Snakebite is an endemic global crisis. It annually affects about 4.5 million people around the world, seriously injuring 2.7 million people, and claiming 81,000-138,000 lives. Snakebite envenoming predominantly afflicts the rural poor people. The greatest burden of snakebite is experienced in the tropical world. Sudan is one of the countries with the highest snakebite incidences and mortality rate. Children are more expose to snakebites in comparison to adults; they are at more risk of severe adverse effects due to their small sizes. The current paper focuses on epidemiology of snakebites among children in Gadarif eastern Sudan. It was a cross sectional hospital based study conducted in Gadarif from 1st June to 31st December 2018. The study comprised 56 snake bitted children, 64.3% of them were males and 35.7% were females. 94.6% of the children were from rural areas. Most of the affected children were of ages over 5 years old (89.3%) and 10.7% were ≤ 5 years old. Clinical features and complications were observed in 30.3% of the patients. 94.6% of the patients received Anti-Snake Venom (ASV). Allergic reactions to ASV were noticed in 3.6%. After treatment, 64.3% of the children were completely recovered and discharged homes, 14.3% of the children were died. Our study revealed that there was high mortality rate in children due to snakebites that were observed among delayed patients with>6 hours after being bitten. To manage the time of first aid treatment and reduce the referring patients to urban hospitals, ASV should be a part of primary health care package in Primary Health Centers and other rural medical facilities in Gadarif. Government of Sudan must improve transportation and Health bodies have to develop national local specific ASV and prepared a National Snakebite Management Protocol for best approach to deal with the problem of snakebites.

Keywords: Snakebites; Envenoming; Gadarif; Children; Sudan

Introduction

Snakebite is an endemic global crisis. It annually affects about 4.5 million people around the world, seriously injuring 2.7 million people, and claiming 81,000 to 138,000 lives [1,2]. Snakebite envenoming predominantly afflicts the rural poor, including migrant workers, farmers, and displaced people fleeing conflict or violence due the nature of their socioeconomic activities and their involvement in agriculture [3]. Snakebite envenoming kills more people than any other disease on WHO’s Neglected Tropical Diseases list such as cholera, leishmaniasis and schistosomiasis [4,5]. Also, snakebites might result in loss of limbs or chronic problems [6,7]. About 2400 snake species were found in the world, 10% of them are venomous [8]. The risk of envenoming of venomous snakes varies according to the species [9]. Venom may cause bleeding, kidney failure, cardiac arrest, vascular endothelium, blood coagulability, tissue death around the site of bite, breathing problems, paralysis of the ocular, bulbar, neck muscles, limb girdle muscles, diaphragm and intercostals muscles [10,11].

The greatest burden of snakebite is experienced in the tropical world; where many nations remain under developed and suffer from poor health facilities, poor governance, political and social insecurity [12-14]. For instance, more than 20,000 people die from snakebites each year in sub-Saharan Africa alone with a devastating impact on victims, their families and communities. In most parts of sub-Saharan Africa access to proper treatment is limited, with unavailability of quality anti-venoms and if the anti-venom is available it costs several times the yearly salary of a farmer in South Sudan for example.

In 2009, the World Health Organization added snakebite to the list of Neglected Tropical Diseases, but made no provision to seek global funding to do anything about the problem. Like all endeavors, global health is highly politicized, and it wasn’t long before snake bite was downgraded by WHO under a sub-definition: “Other neglected” conditions [15]. Finally WHO has released a strategy that aims to cut in half the number of deaths and disability due to snakebites by 2030.

Collection and classification of snake species in Sudan was started during the era of the Anglo-Egyptian Sudan in 1920, and by 1930 the collection contained 220 snake species [16]. Sudan Medical Service at that time undertook to classify all snake species in the collection and the number of snake species increased in the short space of three years to more than 900 species, but among the collection only about 39 snakes were classified [16,17]. Sadly, neither the mission of the snake classification has been achieved nor national anti-venom has been developed in Sudan. It is obviously that snake classification and the development of local anti-venom are of extreme importance for the survival and the proper treatment of victims of snakebites in Sudan.
There are many modes of snakebite treatment practiced by the Sudanese people that most of them are of psychological effects, while some of these treating practices are harmful. Of the more rationally inspired may be mentioned ligature, incision, excision and cupping [16,17]. As public remedies are used eggs, milk, a folk antidote of world-wide use, lemons, roots, and portions of rhinoceros horn; from cups of this last material other remedies may be drunk and thereby acquire added virtue. Most of the public remedies are intended to induce vomiting to expulse the venom presumably.

