

Original article

Snakebite incidents treated in the city of Sorocaba – São Paulo, Brazil

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ABSTRACT

Abstract: Incidents involving snakebites in humans are a significant public health issue in tropical areas. They are frequent in the Sorocaba Region, in the state of São Paulo, Brazil. In order to acknowledge the epidemiological, clinical and laboratory characteristics of those incidents in the city of Sorocaba, this study was carried out in the period going from 2013 to 2017. **Methodology:** Descriptive and cross-sectional epidemiological study, using data obtained from the Epidemiological Notification Forms. **Results:** 158 (75.3%) of the reported incidents were ascribed to snakes of the *Bothrops* sp genus; 20 (9.5%) incidents to *Crotalus* sp; 2 (1.0%) to *Elapidae* sp; 11 (5.2%) to non-venomous snakes; and 19 (9.0%) non-identified – totaling 210 patients, of which 133 (63.3%) were male and 77 (36.7%) female, and whose age group ranged from less than 1 year old to 90 years old. 138 (65.8%) incidents occurred in urban areas; 40 (19.0%) took place in rural areas; and 3 (1.4%) in peri-urban areas. 159 (75.7%) incidents were reported as work-related accidents, and 71 (64.6%) of the patients had low schooling, unfinished elementary education. Symptoms resulting from envenomation occurred in 191 (91%) patients, and 3 adults died (1.4%). The time span between the incident and the assistance was less than 3 hours in 109 (52%) cases; more than 3 up to 12 hours in 42 (23.2%) cases; and longer than 12 hours in 29 (16.6%). Treatment used 1,309 antivenom serum vials. **Conclusion:** Ophidism is a significant public health issue in the Sorocaba Region, and it mostly affects children from zero to 10 years old. The lethality rate is higher in comparison with other Brazilian regions. The results of this study indicate this matter as of great importance, and they highlight the urge to reassess healthcare regarding snakebites in the region. As these kinds of incidents are usual and preventable, this topic should be part of the educational program in elementary education and healthcare courses, as well as part of the mandatory program in Brazilian medical and nursing schools.

KEYWORDS: Ophidism; Serpents; Snakes; Venomous animals; Snakebite incidents.

RESUMO

Resumo: Os acidentes ofídicos humanos são um importante problema de saúde pública nas áreas tropicais. Na região de Sorocaba, São Paulo, Brasil, ocorre o mesmo. Com o objetivo de se conhecer as características epidemiológicas, clínicas e laboratoriais dos acidentes atendidos na cidade de Sorocaba foi realizado o presente estudo, no período de 2013 a 2017. **Metodologia:** Estudo epidemiológico descritivo e transversal com dados obtidos das Fichas de Notificação Epidemiológica. **Resultados:** Foram notificados 158 (75,3%) acidentes atribuídos às serpentes do gênero *Bothrops* sp, 20 (9,5%) por *Crotalus* sp, 2 (1,0%) por *Elapidae* sp, 11 (5,2%) não peçonhentas e 19 (9,0%) sem identificação, totalizando 210 pacientes. Desses, 133 (63,3%) vítimas eram do sexo masculino e 77 (36,7%) feminino, cujas faixas etárias variaram entre menores de 1 ano até 90 anos. Em 138 (65,8%) pacientes o acidente ocorreu na zona urbana, em 40 (19,0%) na rural e em 3 (1,4%) na periurbana. Em 159 (75,7%) casos o acidente foi notificado como de trabalho; 71 (64,6%) acidentados tinham baixa escolaridade, ensino fundamental incompleto. Os sintomas decorrentes do envenenamento ocorreram em 191 (91%) pacientes e 3 (1,4%) adultos morreram. O intervalo de tempo transcorrido entre o acidente e o atendimento em 109 (52%) casos foi igual ou menor que três horas; em 42 (23,2%) maior que três até doze horas; e em 29 (16,6%) maior que 12 horas. A alteração no tempo de coagulação ocorreu em 98 (46,7%) pacientes. No tratamento foram utilizadas 1.309 ampolas de soro anti-peçonhento. **Conclusão:** O ofidismo é importante agravo de saúde pública na região de Sorocaba, acometendo mais crianças na faixa etária entre 0 e 10 anos e maior letalidade quando comparado a outras regiões brasileiras. Os resultados deste estudo reforçam a importância do tema e sinalizam a necessidade de reavaliação da atenção à saúde em relação ao ofidismo nessa região. Por envolver acidentes frequentes e passíveis de prevenção, esse agravo deveria fazer parte da programação pedagógica do ensino fundamental e dos cursos da área da saúde, como conteúdo obrigatório das escolas de medicina e de enfermagem no Brasil.

PALAVRAS-CHAVE: Ofidismo, serpentes, cobras, animais peçonhentos, acidentes ofídicos.

INTRODUCTION

Snakebite incidents represent a serious public health issue in tropical areas over the world.¹ In 2009, the World Health Organization (WHO) included them in the list of neglected tropical diseases, mainly affecting people living in rural areas and working in the agricultural industry - a significant workforce in developing countries. Snakebite poisoning causes morbidity and mortality, usually requiring hospitalization, and resulting in permanent disability, or death in more severe cases.^{2,3} Delayed medical assistance, as well as the lack of antivenom serum and supportive care, are considered main contributive factors in high morbidity and mortality.^{4,5}

WHO estimates the occurrence of 5.4 million snakebites in humans per year in the world, resulting in 2.7 million poisonings, 81,000 to 138,000 deaths, and approximately three times those numbers of survivors with severity and sequelae.⁴

In Brazil, 31,395 incidents involving snakes were recorded in 2020, 121 of which resulting in death. The cases involving bothrops correspond to 70%, followed by the ones ascribed to rattlesnakes (9%), and the rest to bushmasters and coral snakes. The most afflicted individuals are male rural workers who do not use personal protective equipment (PPE) nor have access to agricultural machinery, and therefore are more susceptible to those incidents.⁵ Snakebites occur more often in daytime, mainly affecting the lower limbs. They are also related to climatic factors, occurring mostly between September and March in the South, Southeast and Center-West regions, and from January to May in the North-Eastern region.¹ The serpents' metabolism is controlled by ambient temperature, and they are more active in the warmest seasons, making it easier for the victim to come across the predator animal.^{6,7}

