essential medicines is vital for the treatment of envenomed patients, and the prevention of complications and deaths

associated with SBE. The availability of antivenoms at health facilities involves upstream, midstream, and downstream factors that include development and manufacture, registration, pricing, procurement, supply, prescribing, and dispensing of antivenoms (Potet et al., 2021). Key issues are the access to safe and effective antivenoms in sufficient amounts, the distribution of antivenoms to health posts in regions of a high incidence of SBE based on sound epidemiological evidence, and the adequate management and use of these products by the health staff. These, in turn, are intimately related to the coverage, organization, and quality of the public health system. There is great heterogeneity in this scenario on a global basis (Fan and Monteiro, 2018; Gutiérrez, 2012; Habib and Warrell, 2013; Oliveira et al., 2022; Potet et al., 2021), and therefore, analysis of antivenom availability and accessibility in specific regional and national contexts is a relevant task.

Costa Rica has a robust public health system since the last century

(Botey-Sobrado, 2019; Palmer, 2003). A significant strengthening of this system at the primary care level occurred in the 1990s with the creation of the EBAIS, which are widely distributed in the country (Rosero-Bixby, 2004; Saénz et al., 2010). Through this universalized public health system, Costa Rica has reached high standards in health parameters (Martínez Franzoni and Sánchez-Ancochea, 2019; Saénz et al., 2010). CCSS provides most of the health care services in Costa Rica through a network that includes all three levels of attention covering more than 95% of the population (Arce Ramírez, 2021). At the primary level, it delivers health promotion and disease prevention activities, as well as basic medical attention. The secondary level includes a more specialized medical provision, while the tertiary level comprises the most specialized human and technological resources. The selection and distribution of medicines, including antivenoms, are based on the identification of the most common pathologies at each level of care (Caja Costarricense de Seguro Social, 2021; Saénz et al., 2011).

The management of SBE has benefited from these institutional developments. The local production of antivenoms at Instituto Clodomiro Picado, and their acquisition by CCSS, have ensured the coverage of the national needs for these medicines since 1970 (Gutiérrez et al., 2020). In Costa Rica, antivenoms are part of the country's essential medicines list and can be prescribed by any physician, regardless of their specialization or level of care where they work (Gutiérrez et al., 2009). As observed in this study, both polyvalent and anticoral antivenoms are distributed at the three levels of the health care system, with some exceptions. The availability of antivenoms at the primary health care level was introduced several years ago and constitutes a significant advance as it has contributed to the shortening in the time lapse between a snakebite event and the administration of antivenom. In agreement with this, 38% of patients suffering a snakebite during the years 2012–2014, were initially attended at the primary level (Sasa and Segura Cano, 2020). Moreover, most patients received treatment less than 3 h after the bite, although there is still a proportion of them that access health facilities after a delay of more than 5 h (Sasa and Segura Cano, 2020). It is necessary to identify the causes behind such delays and implement interventions to correct them. A prolonged delay in medical attention after snakebites is generally associated with poor outcomes, as described in Nepal, Nigeria, and Brazil (Iliyasu et al., 2015; Magalhães et al., 2022; Sharma et al., 2004). Limited access to health facilities, and therefore to antivenoms, affects populations in remote rural locations in many countries, including indigenous communities (Cristino et al., 2021; Fan and Monteiro, 2018), an issue that demands renewed public health interventions.

Antivenom administration at all levels of care in Costa Rica requires the presence of a physician, as well as access to resources for intravenous infusion, including saline solution, and drugs to treat possible adverse reactions (antihistamines, steroids, and adrenaline). When the antivenom is administered at the primary level, upon stabilization the patient is transferred to the next level of attention for follow-up (Dirección de Farmacoepidemiología, 2008). Such widespread antivenom accessibility, together with the universal character of the health system, constitutes a highly favorable situation for the management of SBE in this country. Indeed, regardless of the location, level of attention, and consultation hours, antivenom availability was similar and no statistically significant differences were identified in the sample analyzed.