In Sudan a country with a long history of civil war, corruption, violation of human rights, political and economic instability, the successive governments of Sudan have given very little attention to the protection and development of the Sudanese individual especially children and little has been achieved in the field of proper treatment of snakebites and in the combating its incidences. Sudan is one of the countries with the highest snakebite incidences and mortality rate in the world [18]. Most of the fatalities are due to the fact that victims do not reach the hospital in a time [18]. Moreover, local communities are not well aware of the occupational risk factors and the simple protective measures that can minimize the snakebites. In spite of the fact that poisonous snakebite is a life threatening emergency [4], the problem does not get the appropriate attention in research in developing tropical countries as in case of Sudan.

Gadarif state is the most important economical and agricultural region in the Sudan. For their livelihood, people in Gadarif depend on agriculture; snakebite is a real danger to the lives of the populations of Gadarif especially during the rainy season from August to November months every year.

Children are more expose to snakebites in comparison to adults and are at more risk of severe adverse effects due to their small sizes [19]. In spite of this fact, most of studies on snakebites were carried out on adult patients [18,20]. In this respect this study is important. The current paper focuses on epidemiology of snakebites among children in the Gadarif eastern Sudan.

Materials and Methods

Study design and study area

This was a cross sectional hospital based study of snakebite among children conducted at Gadarif Pediatrics Teaching Hospital from 1st June to 31st December 2018. To achieve the study, structured questionnaires were used to collect data from the victims and were filled by medical officers. Gadarif state is located in the East of Sudan, about 414 km from Khartoum which is mainly agricultural area, with abundant rainfall. The rainy season occurs between the months of July to October every year.

Ethical approval

The approval of study was taken from the research and ethical committee of the Faculty of Medicine and Health Sciences at the University of Gadarif. Informed consent was taken from the parents of the study group.

Data analysis

Data were double-checked analyzed using SPSS software (SPSS Inc., Chicago, IL, USA, version 16.0). p<0.05 was considered significant.

Results

This study comprised 56 snake bitted children, out of which 36 children (64.3%) were males and 20 children (35.7%) were females. Fifty three children (94.6%) were from rural areas (Table 1). Most of the affected children by snakebites were of ages over 5 years old that comprised 50 children (89.3%) and 6 children (10.7%) were ≤ 5 years old. Generally the age range of the studied children was between 2-16 years old; with the mean value was 10.04 (SD ± 4) years old.

<table>
<thead>
<tr>
<th>Residence</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>2</td>
<td>3.6</td>
</tr>
<tr>
<td>Rural</td>
<td>53</td>
<td>94.6</td>
</tr>
<tr>
<td>Unknown</td>
<td>1</td>
<td>1.8</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 1: Shows the geographical distribution of the patients.

Twenty five (25)(44.6%) of the snake bitted children were presented to the Hospital within 6 hours after being bitten (Table 2). Thirty nine (39) (69.6%) of children were bitten on the lower limbs, whereas 13 (23.2%) children were bitten on the upper limbs and 4 (7.1%) children were bitten on the other sites of the body.

<table>
<thead>
<tr>
<th>Time from bite</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;6 hours</td>
<td>25</td>
<td>44.6</td>
</tr>
<tr>
<td>6 -12 hours</td>
<td>16</td>
<td>28.6</td>
</tr>
<tr>
<td>12- 24 hours</td>
<td>4</td>
<td>7.1</td>
</tr>
<tr>
<td>&gt;24 hours</td>
<td>8</td>
<td>14.3</td>
</tr>
<tr>
<td>Unknown</td>
<td>3</td>
<td>5.4</td>
</tr>
<tr>
<td>Total</td>
<td>56</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2: Shows time-period of snakebites until arrival to Hospital.

Clinical features and complications of the snake bites were observed in 22(39.3%) affected children. The clinical features and complications include: local bleeding, hematuria, epistaxis, intracranial bleeding, disseminating intravascular coagulopathy (DIC), pain, cellulitis, epistaxis associated with hemoptysis, vomiting, and local bleeding associated with swelling, fever associated with convulsion, convulsion associated with spasticity, inguinal LN enlargement, rectal bleeding and anemic heart failure. Figure 1 shows distribution of the clinical features and the complications of the snakebites among the affected children.
On the other hand, 53(94.6%) of the affected children received anti-snake venom (polyvalent) and 3(5.4%) children their data were missed. Allergic reactions to anti-venom in forms of urticaria, pain and vomiting at the time of injection were noticed in 2(3.6%) children. The stay of snake bitten children in hospital was evaluated that 22 (39.3%) had a stay of less than 7 days, 25(44.6%) had a stay of over 7 days and 9 (16.1%) their data were missed.