In Brazil, the ophidian fauna of medical interest is represented by the genera *Bothrops* sp, *Crotalus* sp, and *Lachesis* sp, belonging to family Viperidae, and *Micrurus* sp, of family Elapidae.¹⁰ The most clinically relevant species are: *B. jararaca*, *B. jararacuçu*, *B. alternatus*, *B. moojeni*, *B. atrox*, *B. neuwiedi*, *C. durissus*, *L. muta*, and *M. corallinus*.¹¹ Around 30 species of the *Bothrops* sp genus are spread through the country, and they are popularly known, in Portuguese, as jararaca, ouricana, jararacuçu, urutu-cruzeira, jararaca-do-rabo-branco, malha-de-sapo, patrona, surucucurana, comboia, and caiçara, amongst other denominations.^{11,12,14} Those snakes mainly inhabit rural areas and large cities outskirts; they prefer humid environments like forests and farmlands, and have predominantly nocturne habits.¹² They show aggressive behavior, silently striking when they feel threatened.

Bothrop incidents correspond to the most epidemiologically important ones in the country, as they are responsible for about 90% of envenomings.^{16,17} The venoms have complex composition, with different physiopathological activities. The bothrop has proteolytic activity, mainly causing pain, edema, blisters and necrosis at the bite region, and coagulant action, causing hemorrhages and kidney malfunctions, which can lead to acute renal failure.¹⁷ The symptoms resulting from this poisoning are classified as mild, moderate and severe. The mild ones are the most frequent, being characterized by pain and mild or absent local edema, with or without alteration in clotting time. The moderate symptoms are typified by pain and evident edema that extends beyond the affected anatomic segment, in conjunction or not with local or systemic hemorrhagic alterations, such as gingivorrhagia, epistaxis, and hematuria. The severe cases present intense and extensive hardened local edema, which may reach the entire limb, usually in conjunction with acute pain, and occasionally presenting blisters and necrosis.¹⁶ As a result of the edema, there might be signs of local ischemia and compartment syndrome. The specific treatment consists in intravenous administration of the anti-bothropic serum (SAB), as early as possible, dosed according to the severity of the case.^{16,17}

Species of genera *Crotalus* sp are popularly known as rattlesnakes-in Portuguese, cascavel, cascavel-quatro-ventas, boicinga, maracamboia and maracá, amongst other denominations.¹⁶ They can be found in open fields, and in dry, sandy and rocky areas, rarely in the coast; they are not found in forests nor in Pantanal.¹³ Striking is not their habit, and once feeling threatened they expose their presence by the distinctive sound of the rattle on their tail. That genus is responsible for 7.7% of the registered snakebite incidents in Brazil. Their venom has physiopathogenic neurotoxic activity, causing peripheral motor paralysis, uni or bipalpebral ptosis, myotoxic, which can lead to rhabdomyolysis, with darker coloration of the urine and an anticoagulant action.^{16,17} Those incidents classified as mild present mild palpebral ptosis and visual blurring of late onset, and mild or absent myalgia. Moderate cases present mild, early onset palpebral ptosis and visual blurring, mild myalgia and dark urine, while the severe ones present evident and intense palpebral ptosis and visual blurring, mydriasis, intense and generalized myalgia, dark urine, oliguria or anuria. Treatment for those incidents use anti-crotalus serum (SAC), intravenously administered, and dosed according to the severity of the case.^{16,17}

Serpents of the *Lachesis* sp genus, popularly known as bushmasters-in Portuguese, surucucu, surucucu-pico-de-jaca, surucutinga and malha-de-fogo - have the higher volume of venom. They are the most venomous snakes in the Americas, reaching up to 3.5 meters length. Those animals inhabit forest regions in the Amazon, the Atlantic Forest, and some enclaves in humid forests in the Northeast region.¹⁴ The casuistry of those incidents in

the country is still unclear, as there are only few cases reported in medical literature.¹⁶ Those snakes are found in dense forests, areas with low population density and inefficient notification systems.¹³ Their venom has proteolytic physiopathogenic activity, causing necrosis and tissue lesions such as blisters, pain and local edema; hemorrhagic activity usually limited to the bite region and neurotoxic activity, causing dizziness, vision darkening, bradycardia, and diarrhea. Those incidents are classified as moderate or severe. Moderate cases present local pain, edema, blisters and mild hemorrhage. The severe ones, apart from those symptoms, present abdominal cramps, diarrhea, bradycardia and hypotension. Treatment uses anti-lacetic serum (SAL), intravenously administered, and dosed according to the severity of the case.¹⁶

Serpents of the *Micrurus* sp genus are small or medium-sized, some of them reaching up to 1 meter length. Popularly called coral, coral verdadeira or boicorá in Portuguese, they have a ring-designed body, in red, black and white, presenting various combinations along the body. Specimens of this genus are mostly found in the Amazon region and bordering areas.¹³ Cases represent 0.4 of registered snakebite incidents in the country. The *Micrurus* sp venom has neurotoxic physiopathogenic activity, causing vomiting and paresthesia, tending to proximal progression, progressive muscle weakness and eyelid ptosis, ophthalmoplegia, and may progress to acute respiratory failure, apnea, and death. Elapidic incidents are considered severe, and the treatments uses intravenous administration of anti-elapidic serum (SAE).^{16,17}

Snake antivenom, antivenene or antivenin sera are heterologous, usually obtained from equines that were previously immunized with venoms of a particular snake genus.^{16,25}

In this study, the venomous serpents found in the snakes inventory from the Municipal Natural Park Biodiversity Corridor - PNMCBio in Sorocaba, conducted between August 2014 and July 2015, were: *Crotalus durissus terrificus* and *Bothrops jararaca*. The vegetation in that region is a transition between the Cerrado and the Atlantic Forest biomes.¹⁸

CASUISTRY AND METHODS

This is a descriptive, cross-sectional, retrospective epidemiological study of the characteristics of human incidents by venomous snakes treated in the city of Sorocaba, located in the countryside of the state of São Paulo. It is the fourth most populous city in the state, with an estimated population of 659, 871 residents.⁹

Healthcare service in Sorocaba treats patients from neighboring towns in that region, including Alambari, Alumínio, Araçariguama, Araçoiaba da Serra, Boituva, Capela do Alto, Cerquilha, Cesário Lange, Ibiúna, Iperó, Itapetininga, Itu, Jumirim, Mairinque, Piedade, Pilar do Sul, Porto Feliz, Salto, Salto de Pirapora, São Miguel Arcanjo, São Roque, Sarapuí, Sorocaba, Tapiraí, Tatuí, Tietê, and Votorantim. Sorocaba also serves other towns, thus it is a reference in treatment for snakebite incidents.