Our observations identified several facilities, at the primary and secondary levels of care, which did not report having antivenom in stock. The main reasons pointed out by participants are the short time required to transfer the patient to the next level of attention and the low number of snakebite cases attended in these facilities. In contrast, all facilities located in rural settings of high snakebite incidence and patient transfer journeys of more than 2 h reported having antivenom stocks. This suggests that, depending on the prevalence of SBE and the closeness to other health facilities, it may not be necessary to deploy antivenoms in all health centers, as observed in this study. Thus, a robust epidemiological information base is necessary for effective policies of antivenom

deployment.

It was of interest to assess the number of antivenom vials kept in health facilities *vis-à-vis* the recommended dose to treat an envenoming event. The current protocols of antivenom dosage in Costa Rica indicate that the dose of polyvalent antivenom depends on the severity of the case, regardless of the age of the patient. For mild cases, a dose of five vials is recommended, while in moderate to severe cases ten vials should be used. In exceptionally critical cases, an initial dose of fifteen vials is recommended. In the case of envenoming by coral snakes (*Micrurus* sp), the initial recommended dose for anticoral antivenom is ten vials. For viperid envenoming, when clinical manifestations do not resolve within the next 12 h after antivenom administration, an additional dose of five or ten vials is administered (Caja Costarricense de Seguro Social, 2008; Gutiérrez, 2021b). In agreement, a study of snakebites attended in six hospitals in Costa Rica in 2012–2014 showed that in 76% of the cases the number of vials used ranged between 10 and 15 vials, although there were cases in which lower and higher doses were employed (Sasa and Segura Cano, 2020).

In terms of stock management, the number of vials available in the healthcare facilities reported by the pharmacists that responded the survey, is consistent with the treatment guidelines of CCSS, since most centers reported having a stock of 20 vials or more of polyvalent antivenom. However, four health centers (two rural and two urban) had less than 10 antivenom vials at the time of the survey. This is an important observation for further research on antivenom distribution policies, to ensure that each health facility has a minimum stock sufficient to treat at least one case of SBE. In general, those posts with enough antivenom stock are located rural settings with a high incidence of SBE (Hansson et al., 2013; Sasa and Segura Cano, 2020).

The management and distribution of antivenoms in the public health system of Costa Rica involve centralized and decentralized distribution channels. As shown in Fig. 2, all establishments can request antivenom directly from the central distribution center of CCSS. Additionally, in special circumstances when antivenom is immediately needed because the stock is lower than the recommended dose, or has been recently used, antivenoms can also be requested from the nearest health posts at various levels of attention (Fig. 2). It is therefore of relevance to ensure the efficacy of these distribution channels to avoid delays in antivenom administration to envenomed patients. Moreover, in settings with a high incidence of SBE, where several cases may occur simultaneously, it is necessary to keep antivenom stocks that allow the management of several cases in a single day. On the other hand, adequate product final disposition is an important part of the management process. Fig. 2 shows the possible pathways for antivenom destruction due to deterioration, expiration, or loss of the cold chain, among other factors. The ultimate destruction is carried out centrally.

Pharmacists play a key role in the professional team in charge of managing SBE, and there is a paucity of studies surveying hospital pharmacists on this topic (AlTamimi et al., 2018; Braitberg et al., 2021). Therefore, another goal of this study was to assess the perceptions of pharmacists working in public health centers on several aspects of antivenom management. More than half of the pharmacists that responded to the survey knew of the existence of a protocol for the management of snake envenoming. In general, respondents recognized their role in the overall management of antivenoms. About 65% of pharmacists expressed knowing the procedures related to antivenom storage and handling and 49% indicated that they have the resources for adequate management of the drug. The subject of SBE and antivenom management receives limited attention in the undergraduate Pharmacy university programs. This highlights the need to strengthen this topic in the curricula of these careers, as well as to develop permanent education programs for professionals in coordination with the universities and the Costa Rican Pharmacists Association. Additionally, respondents highlighted the need to expand the knowledge of correct antivenom management to pharmacy technicians. Management of medicines is a complex process that includes scheduling, purchase, storage,