The medical intervention to treat the affected children resulted in 36(64.3%) of the affected children were completely recovered from the snakebite and discharged from the hospital, sadly 8(14.3%) of the affected children were died, while the remained 12(21.4%) survivals were discharged against the medical advices.

**Discussion**

Snake bites were more prevalent among children than in adults [21] in spite of this fact few studies were conducted to address this tragedy. Children are a very important group of any nation as children are the future leaders and the coming adult populations. For any respected government, children must get the due attention and their needs must be met as the future of any nation depends on the investment in children and young generations. Gadarif is a very important region in Sudan in terms of animal wealth and agricultural production. Gadarif is very important for Sudan’s food security. It is famous of its high levels of rainfall and over 80% of its population work in agriculture. The current study investigates the epidemiology of snakebites among children in this very important region of Sudan.

Our study showed that male children (64.3%) were more affected by snake bites in Gadarif than female children (35.7%). Our findings on prevalence of snakebites among children in Gadarif were in agreement with other publications [22,23]. On the other hand our findings showed that the prevalence of snakebites increased with increase in child’s age. The most dangerous age for children in Gadarif to be more liable to snakebite was over 5 years (89.3%). In this respect our findings were in agreement with similar study conducted by Karunanayake et al., in Sri Lanka [19]. Karunanayake and co-researchers reported that the highest number of snake bites (48%) among children were in the age of 6-12 years and lowest (21%) in the age of<1 year.

Direct proportion of snakebite incidences with the increase in children age may be attributed to child’s behavior and nature to play more in the outdoor games. As an occupational disease, snake bite was highly prevalent in rural areas where peoples are engaged in agricultural related activities (Aga et al.). Our study revealed that snake bite incidences were more prevalent in rural areas of Gadarif. In Gadarif, older children especially in rural areas and in poor families are given responsibility to help their families to carry out outdoor activities such as grass and weeds cleaning, crops collection, animal grazing and firewood collection etc. These activities expose them to the more danger of snake bites [24].

Our study showed that the most affected parts of the body of the snake bitten children were the extremities, hands and feet. These findings are in line with the findings of Tavares et al., [25]. The snakebites at the lower limbs were three times higher (69.6%) than the bites at the upper limbs (23.2%). The findings are in agreement with some international publications [23,26]. Snake bites occurred while the children were walking, playing in the dark or while involving in other activities. Snake bites at the trunk were observed when the victims were sleeping on the ground at the time of the bite. Spano et al., [27] reported that limbs were the commonest parts of the body affected by snakebites. Brito and Barbosa [28] reported that, elevated incidences of snakebites may be as a result of the lack of protective equipments, especially in regions where there is no use of machinery in agricultural activities. Zulkifi [29] argued that in most cases the snakebites occurred while it was stepped on it inadvertently. Other reasons of snakebites may due to feet being bared during walking and playing in snake endemic zones; hence using of protective footwears can reduce the snake bite incidences.

Snakebite envenoming cause different manifestations on the victim that include neurotoxicity, myotoxicity, renal failure, edema and bleeding, which are resulted of activation of blood clotting factors and intravascular hemolysis [30]. Different kinds of venoms have different types of venoms and that are the causes of different symptoms resulted from a snakebite [31].

Our study showed that on snake bitten victim arrival 39.3% of the patients had local swelling at the place of biting, this was in agreement with a similar study conducted by Maduwaige et al., [32]. 31.2% of our patients suffered bleeding from various sites of the body that include bleeding of bite site, hematuria, hematemosis, hemoptysis, gum bleeding, intra peritoneal bleeding, intracranial bleeding and rectal bleeding. 7.1% of the victims suffered vomiting, 7.1% suffered pain associated with fever, 28.6% suffered cellulitis and 1.8% subjects got bilateral inguinal lymph node enlargement. Complications developed in patients as a result of snakebites include disseminated intravascular coagulopathy (17.9%), anemic heart failure (1.8%), convulsion and spasticity in the upper limbs (1.8%) and 3.6% of the victims developed abscess and referred to surgery. Convulsion and spasticity occurred might due to intracranial bleeding or neurotoxic effects.