Data of studied cases were obtained from the Epidemiological Notification Forms, in the Notification of Grievance Information System (Sinan), and were consolidated by the Center for Epidemiological Surveillance of the State of São Paulo (CVE), in the period from 2013 to 2017. The incidents caused by snakebites were chosen according to the following information: age, gender, schooling, month, city and site of the incident, time span between the incident and the assistance, attendance place, anatomic region of the human body inflicted by the bite, local and/or systemic clinical manifestations, laboratory data on clotting time, specificity of the administered heterologous antivenom serum, respective number of vials and the case outcome. The obtained data were grouped and their respective frequencies were established, some of them being presented in the form of tables and graphs, and others in the form of a map.

The secrecy and confidentiality of data and patient identification were addressed following the ethical principles and good practices of scientific studies involving human beings, according to the Declaration of Helsinki, guaranteed by the Commitment and Non-Disclosure Agreement signed by the author of this study. The research was initiated after being approved by the Research Ethics Committee (CEP) of the Medical and Health Sciences Scholl in the Catholic Pontifical University of São Paulo, Sorocaba campus (FCMS/PUC-SP), process n. 2,707,895, and after being authorized by the Education in Health Sector at the Sorocaba Health Department to use data from the Epidemiological Surveillance.

There is no conflict of interest on the part of the authors.

RESULTS

During the period this study was carried out, 210 cases of snakebite incidents were reported, 158 of which were ascribed to snakes of the *Bothrops* sp genus; 20 (9.5%) to *Crotalus* sp; 2 (1.0%) to *Elapidae* sp; 11 (5.2%) to non-venomous snakes; and 19 (9.0%) non-identified. Out of those patients, 133 (63.3%) were male and 77 (36.7%) female; their respective age group ranged from less than 1 year old to 90 years old ([Table 1](#)).

Table 1. Snakebite incidents treated in the city of Sorocaba, distributed by gender and age, in the period from 2013 to 2017.

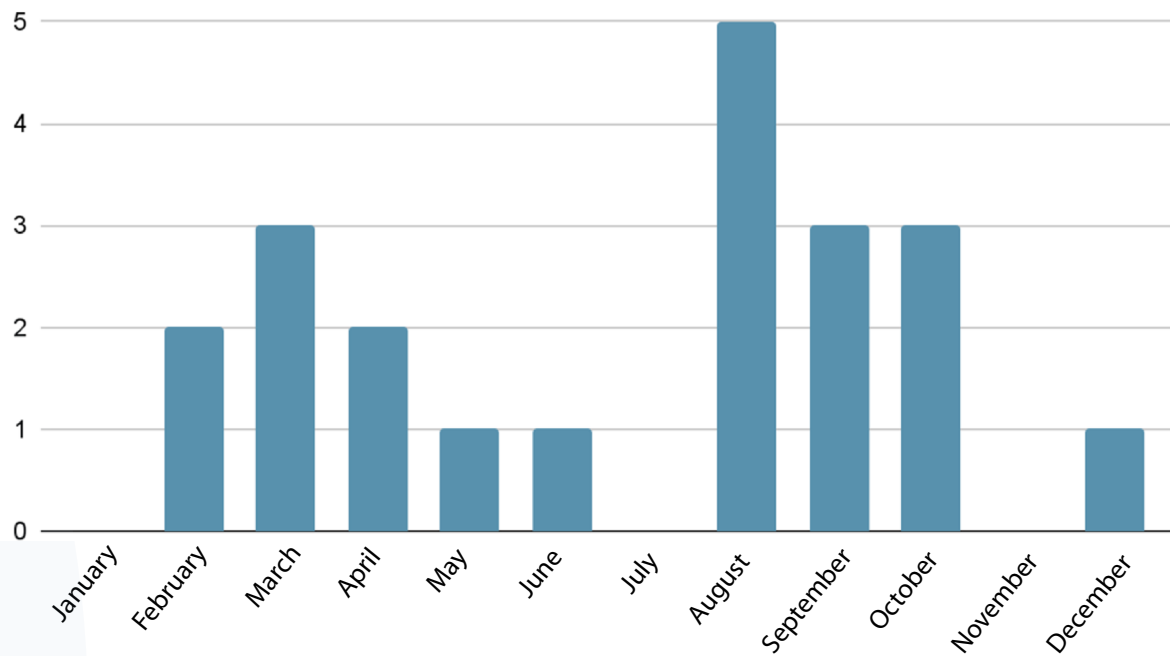
Age years	Male	Female	Subtotal
	N	N	N
0-10	22	16	38
11-20	11	14	25
21-30	20	10	30
31-40	26	12	38
41-50	21	11	32
51-60	22	9	31
61-70	4	3	7
71-80	5	2	7
81-90	2	0	2
Subtotal	133	77	210

The schooling level of the 110 patients with this registered information is shown in Table 2, while their monthly distribution is shown in Graphs [1, 2, 3, 4](#) and [5](#).

