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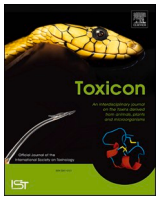

First aid and pre-hospital practices in snakebite victims: The persistent use of harmful interventions

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ABSTRACT

First aid intervention and pre-hospital (FAPH) practices are common in patients suffering from snakebite envenomation (SBE). In this study, we have reviewed the literature concerning the use of these practices in various regions of the world in the period 1947–2023 based on published prospective studies. A total of 71 publications fulfilled the inclusion criteria. In terms of the total number of patients in all studies that used each FAPH intervention, the most common practice was the application of tourniquets (45.8%). Other FAPH practices described include cuts/incisions (6.7%), the application of a variety of natural or synthetic substances at the bite site (5.6%), and ingestion of natural, usually herbal, remedies (2.9%). Washing the site of the bite was described in 9.1% of patients. There were other less frequent FAPH practices, including suction, splinting-immobilization, pressure-bandage, ice packs, application of a snake/black stone, and administration of alcoholic beverages. There were differences in the extent of application of FAPH interventions in different continents. Tourniquets were highest (55.7%) in Asia. Topical application of various products was common in South America, while pressure-bandage was only reported in Australia. We did not find any statistically significant variations in the frequency of the most frequent FAPH interventions at three-time intervals (before 2006, between 2006 and 2015, and after 2015). Our findings highlight the use of FAPH interventions in patients suffering SBE, some of which are known to be harmful. It is necessary to study these practices to a higher level of geographic granularity, using community-based surveys. Programs tailored to local contexts should be promoted, aimed at avoiding the use of harmful FAPH practices. It is also necessary to assess the efficacy and safety of some interventions through robust preclinical and clinical studies.

1. Introduction

Snakebite envenomation (SBE) is a significant medical and public health burden in the tropical agricultural world. The highest disease burden is reported in south and south-east Asia, sub-Saharan Africa, Latin America and some regions of Oceania (Kasturiratne et al., 2008; Mohapatra et al., 2011). Most snakebite victims have low economic status, agricultural backgrounds, and limited healthcare access (Harrison et al., 2009). It is estimated that, annually, 1.8 to 2.7 million snakebites and 81,410 to 137,880 deaths are reported globally (Gutiérrez et al., 2017). Local effects of SBE develop due to the action of snake venom around the bite site, and systemically distributed venom can result in coagulopathy, neurotoxicity, myotoxicity, nephrotoxicity, and cardiotoxicity, depending on the characteristics of the venom. A significant proportion of SBE victims develop life-long disabilities and psychological sequelae (Gutiérrez et al., 2017). Animal-derived antivenom is considered the mainstay of treating SBE in hospitals in addition to other supporting care, including mechanical ventilation and renal replacement therapy (Warrell, 2010).

Snakebite victims practice various first aid and pre-hospital (FAPH) practices to stop or delay the effects of snake venom until they are admitted to the hospital for antivenom treatment (Avau et al., 2016; Parker-Cote and Meggs, 2018). In many cases, particularly in regions with poor accessibility to health care, people rely mostly on FAPH practices (Harris et al., 2010; Kularatne et al., 2014a,b), and many of them do not reach health facilities. Application of tourniquets, ingestion of herbal products, topical application of local remedies, cuts/incision at the bite site, application of pressure-bandage, splinting of the bitten

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limb, washing the bite site, application of electric shock and use of suction apparatus are reported well-known first aid and FAPH practices reported in snakebite victims (Kularatne et al., 2014a,b; Maduwage et al., 2013; Parker-Cote and Meggs, 2018). Less frequently, application of snakestones, tattooing, placing the ice packs and burning or cutting the bite also have been reported (Abouyannis et al., 2023; Alfred et al., 2019; Blaylock, 2004; Tun-Pe et al., 1987). Some of these practices are more commonly seen in certain geographical regions than others. The beneficial and harmful effects of FAPH practices have been debated over the decades due to a lack of scientific evidence in most of them. Some practices, such as the application of arterial tourniquets, cut/incisions, and electric shock, have been strongly discouraged by snakebite management guidelines due to their harmful effects, associated with the development of severe complications and life-long disabilities (WHO, 2016, 2010). There is evidence of effectiveness of the application of pressure-bandage for retarding the systemic absorption of venom in the case of Australian elapid snakebites; however, there are unsolved issues related to this FAPH intervention (Avau et al., 2016; Currie et al., 2008; Sutherland et al., 1979).