In our study most of the patients (50%) were brought to the hospital within six hours or more after being bitten. Reid et al., reported that one of the reasons for the delay of snakebitten victims to come to hospital was that the community preferred trying traditional and folk medicine first rather than coming to the hospital immediately. Stay in hospital was longer for severe envenomed patients (44.6%).

In our study 44.6% of the patients received anti-snake venom (ASV) within six hours of arrival to hospital and 14.3% of the patients received anti-venom therapy within more than 24 hour. This was in agreement with a study published by Pandey et al., [33]. Other studies on snakebites noted low rate of patients treated within 1 hr after snakebite [34,35]. However, delayed access to medical treatment remains a common reason for developing complications. Anti-snake
venom dosage varies according to severity of the cases. In our study most cases were uncomplicated and the victims received at least a single dose of ASV, while in complicated cases the victims received more than 4 doses of ASV. A recent study on snakebites conducted in northern India reported that severely envenomed victims received a higher dosage of anti-venom than those mildly and moderately envenomed [36]. The reversibility of snake venom paralysis to snake anti-venom depends on several factors that include the time since bite and the specific types of neurotoxins present in an involved snake species’ venom [37,38].

Rural populations are not only exposed to the injuries of snake bites but they also present at higher relative risk of death [36]. Our study revealed that there was high mortality rate (14.3%) from the snakebites in Gadarif and all the death cases were form rural inhabitants. Our findings were in agreement with previous study carried out in Brazil by Tavares et al., [26]. The 14.3% mortality form snakebites in our study were attributed to DIC, intracranial bleeding, intraperitoneal bleeding, rectal bleeding, and anemic heart failure. All the 8 cases of death out of 56 victims have occurred in patients presenting beyond 24 hours of the bite. This means that survival of the patient from snakebite is directly proportional to early arrival to hospital to receive the appropriate treatment.

In general our findings on snakebite envenoming among children in Gadarif were in agreement with international publications on snakebite envenoming [37-40]. The high incidences of snakebites and high fatality rate from snakebites in Gadarif that revealed by this study might attributed to lack of knowledge about the protective measures against snakebites, poverty, poor governance, availability of specific anti-venoms, lack a/o poor health facilities and social insecurity [41,42].

Since snakebite in Gadarif eastern Sudan is a rural problem, primarily affecting the farmers, rural labors and their families it would make sense for anti-venom and associated treatment to be available at Primary Health Centers and other rural medical facilities.

Conclusion and Recommendations

Snakebite envenoming among children in Gadarif eastern Sudan is a rural problem, primarily affecting children of ages more than 5 years. Snakebite envenoming in Gadarif caused high mortality rate due to the fact that most of the victims arrived late to the hospital with more than 6 hours after being bitten. The mortality rate was higher in delayed patients. Hospitals in Gadarif State are present in the capital Gadarif city and in the towns of the State that are located some tens kilometers far from a near village with additional difficulties of availability of anti-venoms, norther India reported that severely envenomed victims received a higher dosage of anti-venom than those mildly and moderately envenomed [36]. The reversibility of snake venom paralysis to snake anti-venom depends on several factors that include the time since bite and the specific types of neurotoxins present in an involved snake species’ venom [37,38].

Children should be educated on the importance of protective wears such as shoes during walking, playing and during working on farms. Furthermore, rural populations should be educated on preventive measures and the importance of the first aid of treatment of snake bite. To manage the time of first aid treatment and reduce the referring patients to urban hospitals, ASV should be a part of primary health care package in Primary Health Centers and other rural medical facilities where snake bites are common. Some measures to prevent snakebite include avoid areas where snakes maybe hiding, such as under rocks and logs, avoid picking up or playing with any snake unless you have been properly trained, don't provoke a snake, tap ahead of you with a walking stick before entering an area where you can't see your feet. Snakes will try to avoid you if given enough warming. Wear long pants and boots in an area known to have snakes, if possible. And finally, Government of Sudan and Health bodies in the country have to develop national local specific ASV and prepared a National Snakebite Management Protocol to provide doctors and lay people with the best possible, evidence-based approach to deal with the problem of snakebites in the country.

Conflict of Interests

The authors declare that they do not have conflict of interests regarding this work.

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Authors Contributions

All authors contributed substantially to the study conception and design, data collection and analysis, and drafting and revision of the article. All authors approved the final version to be published.

References