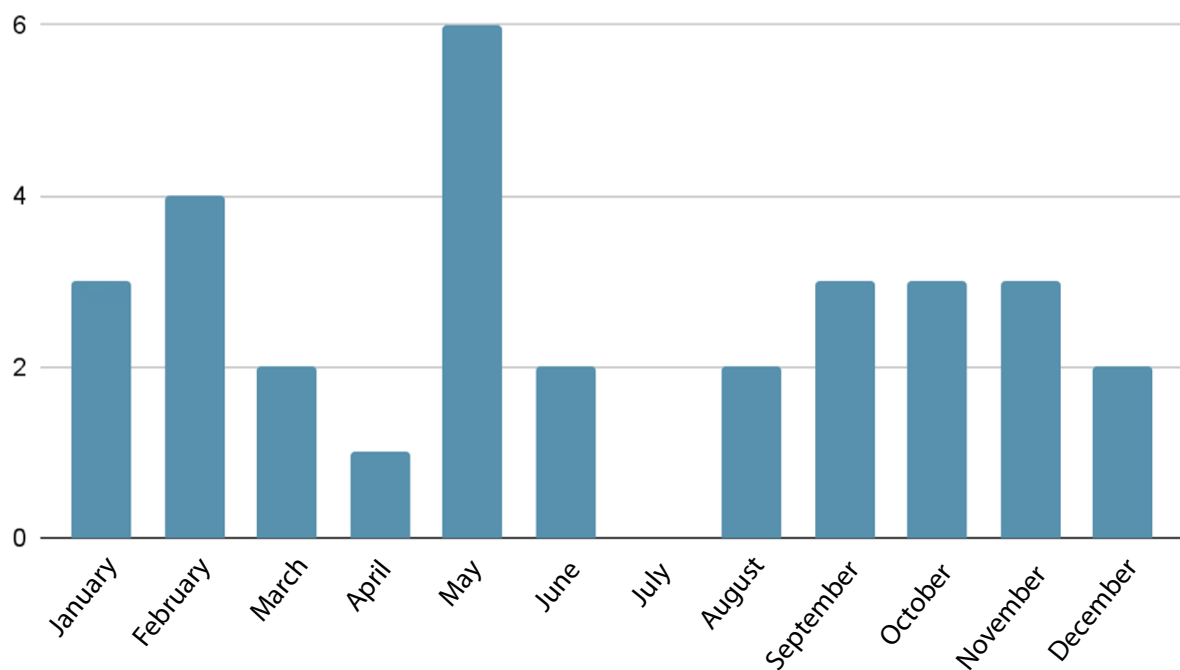
Table 2. Snakebite incidents treated in the city of Sorocaba, according to patients' schooling level, in the period from 2013 to 2017.

Schooling	N	%
Illiterate	26	23,7
Unfinished 1st - 4th grade	12	10,9
Complete 1st - 4th grade	10	9,1
Unfinished 5th - 8th grade	23	20,9
Complete Basic Education	9	8,2
Unfinished Secondary Education	8	7,3
Complete Secondary Education	15	13,6
Unfinished Higher Education	2	1,8
Complete Higher Education	5	4,5
Total	110	100,0

Graph 1. Snakebite incidents treated in the city of Sorocaba, by month of occurrence, in the year of 2013.

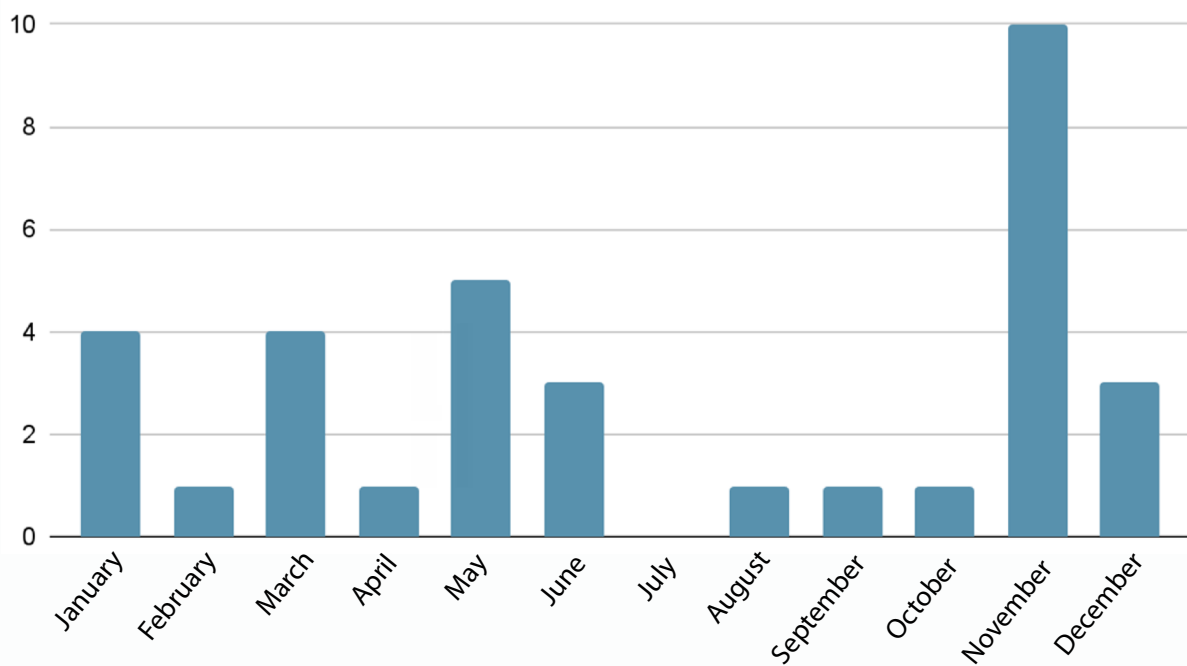


Graph 2. Snakebite incidents treated in the city of Sorocaba, by month of occurrence, in the year of 2014.