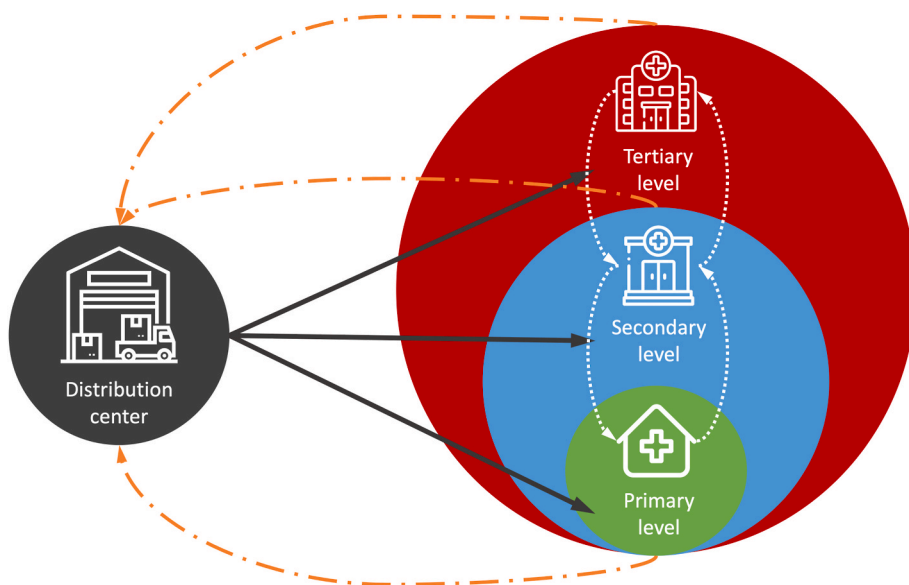


Fig. 2. Antivenom distribution from a centralized center to the different levels of care in the Costa Rican public healthcare system. Continuous black lines indicate the movement of antivenoms from the distribution center to the attention centers. Dotted white lines depict exchanges between the system network of health centers, and dashed orange lines represent returns to the distribution center for antivenom destruction. (For interpretation of the references to color in this figure legend, the reader is referred to the Web version of this article.)

distribution, control, and destruction of these products. Thus, the entire healthcare team must be well-informed and trained to ensure a safe and rational use of this medication in all steps of this process. Overall, our findings underscore the need to strengthen an interdisciplinary approach among health professionals in antivenom management and use.

This study has a number of limitations. Despite multiple efforts to contact pharmacists, and the collaboration of the Costa Rican Pharmacists Association by sending survey and reminder emails, our sample remained small. Therefore, the findings of this study should be considered preliminary, and future work is necessary to have a more representative sample of pharmacists and health facilities in the country. On the other hand, this evaluation shows the perception of those who responded to the survey and does not correspond to data directly verified by CCSS authorities. An additional limitation relates to the fact that not all primary health care facilities have a pharmacist. Therefore, a thorough analysis of antivenom availability at this level of care should rely on other sources of information, a pending issue for future investigations. Noteworthy, this project was carried out during the COVID-19 pandemic, so the attention and priorities of hospital pharmacists could have been focused on other activities since all centers at CCSS oversaw the provision of care to people affected by this infectious disease. This might partially explain the low rate of response to the survey. Despite these limitations, we were able to collect information from urban and rural centers, from health facilities at the three levels of care and from facilities having different schedules of attention, thus offering a first insight into the situation of antivenom availability in the public health system of Costa Rica and on the role played by pharmacists in antivenom management. Further studies are necessary to expand these observations in order to have a comprehensive view of this subject in this country.

Credit author statement

Conceptualization: ALS, MSQ, WMV, JMG. -Formal analysis: ALS, MSQ, WMV, JMG. -Investigation: ALS, MSQ, WMV, JMG, JMH, CR. -Methodology: ALS, MSQ, WMV, JMG, JMH, CR. -Writing-original draft preparation: JMG, ALS, MSQ, WMV. -Writing-review and editing: JMG, ALS, MSQ, WM. All authors agree with the final content of this manuscript.

Ethical statement

The Bioethics Committee for Human Investigation of the University of Costa Rica approved the study protocol and issued an exemption for the use of the Informed Consent form (approval number CEC # 419–2021).

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: José María Gutierrez works for Instituto Clodomiro Picado, an institution in charge of antivenom production in Costa Rica.

Data availability

Data will be made available on request.

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