Owing to the great variability of snake venom composition and clinical manifestations of envenomations, some FAPH practices may be effective for envenomations by some species of snakes but could have harmful effects for other species (Bush et al., 2004; Hack et al., 2011; Tun-Pe et al., 1995). As an example, the practice of pressure-bandage for Australian elapid envenomation delays venom absorption (Murrell, 1981; Sutherland et al., 1979). Still, potentially, it aggravates the development of local tissue necrosis following envenomation by some species of cobras and in the case of envenomations inflicted by viperid snakes. Most FAPH care has evolved from the patient's beliefs, personal experiences, anecdotical information, and opinions of traditional snakebite healers. The World Health Organization (WHO) has made a substantial effort to formulate regional snakebite management guidelines in addition to the country-specific guidelines (WHO, 2016, 2010). These efforts have increased the awareness of effective and harmful FAPH practices. Owing to the relevance of this aspect in the management of SBE, it is necessary to assess the extent of these practices in various regions of the world, as well as their evolution along the past decades. Such analysis will provide evidence upon which to develop specific programs and interventions adapted to each particular context.

This review describes the region-specific FAPH practices in SBE and how these practices have changed over time based on the collative evidence reported in published literature.

2. Methods

We searched PubMed from 1947 to August 2023 and included all prospectively conducted human studies on SBE. The following keywords were used: "snakebite", "snake envenoming", "snake envenomation", "elapidae", "viperidae", "colubridae", "crotalidae", "first aid", "pre-hospital care", "tourniquet", "ligature", "topical application", "ingestion of local remedies", "cuts", "incision", "snake stone", "pressure-bandage", "pressure immobilization", "splinting", "pressure pad", "constriction bandage", "ice packs", "electric shock", "suction", "extractor", "burn", "tattooing" and "insufflation".

Eligible studies were selected by reading titles and abstracts, and the whole publication was referred to during the data extraction. Reference lists in the identified articles were searched to find additional publications. Only studies published in English were reviewed, and only the studies that described the practice of first aid and pre-hospital care in SBE were included in the analysis. Data was presented in numerical values, standard deviations (SD), range and percentages. Results were presented in three different ways: (a) The number of studies, and the corresponding percentages, that reported the use of each FAPH intervention; (b) the percentage of all patients included in the studies that used each FAPH intervention; and (b) the mean study-wise percentage, i.e., the mean value of the percentage of use of each FAPH intervention calculated in each study, with the corresponding range.

The data were analysed according to the continents and three-time intervals (before 2006, 2006 to 2015 and after 2015) to reveal the geographical variations and the change in practices over time, respectively. The study-wise percentages of the application of tourniquets, ingestion of herbal products, topical application and cut/incisions over the three time periods were compared using one-way ANOVA. All statistical analyses were performed, and graphs were generated using GraphPad Prism 5.0 (GraphPad Software Inc, California).

3. Results

We identified 480 studies, of which, upon examination, 71 were included for review. There were 62 prospective observational studies, 7 randomised controlled trials testing two or three antivenoms, 1 comparative trial, and 1 dose-finding study. Most of the studies were done in Asia (44, 61.9%) and then South America (15, 21.1%), Africa (7, 9.9%), Australia and Papua New Guinea (3, 4.2%), and North America (2, 2.8%). The details of the each FAPH practices reported in the included studies are given in Supplementary Table 1.

Of the selected number of 71 studies, application of tourniquet was described in 61 of them (85.9%), while ingestion of herbal products in 17 (23.9%), topical applications in 24 (33.8%), cuts/incisions in 26 (36.6%), and washing the bite site in 15 (21.1%) of the studies. The application of pressure-bandage was reported in 2 studies done in Australia. The practice of other methods, including applying dressing over the bite site, splinting-immobilization, applying black/snake stone, suction, electric shock, and other methods, were described in less than 15% of the studies. Tattooing of the bitten limb, burning the bite site, alcohol ingestion, and insufflations (included in Other Methods category in Table 1) were reported in few studies. Total and continent-specific FAPH practices for SBE are provided in Table 1.