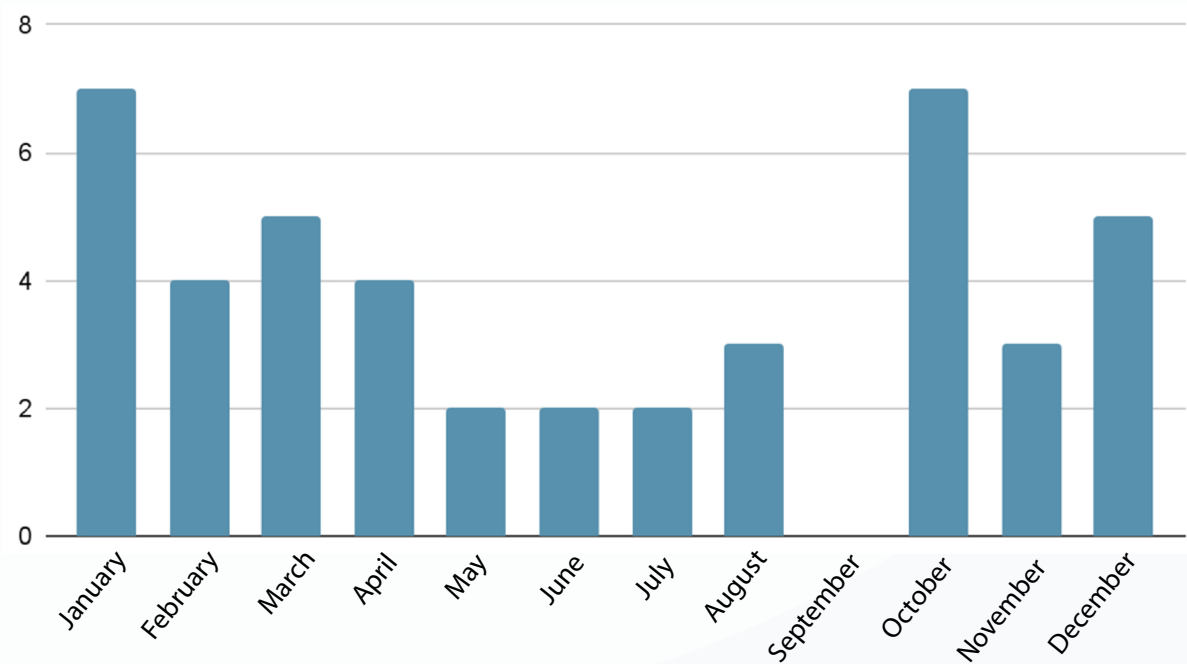


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Graph 3. Snakebite incidents treated in the city of Sorocaba, by month of occurrence, in the year of 2015.

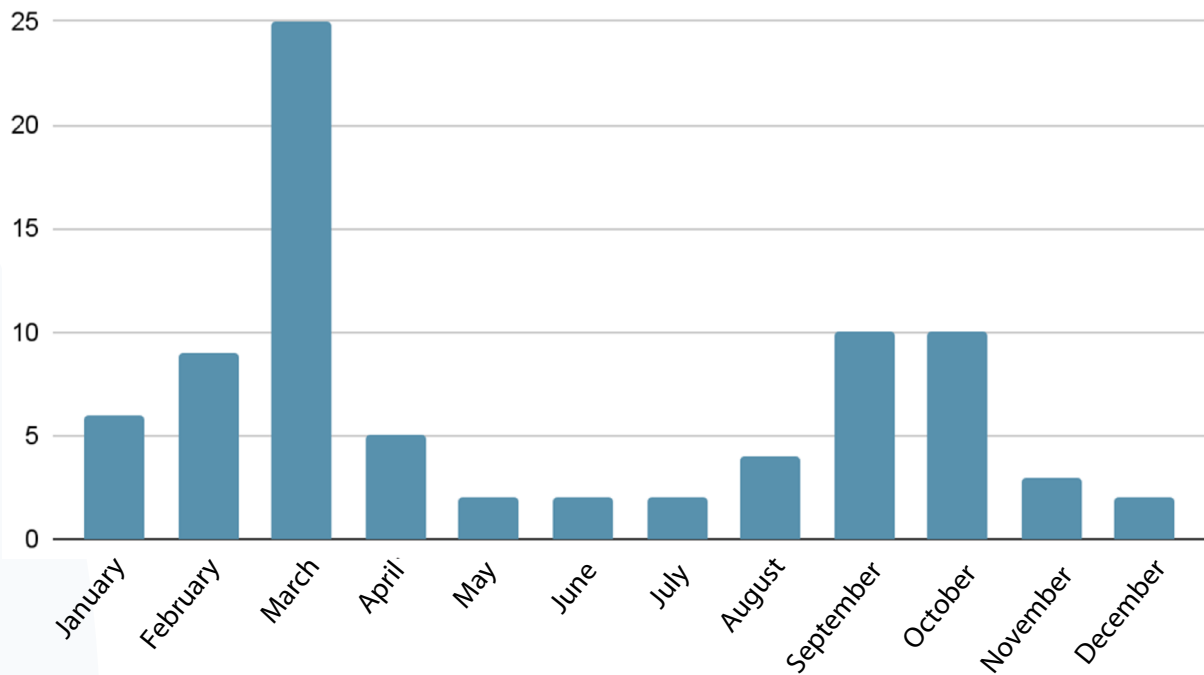


Graph 4. Snakebite incidents treated in the city of Sorocaba, by month of occurrence, in the year of 2016.



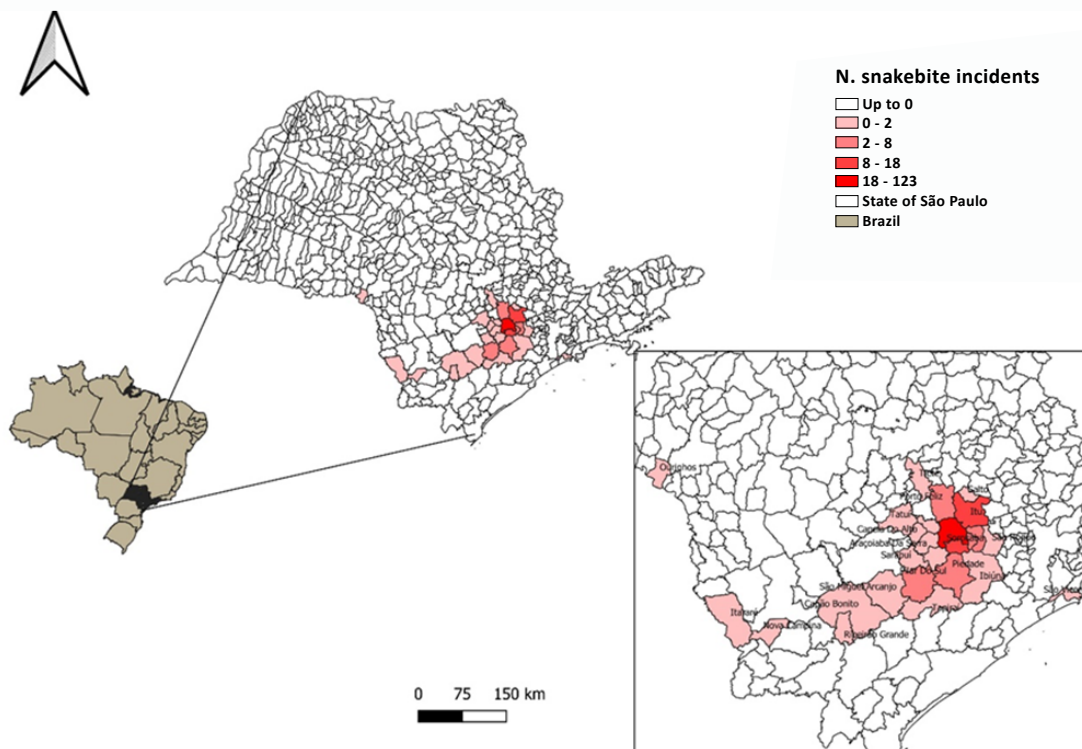
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Graph 5. Snakebite incidents treated in the city of Sorocaba, by month of occurrence, in the year of 2017.



Out of the 210 treated cases in the city, 85 (40.5%) happened in neighboring towns: Votorantim (18), Itu (11), Mairinque (8), Piedade (7), Alumínio (6), Porto Feliz (5), Pilar do Sul (5), Araçariguama (2), Iperó (2), Salto (2), Salto de Pirapora (2), Tapiraí (2), Tietê (2), Araçoiaba da Serra (1), Capão Bonito (1), Capela do Alto (1), Ibiúna (1), Itararé (1), Nova Campina (1), Ourinhos (1), Ribeirão Grande (1), São Miguel Arcanjo (1), São Roque (1), São Vicente, (1) Sarapuí (1) and Tatuí (1); in 2 of them (0.9%) this information was not available. The towns of Ourinhos and São Vicente are not part of the Sorocaba Region ([Figure 1](#)).

Figure 1. Snakebite incidents treated in the city of Sorocaba, by town of occurrence, in the period from 2013 to 2017.

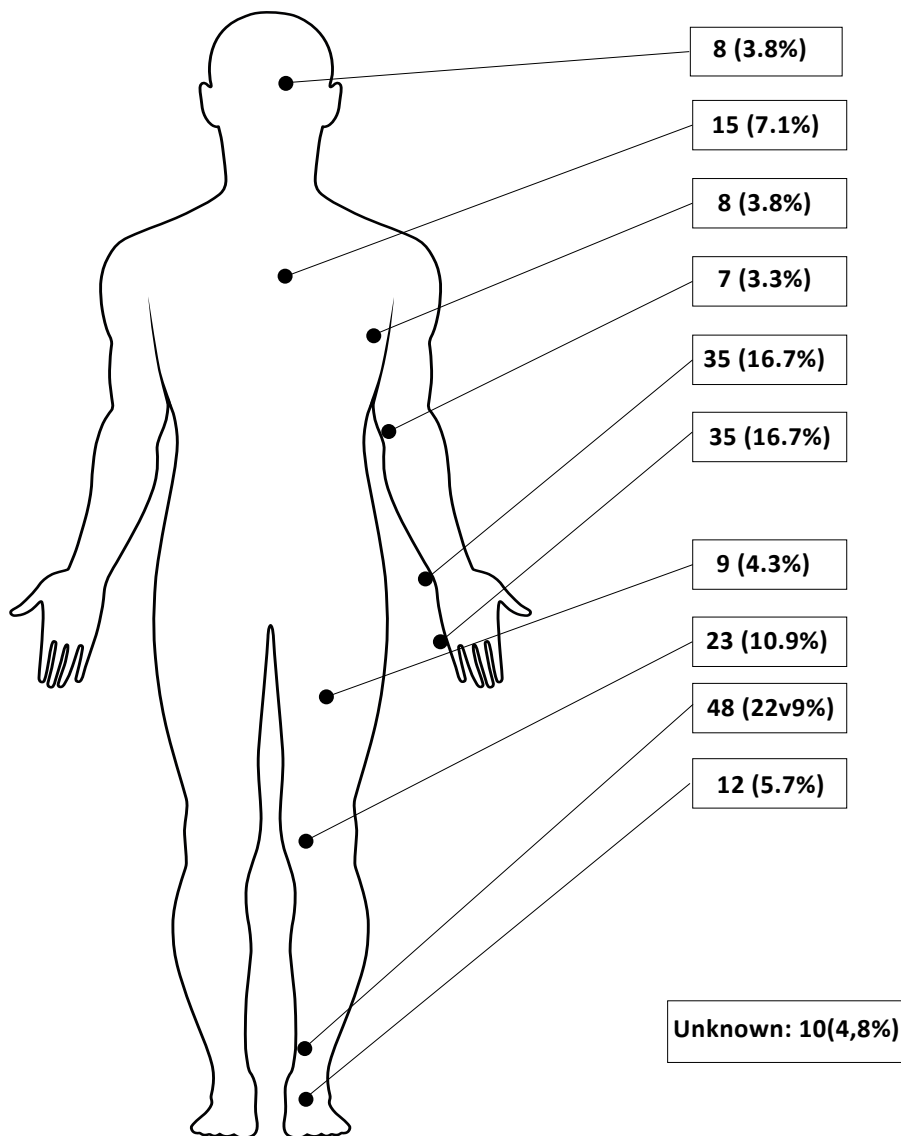


Urban areas were the geographic location of occurrence of those incidents in 138 (65.8%) cases; rural areas, in 40 (19.0%); and peri-urban areas, in 3 (1.4%). In 29 cases (13.8%), that information was not available. Of this total, 159 (75.7%) were considered as work-related accidents.

The various affected anatomic regions of the human body and their respective frequencies are shown in [Figure 2](#).