The application of tourniquets was as high as 45.8% of all cases (mean study-wise percentage: 47.4, range 3.4–100.0), while making cuts/incisions was applied in 6.7% of cases (mean study-wise percentage: 17.7, range 0.4–92.9) of patients. Ingestion of natural, usually herbal, remedies was used in 2.9% of cases (mean study-wise percentage: 16.9, range 1.0–62.0%), and 5.6% of cases (mean study-wise percentage: 23.3 range 0.5–95.2%) victims applied various products at the bite site. Moreover, 9.1% of cases (mean study-wise percentage: 46.2, range 3.0–92.9%) washed the bite site, and 0.8% (mean study-wise percentage: 7.4, range 0.1–23.3%) used black/snake stone.

Global and region-wise FAPH practices in SBE are shown in Fig. 1 and Table 1. Application of tourniquet was highest in Asia, 55.7% (mean study-wise percentage: 55.3, range 7.6–100.0%), followed by South America, 31.8% (mean study-wise percentage: 36.3, range 5.3–76.2%) and Africa, 17.8% (mean study-wise percentage: 41.8, range 6.3–78.0%). ANOVA evidenced a significant difference in the use of tourniquets between continents when assessed based on the mean study-wise percentage. Ingestion of herbal preparations was reported in 6.0% of cases in Africa (mean study-wise percentage: 38.0, range 13.9–62.0%), in 4.2% of cases in South America (mean study-wise percentage: 11.5, range 3.2–28.3%) and in 2.4% of cases in Asia (mean study-wise percentage: 15.8, range 1.0–35.8%). Topical application of various products is a common practice among South American SBE victims, 19.1% of cases (mean study-wise percentage: 34.2, range 2.2–76.2%), followed by Africa, 6.2% (mean study-wise percentage: 34.9, range 16.7–84.3%), being 2.7% in Asia (mean study-wise percentage: 16.6, range 0.5–95.2%). Cuts/incisions were described in 14.5% in South America (mean study-wise percentage: 16.3, range 0.8–76.0%), 6.0% in Africa (mean study-wise percentage: 13.4, range 9.9–21.0%), and 4.6% of cases in Asia (mean study-wise percentage: 18.3, range 0.4–92.9%), and. The two studies describing pressure-bandage application showed that it was used in 39.0% of cases (mean study-wise percentage: 53.0, range 44.4–61.5%) of Australian snakebite victims referred to in these studies.

Table 1
Total and region-specific first aid and prehospital (FAPH) practices in SBE described in 71 included studies.

	Total			Africa			Asia			South America			North America			Oceania		
	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (range)#
Total number of studies	71			7			44			15			2			3		
Tourniquet	61 (85.9)	45.8	47.4 (3.4 – 100)	6 (85.7)	17.8	41.8 (6.3 – 78.0)	37 (84.1)	55.7	55.3 (7.6 – 100.0)	13 (86.7)	31.8	36.3 (5.3 – 76.2)	2 (100.0)	11.3	13.5 (3.4 – 23.7)	2 (66.7)	11.7	19.8 (7.4 – 32.2)
Ingestion of herbal products	17 (23.9)	2.9	16.9 (1.0 – 62.0)	2 (28.6)	6.0	38.0 (13.9 – 62.0)	9 (20.5)	2.4	15.8 (1.0 – 35.8)	6 (40.4)	4.2	11.5 (3.2 – 28.3)	-	-	-	-	-	-
Topical application	24 (33.8)	5.6	23.3 (0.5 – 95.2)	4 (57.1)	6.2	34.9 (16.7 – 84.3)	14 (31.8)	2.7	16.6 (0.5 – 95.2)	5 (33.3)	19.1	34.2 (2.2 – 76.2)	1 (100.0)	6.2	15.8	-	-	-
Cuts/Incisions	26 (36.6)	6.7	17.7 (0.4 – 92.9)	4 (57.1)	6.0	13.4 (9.9 – 21.0)	14 (31.8)	4.6	18.3 (0.4 – 92.9)	6 (40.0)	14.5	16.3 (0.8 – 76.0)	1 (100.0)	7.2	18.4	1 (33.3)	12.2	34.6
Washing the bite site	15 (21.1)	9.1	46.2 (3.0 – 92.9)	-	-	-	13 (29.5)	13.1	52.1 (3.0 – 92.9)	2 (13.3)	0.4	7.8 (5.3 – 10.3)	-	-	-	-	-	-
Ice packs	3 (4.2)	0.2	6.3 2.3 – 10.2	-	-	-	2 (4.5)	0.2	4.4 (2.3 – 6.5)	-	-	-	1 (100.0)	6.2	10.2	-	-	-
Splinting/immobilisation	5 (7.0)	0.5	4.6 (1.9-9.9)	-	-	-	4 (9.1)	0.8	4.0 (1.9 – 9.9)	1 (6.7)	0.1	6.9	-	-	-	-	-	-
Application of pressure bandage	2 (2.8)	1.6	53.0 (44.4-61.5)	-	-	-	-	-	-	-	-	-	-	-	-	2 (66.7)	39.0	53.0 (44.4-61.5)
Alcohol ingestion	2 (2.8)	0.2	20.6 (1.1 – 40.0)	1 (14.3)	1.6	40.0	1 (2.3)	0.02	1.1	-	-	-	-	-	-	-	-	-
Dressing of the bite site	1 (1.4)	0.1	2.0	-	-	-	1 (2.3)	0.2	2.0	-	-	-	-	-	-	-	-	-
Black stones/snake stones	5 (7.0)	0.8	7.4 (0.1 – 23.3)	2 (28.6)	7.8	14.5 (5.6 – 28.9)	2 (4.5)	0.03	2.6 (0.2 – 5.1)	1 (6.7)	0.1	2.8	-	-	-	-	-	-
Suction	5 (7.0)	0.1	3.1 (1.0 – 8.2)	-	-	-	1 (2.3)	0.02	0.1	2 (13.3)	0.3	4.6 (1.0 – 8.2)	1 (100.0)	1.0	2.6	1 (33.3)	0.2	3.7
Other methods	10 (14.1)	1.3	7.8 (0.1 – 38.4)	2 (28.6)	0.3	2.5 (0.8 – 5.0)	6 (13.6)	1.6	5.2 (0.1 – 8.9)	2 (13.3)	1.3	20.9 (3.4 – 38.4)	-	-	-	-	-	-

(- : not reported).

*Refers to the number of studies, and the corresponding percentage related to the total number of studies, that reported the use of each FAPH intervention.

&Refers to the percentage of all patients described in the studies that used each FAPH intervention.

#Refers to the mean values of the percentages of use of each FAPH intervention calculated per study, i.e., the number of victims who practice each FAPH / number of total victims reported in each study. Results are presented as means and range (in parentheses).

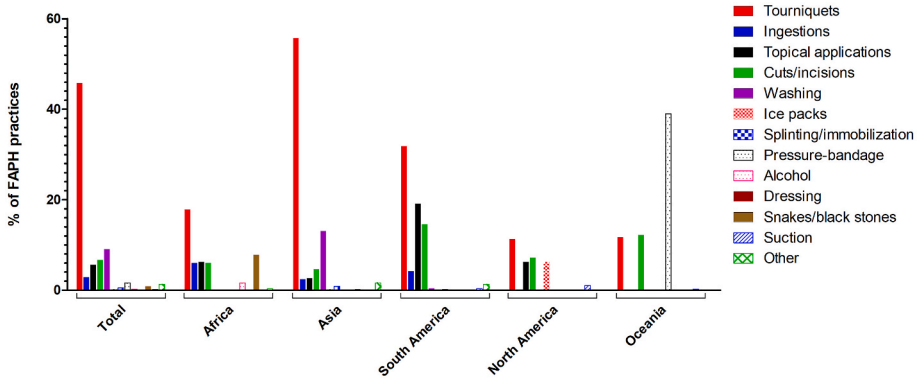

Fig. 1. Percentages of global and regional first aid and prehospital care (FAPH) practices in SBE. Numbers refers to the percentage of all patients described in the studies that used each FAPH intervention.