The presence of clinical symptoms was registered in 191 (91.0%) cases; no symptoms, in 8 (3.8%); and no information was available in 11 (5.2%). Out of the patients presenting symptoms, 159 (83.2%) had local manifestations from the poisoning; 31 (16.3%) had local and systemic manifestations; and 1 (0.5%) had only systemic manifestations. Among those patients with systemic clinical symptoms, 10 showed neuromuscular symptoms; 5 had vagal changes; 3 myotoxic; 1 renal impairment; 1 shock and acute renal failure; and the 11 remaining patients presented headache, dyspnea, and drowsiness.

Figure 2. Snakebite incidents treated in the city of Sorocaba and the anatomic topography of the human body in which the injury occurred, in the period from 2013 to 2017.



During the period of the study, there were 3 (1.4%) deaths caused by bothrop incidents, all of them in the city of Sorocaba. The first death, in 2016, was of a 49-year-old man, injured in the arm, at home. The time span between the incident and the assistance to the victim was from 6 to 12 hours. The patient was administered 12 vials of anti-bothropic serum and 20 vials of anti-bothropic-lacetic serum, as the incident was considered severe. He evolved with significant arm necrosis, functional deficit, secondary infection, acute renal failure, acute respiratory failure, and refractory septic shock. The second death, in 2017, was of a 31-year-old male patient whose injury topography was not registered; he had symptoms of local pain, edema, and deep vein thrombosis. The incident happened in the rural area, and nothing else was available in the notification form. The third death, also in 2017, was of a 16-year-old male teenager. The anatomic location was not reported, and the incident happened on a fishing boat, in the rural area. The patient showed pain and local edema, which evolved to compartment syndrome, respiratory failure, and shock. The time span between the incident and the assistance was from 1 to 3 hours. The patient was treated with 12 vials of anti-bothropic serum, and that was all information available. The dates of respective deaths were not available either.

The first patient who evolved to death was partially treated with anti-bothropic-lacetic serum due to a lack of anti-bothropic serum at the time of assistance; although the region shows no presence of snakes of the *Lachesis* sp genus.

The time span elapsed, in hours, between the time of the incident and the time of medical assistance for the specific treatment was reported in 181 (86.2%) cases. The results are shown in Table 3.

Table 3. Snakebite incidents treated in the city of Sorocaba, and the respective time span between the incident and the medical assistance, in the period from 2013 to 2017.

Time span in hours	Cases (N)	%
0 1	53	29,3
1 3	56	30,9
3 6	30	16,6
6 12	12	6,6
12 24	9	5,0
≥ 24	21	11,6
Total	181	100,0

Clotting time was altered in 98 (46.7%) cases; unaltered in 61 (29.0%); and the test was not performed in 51 (24.3%).

The number of equine heterologous serum vials used in the treatment of those patients was 1,309 vials, of which 961 (73.4%) were anti-bothropic serum; 330 (25.2%) anti-bothropic-laquetic serum; and 18 (1.4%) anti-crotalus serum.

DISCUSSION

The occurrence of snakebite incidents in the city of Sorocaba was the same as registered in other regions in the country.^{10,11} The ones caused by snakes of the *Bothrops* sp genus are mostly frequent, as that genus show the largest number of specimens in the Brazilian territory.

Regarding the occurrence by gender, 133 (63.3%) patients were male, and 77 (36.7%) female. The same distribution was found in the studies by Albuquerque et al.,¹ in the state of Ceará; Machado et al.,¹² in the state of Rio de Janeiro; Silva et al.,¹³ in the state of Minas Gerais; Lemos et al.,¹⁴ in the city of Campina Grande, state of Paraíba; Ribeiro and Jorge,¹⁵ in the city of São Paulo; and Feitosa et al.,⁷ also in Ceará. The higher number of incidents in males can be explained by their labor activity, according to data from the Brazilian Department of Health.¹¹

Regarding the age group of the victims, most of the cases happened to 0-10 year-old and 31-40 year-old patients (38 cases in each group); followed by 41-50 year-old patients (32 cases). According to data from the Brazilian Department of Health¹⁶, and from the study by Pinho and Pereira,¹⁷ most of the cases were observed in the 31-40 age group, which can be explained by the fact that those are young, labor-active individuals at higher risk of exposure.

Snakebite incidents are less usual in children, according to the Brazilian Department of Health¹⁰, to Oliveira et al.,¹⁹ and to Martins et al.²⁰ In this study, however, 38 (18.1%) incidents in children between 0-10 years old were reported; this number is considered high when compared with the ones registered in medical literature. No causal relationship could be established.

When occurring in children, snakebite incidents tend to be more severe because the volume of inoculated venom is the same as in adults, resulting in a larger amount of the substance in relation to the body surface area, thus requiring more medical care, at

a higher risk of sequelae.¹ The fact that this research has found a higher occurrence of those incidents in the 0-10 age group in comparison with the official casuistry may help in planning of educational material for basic education in the region, with the purpose of informing and preventing future incidents.

The low schooling level of those patients, in the 110 cases with that information available, is also shown in material from the Brazilian Department of Health¹¹ and in the studies by Pinho and Pereira,¹⁷ Feitosa et al.,⁷ Moreira et al.,²¹ and Segura et al.²² According to these authors, low levels of education are related to the fact that the injured are rural workers.

Regarding the place of occurrence, 138 (65.8%) cases were registered in urban areas, and only 40 (19.0%) in rural areas, probably due to the expansion of urban centers over rural areas in the Sorocaba Region. In many areas considered urban, rural activity is still carried out, and the dividing line is not precise. Another possibility for such inversion are the environmental changes the region has undergone over the last years, which led to snakes migration to urban areas, due to deforestation and the occupation of their natural habitats by both industrial and residential constructions.

As for occurrence regarding the weather, those incidents concentrate in warm, rainy months, in agreement with technical reports from the Brazilian Department of Health,^{11,16} as well as with what Martins et al.²⁰ have observed. It happens because snakes are cold-blooded, poikilothermic animals, whose metabolism depends on the ambient temperature. In warm months, their metabolism is higher, therefore so is their activity. In those same months, human labor in agricultural activities in rural areas is also more intensive, as planting season for many crops match the rainy season, like March in the Southeast region. That month had the highest number of notifications in this study, of 39 (18.6%) cases, considering the five-year average. Acknowledging the months of the year with the highest occurrence of those incidents helps cities in planning their public health actions, in the administrative, assistance, preventive, and educational spheres.