There were 19, 20, and 32 studies published before 2006, 2006 to 2015 and after 2015, respectively (Table 2), which allowed us to assess the change of some FAPH practices over time (Fig. 2, Table 2). When data was analysed using the mean study-wise percentage and the corresponding standard deviation, there are no significant differences (by ANOVA) in the application of tourniquets, ingestion of herbal products, topical applications and cuts/incisions (each intervention analysed separately) in these three-time intervals (Fig. 2).

4. Discussion

Our findings, based on prospective clinical and epidemiological studies published over various decades, reveal the continuous use of FAPH interventions in SBE in many world regions. Tourniquets are widely used in all regions, and other modalities of FAPH are also common, but their frequency varies depending on the region, such as ingestion or local application of substances, and washing the site of the bite. On the other hand, cuts and incisions were also described in all continents. Alcohol administration and the use of black/snake stone were described in Africa. In turn, pressure-bandage has been common in Oceania, but not in other continents. When FAPH interventions were analysed in three-time intervals it became evident that the use of tourniquets has remained high over time, whereas other interventions peaked in some time intervals and decreased in others, although no significant variations over time were observed in the four most frequent FAPH interventions.

Owing to the scarcity of data in many countries, our study could not have a higher degree of granularity, which would allow the assessment of differences in countries within a region. However, existing data suggest that these differences occur. For example, FAPH interventions have been described as frequent in some Latin American countries, such as Brazil (da Silva et al., 2019) and Colombia (León-Núñez et al., 2020). In contrast, in the case of Costa Rica, a study described that only 2.9% of SBE in the year 1996 resorted to FAPH interventions (Arroyo et al.,

Table 2
Change of first aid and pre-hospital (FAPH) practices over three-time intervals from 1979 to 2023.

	Before 2006			2006 - 2015			After 2015		
	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (SD)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (SD)#	Number of studies (%)*	Percentage of use&	Mean study-wise percentage of use (SD)#
Number of studies	19			20			32		
Tourniquet	18 (94.7)	51.2	46.4 (27.0)	14 (70.0)	40.9	49.7 (28.4)	29 (90.6)	47.0	46.9 (27.8)
Ingestion of herbal products	2 (10.5)	3.5	37.9 (34.1)	5 (25.0)	2.9	8.1 (5.4)	10 (31.2)	2.7	17.0 (11.3)
Topical application	4 (21.0)	1.5	11.2 (7.2)	6 (30.0)	2.8	30.7 (33.6)	14 (43.7)	9.4	23.6 (28.1)
Cuts/Incisions	6 (31.6)	4.8	14.9 (11.4)	6 (30.0	5.1	23.6 (34.9)	14 (43.7)	8.6	16.5 (21.6)
Washing the bite site	1 (5.3)	5.2	43.5	4 (20.0)	17.9	54.5 (12.7)	10 (31.2)	4.4	43.1 (32.2)
Ice packs	1 (5.3)	0.2	10.2	-	-	-	2 (6.2)	0.3	4.4 (3.0)
Splinting/immobilisation	-	-	-	1 (5.0)	0.4	1.9	4 (12.5)	0.9	5.2 (3.9)
Application of pressure bandage	-	-	-	2 (10.0)	4.8	53.0 (12.1)	-	-	-
Alcohol ingestion	1 (5.3)	0.9	40.0	-	-	-	1 (3.1)	0.03	1.1
Dressing of the bite site	-	-	-	1 (5.0)	0.4	2.0	-	-	-
Black stones/snake stones	-	-	-	3 (15.0)	0.1	2.8 (2.8)	2 (6.2)	1.7	9.5 (12.2)
Suction	1 (5.3)	0.2	8.2	2 (10.0)	0.04	1.9 (2.5)	2 (6.2)	0.03	1.8 (1.2)
Other methods	3 (15.8)	1.4	15.0 (20.4)	3 (15.0)	0.1	2.1 (2.9)	5 (15.6)	2.2	5.7 (3.2)

(- : not reported).

*Refers to the number of studies, and the corresponding percentage related to the total number of studies, that reported the use of each FAPH intervention.

&Refers to the percentage of all patients described in the studies that used each FAPH intervention.

#Refers to the mean values of the percentages of use of each FAPH intervention calculated per study, i.e., the number of victims who practice each FAPH / number of total victims reported in each study. Results are presented as means and standard deviations (in parentheses).