The cities with most reported snakebite incidents were Sorocaba, with 123 (58.6%) cases, followed by Votorantim, with 18 (8.6%), and Itu, with 11 (5.2%). The higher number in Sorocaba is probably because the city has the largest population in the region,⁹ besides the fact that most of its inhabitants live in forested or previously deforested areas. A total of 27 towns in the surrounding area reported snakebite incidents in humans, showing the importance of the event in the region.

Information regarding labor activity was found in 159 (75.7%) cases. This finding matches what was reported in other Brazilian regions.¹⁶ Most incidents in the country are work-related accidents that happened to male rural workers or livestock workers, according to Feitosa et al.⁷ That variable, however, oftentimes is incorrectly registered in the Epidemiological Notification Form, since the person notifying the case don't always focus on work-related accident.

The anatomic topographies on the human body which are most affected by snakebite incidents are: the feet, with 48 (22.9%) cases; hands and fingers, with 35 (16.7%) cases each; and legs, with 23 (10.9%) cases. According to Pinho and Pereira,¹⁷ and to Ribeiro and Jorge,¹⁵ the most affected regions were also feet and legs due to their proximity to the ground, where the snakes are usually found. Hands and fingers, however, are also highly compromised regions, due to manual contact with earth.

Out of the 191 (91.0%) patients presenting clinical symptoms caused by snakebites, 169 (88.5%) of the incidents were classified as mild, with local clinical signs such as pain, edema, ecchymosis, and necrosis. According to the Brazilian Department of Health,^{11,23} most of those incidents are mild because it is hard for the snake to inoculate the venom during the act of biting; moreover, striking is a defensive reaction, not a hunting reaction. Death resulting from snakebites is infrequent, mostly in locations with highly complex health care and efficient highway systems such as the city of Sorocaba. It may happen, however, mainly in severe cases, when the venom is directly inoculated into the bloodstream. The lethality rate among victims of venomous animals who were treated in the city was 1.4%, higher than the rate registered in Brazil,^{5,23} 0.4%.

The severity of those incidents has multifactorial causes, such as the size of the serpent (the largest ones produce a greater amount of venom); the volume of inoculated venom during the bite; the relationship between the patient's body surface area and the volume of inoculated venom; venom directly inoculated into the blood vessels; the time span between the incident and the beginning of equine heterologous serotherapy; and inappropriate interventions. Tourniquetting is one of the practices that contribute to aggravation of the patient's condition and to worse prognosis.

The time span between the incident and the treatment with heterologous serotherapy is essential for a better prognosis, as it was observed by many researchers on the subject.^{13,15,17} Those studies showed that the shorter the time span, the better the prognosis. According to Silva et al.,¹³ a span longer than six hours can lead to a poor prognosis. For Sanhajariya et al.,²⁴ after the incident there is a rapid organic distribution

of the inoculated venom between 5 and 58 minutes, demonstrating how decisive a quick assistance with antivenom serum is, as it neutralizes the circulating venom – the venom which keeps fixed in human tissue is not neutralized, and it will carry on with its harmful effect. In this study, 42 (20%) cases had a time span over six hours. Although the towns in Sorocaba Region have efficient highway systems, sometimes in rural areas the precarious roads make it difficult to move around, and the transportation of patients is often poor and slow.

The clotting time (CT) test is essential, as it helps classifying the severity of incidents. It may be altered due to the coagulant action of snake venoms, consuming the fibrinogen, and causing blood incoagulability and hemorrhages.¹⁶ In this study, 98 (46.7%) patients had altered blood clotting. The venom of *Bothrops* sp and some *Crotalus* sp snakes can extend the human blood clotting time, leading to incoagulability and causing hemorrhages. Therefore, ascertaining the clotting time is an essential procedure, which helps to classify the severity of the incident, to treat the patient, and to follow them up after equine heterologous serotherapy, assessing the therapeutic response.

Treatment for snakebites is highly effective; deaths and sequelae can be prevented by administrating antivenom heterologous sera, which are safe and efficient. Those sera are part of the List of Essential Medicines (EML) recommended by the World Health Organization in primary care where those incidents take place.⁴ In this study, 168 (80%) patients underwent equine heterologous serotherapy, totaling 1,039 vials of serum, the only specific treatment for those cases. This immunobiological substance is complex to obtain and demands great technical and financial investment. Furthermore, it requires cold chain logistics for transportation and storage, therefore planning its request and use must be very well-founded. According to Segura et al.,²² heterologous serotherapy concerns several parameters, such as appropriate serum dose conforming to the incident severity classification, the route of administration, the dilution, and the infusion time. Hence, understanding this demand is essential for strategic planning of supply, distribution, and use of those heterologous sera.

In order to conclude, it might be said the results found in this study, besides providing knowledge on the subject in the Sorocaba Region, can also help in planning preventive actions in promoting health. Those actions may reduce the frequency of that grievance, which is considered a public health issue in Brazil and in many other tropical countries. The number of reported cases and deaths caused by snakebites has reinforced the significance of those incidents in the region. Therefore, planning health actions resulting prevention, quick assistance and quick treatment for those patients, in addition to educational

practices on ophidism, may contribute to reducing cases, sequelae and deaths. Those actions involve different industries, from sera production-which is difficult, complex, and costly²⁵– to cold chain for storage, transportation and distribution, planning of strategic supply points, and mapping points of care for the patients.

On the other hand, those incidents involve the whole patient care system, such as a fast and efficient transportation of the victim, good road systems, and a good structure of medical services for assistance and treatment, as well as the training of professionals who will assist that patient. As they are usual in Brazil, as well as preventable, snakebite incidents should be part of educational programs in elementary schools and healthcare courses; the subject could be included as mandatory content in both medical and nursing schools all over the country.

Improperly filling out the Epidemiological Notification Form leads to information gaps on those incidents, making it difficult to obtain knowledge, and to plan and to adopt preventive measures. Training, continuous education and the proper supervision for correctly filling out the form must be part of the actions and goals of the Epidemiological Surveillance Service in the Sorocaba Region.

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