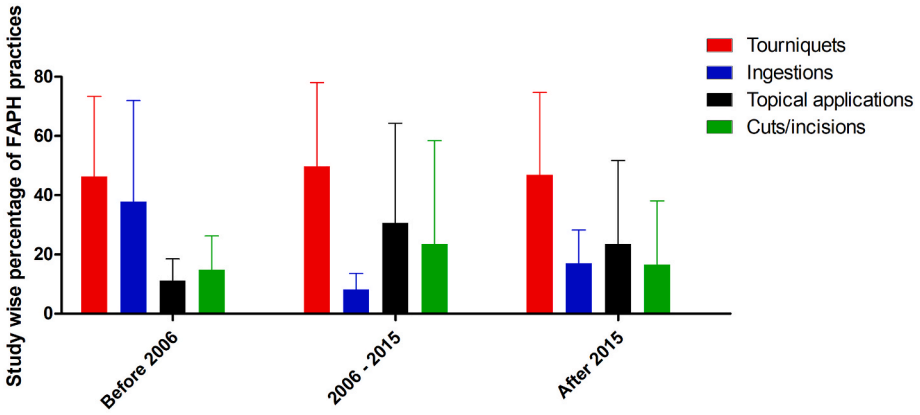

Fig. 2. Changes in the study-wise percentages of various FAPH practices in SBE over the various time in the periods from 1979 to 2023. No significant differences were observed in the application of tourniquets, ingestion of herbal products, topical applications and cuts/incisions between the three-time intervals ($p > 0.05$ by ANOVA).

1999). Such difference can be explained by the permanent public education programs on this topic in this country, and to the widespread existence of public health facilities that can be reached within a relatively short period of time, together with the existence of antivenoms at the primary health care level (Montoya-Vargas et al., 2022; Sasa and Segura, 2020).

The widespread use of harmful FAPH interventions, particularly tourniquets and, to a lower extent, cuts-incisions, is a worrisome finding of this study. Despite the widespread consensus, among the medical and public health community and in many guidelines and public education materials, on the potentially deleterious effects of these interventions, their use in all continents is notorious. The reasons behind this phenomenon should be explored in specific contexts, as they may vary in different settings. Regardless of this, renewed efforts should be carried out in public campaigns to reduce or eradicate their use. Community-based interventions, with an active engagement of community groups and local stakeholders, should be strengthened, along the WHO strategy to reduce the burden of SBE (WHO, 2019), and following relevant efforts being carried out in various regions (Samuel et al., 2020; Vaiyapuri et al., 2023). Another potentially harmful intervention is the local application of synthetic or natural substances, which introduces the risk of contamination, especially in SBE characterized by local tissue damage.

Administration of plant extracts, either orally or around the bite site is part of long-standing ethnobotanical traditions and cultural practices in most regions of the world and is widely used by traditional healers. The low percentage of cases reporting the use of herbal products in our study might be due to the fact that in many instances people using these interventions, generally applied by traditional healers, do not access health facilities and, therefore, would not be captured by our search strategy. An extensive literature has been produced on the preclinical assessment of the efficacy of some of these natural products or compounds isolated from them (see reviews by (Bala et al., 2023; Konrath et al., 2022; Soares et al., 2005)). However, despite this wealth of preclinical data, no natural product has been demonstrated to be effective in SBE in properly designed clinical studies (Konrath et al., 2022; Puzari et al., 2022). It is necessary to foster international efforts to assess, through well designed preclinical and clinical studies, the potential efficacy of natural products used in ethnomedicine for SBE. The use of natural substances as FAPH practice in SBE involves two potentially deleterious consequences. One has to do with the toxicity of some of these extracts, and the other relates to the delay that these interventions

bring for the access of envenomated people to health care facilities (Iliyasu et al., 2015; Sloan et al., 2007).

Several clinical studies have tested various protocols of pressure-bandage in envenomings by *Daboia siamensis* (Tun-Pe et al., 1995), and *Notechis scutatus* (Murrell, 1981), as well as application of three types of pressure-pad using mock venom (Anker et al., 1982, 1983). Results show that these interventions retard the onset of systemic clinical manifestations. The rationale behind them is that pressure and immobilization delay the systemic absorption of the venom, thus allowing a wider window of time to reach health facilities. Our study evidenced that this practice has been described mostly in Australia. Pressure/immobilization is generally not used outside this region, because it should not be implemented in the case of SBE characterized by local tissue damage, such as those of viperids and cytotoxic elapids (Americal College of Medical toxicology, 2011). Preclinical studies using various animal models underscore the efficacy of pressure/immobilization procedures (German et al., 2005; Hack et al., 2011; Meggs et al., 2010; Smyrnioudis et al., 2014; Sutherland et al., 1979; Sutherland and Coulter, 1981). In agreement with this concept, the use of drugs that reduce lymphatic flow delay the onset of systemic neurotoxic envenomation by the Australian elapid *Pseudonaja textilis* (van Helden et al., 2014). These methods need to be further evaluated in controlled clinical trials in SBE that cause systemic neurotoxicity and no local tissue damage, and there is a need to ensure that they are properly applied (Currie et al., 2008; Norris et al., 2005). Clearly, the development of effective first aid interventions should be adapted to the specific features of the pathophysiology of envenomation by different types of snakes.

Regarding other interventions, a study with patients envenomed by the cobra *Naja naja philippinensis*, currently classified as *N. philippinensis*, showed a delayed in systemic venom absorption resultant from the tourniquet application, and a rapid worsening of systemic manifestations of envenomation upon removal of tourniquet (Watt et al., 1988). In contrast, studies carried out in patients envenomated by *Crotalus durissus terrificus* and *Daboia russelii* showed no benefits with the use of tourniquet (Amaral et al., 1998; Tun-Pe et al., 1987). Guidelines for the management of SBE discourage the use of tourniquets due to their harmful effects (see for example WHO, 2010). Other clinical studies have revealed the inefficacy of interventions like extractor pump (Alberts et al., 2004) and electric shock (Dart and Gustafson, 1991; Dart and Gustafson, 1991). These clinical findings concerning suction devices and electric discharges agree with preclinical observations using animal models (Bush et al., 2000; Howe and Meisenheimer, 1988; Johnson et al., 1987; Reitz et al., 1986).

Our study has several limitations. We only considered publications in English, thus possibly missing studies published in other languages that may provide valuable information in particular contexts. Secondly, we only used prospective studies. Although this may have resulted in the loss of additional data, we based this decision on the limitations inherent to retrospective studies. Moreover, some prospective studies detected in our search may not have included FAPH interventions in their design and analysis. Since our study only captured published information in the database searched, it is likely that the use of FAPH interventions is higher than the data hereby presented, owing to the fact that in many locations affected people rely only on these practices and do not reach healthcare facilities, as mentioned above for the ingestion of herbal products. Community-based surveys and similar methodologies are required to fill this gap. Despite these limitations, the bulk of information gathered in this investigation allows us to reach some general trends on this topic.

In conclusion, FAPH interventions in SBE are of common use worldwide, some of which are overly harmful and bring further deleterious consequences for the patients. The continuous use of some of these practices, despite abundant information in the media, clinical guidelines, and public campaigns highlighting their harmful effect, call for the analysis of the best ways to convey this information to have a real impact on these practices. For this, among several strategies, community engagement and involvement are essential, as indicated in the WHO strategy to prevent and control SBE (WHO, 2019). Public awareness campaigns should be tailored to the local cultural contexts and must combine bottom-up with top-down approaches. These demands concerted social research efforts, the involvement of affected communities, and a dialogic partnership between public health systems and traditional healers. Community-based studies are required to have a more accurate perspective of the use of FAPH interventions. Likewise, preclinical and clinical studies should be undertaken to assess some of the more promising interventions, such as pressure-immobilization, and pharmacological interventions that delay systemic venom absorption in the case of neurotoxic SBE that do not cause local tissue damage.

Authors contributions

KM: Kalana Maduwage; SKG: Sujani Kodagoda Gamage; JMG: José María Gutiérrez, Concept: KM, JMG. Formulating database strategy: KM. Database search, selection of studies: KM. Extraction of data and data analysis: KM, SKG. Writing the original version of the manuscript, revising and editing the manuscript: KM, SKG, JMG.

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Ethical statement

Since this manuscript is not based on human or animal involvement, we declare that there are no ethical issues related to this paper.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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Appendix ASupplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.toxicon.2023.107582.

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