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Indigenous venomous snakebites in Switzerland: analysis of reports to the National Poisons Information Centre over 22 years

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Summary

INTRODUCTION: Two venomous snakes, the asp viper (*Vipera aspis*) and the common adder (*Vipera berus*) are native to Switzerland. Bites by both vipers cause mainly local effects, but systemic envenomation is possible.

METHODS: We analysed all calls concerning indigenous venomous snakebites recorded at the Swiss National Poisons Information Centre between 1997 and 2018, including all cases with identification by a herpetologist, and/or with compatible symptoms and circumstances of the exposure.

RESULTS: During the study period, 1,364 cases concerned snakebites. One third (466; 34%) were attributed to indigenous vipers. In 243 (52%) patients, medical follow-up information was available, with good causality between exposure and symptoms in 219 (90%) patients. *Vipera aspis* was identified in 77 of the cases (35%), *Vipera berus* in 54 (25%), and not further specified vipers in 88 (40%). In over two thirds of the 219 cases (155, 71%) adult patients were affected (male 109, female 46; median age 43 years [range 16–90]). Sixty-four patients were children (male 47, female 16; median age 11 years [range 1.3–15.9]). The highest occurrence of bites was in the summer months. In the majority of patients, the clinical course was mild (94; 43%) or moderate (80; 36%); a lower proportion was either asymptomatic (17; 8%) or exhibited severe symptoms (28; 13%). There were no fatalities reported. The most frequent symptoms were local effects at the bite site with mild (100; 46%) to moderate (56; 25%) swelling, pain (65; 30%) and redness (51; 23%). Gastrointestinal symptoms including nausea (31; 14%), vomiting (47; 22%) and abdominal pain (25; 11%) were also common. Other systemic symptoms included cardiovascular effects (e.g., hypotension (20; 9%) or shock [6; 3%]), neurotoxicity (e.g., visual impairment [5; 2.3%]) and haematotoxicity (e.g., coagulopathy [11; 5%]). Seven (3.2%) patients developed anaphylactic reactions. Antivenom was administered in only 20% (24 with moderate and 19 with severe symptoms) with good resolution of symptoms. The mean duration of hospitalization was 2 days (0–12 days).

CONCLUSION: Snakebites in Switzerland can result in severe symptoms, sometimes necessitating antivenom treatment.

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Introduction

From a global perspective, snakebite poses a massive burden in many parts of the world with over 100,000 dead and 400,000 maimed per annum [1]. In contrast, snakebites in Central Europe are not perceived to result in relevant morbidity. Vipers of the family Viperidae currently include 35 genera and more than 350 species worldwide, with the exception of Oceania [2]. Up to 25 species can be found in Europe, North Africa, and Asia [2]. Switzerland is home to two indigenous venomous snakes, the asp viper (*Vipera aspis*) and the common adder (*V. berus*), besides six non-venomous colubrid snakes [3]. Both vipers are small terrestrial snakes of no more than 70 cm length in total, with a short and stocky body and a subtriangular head distinct from the neck. They are of a brownish or olive colour with dark markings (figs 1 and 2). Approximately 10% of them show a melanistic appearance, turning them completely black within the first 2 years of their lives [3, 4]. They weigh a maximum of 100 g and sport solenoglyph venom fangs 3–5 mm in length, which they use for hunting and defence [3]. The species are hard to distinguish by the general population owing to their similar appearance, although the snout of *V. aspis* is upturned and seems more marked than that of *V. berus,* albeit without forming a horn covered with small scales like *V. ammodytes* or *latastei* [4]. In addition, their habitats overlap. Both snakes live in the subalpine regions of the country from 1500 to about 2300 m above sea level [3, 5]. Rarely, they can also be found below and above those altitudes. They are ovoviviparous and hibernate during the winter months. The Convention of Bern of 1979 defines catching or killing snakes in Switzerland as illegal [6]. Their venom is a mixture of proteins, enzymes and polypeptides [7]. It contains, amongst others, hyaluronidases, metalloproteinases, proteases and phospholipase A2 [8]. The effects of bites by both Viper species are very similar with mainly local symptoms, but some populations have also been shown to

infrequently cause neurological and haematological problems [6–16]. The last fatal envenomation in Switzerland dates back to 1961 [7]. In the canton Valais bites by *V. aspis* in 99 patients over 32 years resulted in none or mild symptoms in half of the patients, moderate symptoms in 40% and severe symptoms in 10% of the patients [7]. We wanted to find out if these numbers are still pertinent.

Methods

Data collection

In Switzerland, nationwide (and complementary) consulting to the general public and doctors on poisonings and envenomation resulting from various toxins is provided by the Swiss National Poisons Information Centre (Tox Info Suisse). All calls recorded at the Swiss National Poisons Information Centre from January 1997 to December 2018 related to indigenous snakebites in Switzerland were included. Basic demographic (age, sex, region) and clinical (type of caller, circumstance of exposure) data are systematically collected for all calls related to snake bites and are standardised by a clinical toxicologist. Among patients in hospitals or medical practices for clinical care, the treating physician may provide a follow-up report. This additional information contains further details on the clinical findings, severity, causality assessment, treatment course (e.g., use of antivenom) and clinical outcomes. Standards and quality measures comprise review of each case by a senior clinical toxicologist to ensure completeness and correctness of the entered data. Exceptional cases are discussed by an internal expert panel with clinical toxicologists and poison information specialists present, and discrepancies are resolved by consensus before being entered into the database. This allows a systematic assessment of severity and causality (by Tox Info Suisse experts). The Cantonal Ethics Commission of Zurich approved the use of National Poisons Information Centre patient data without specific informed consent of the patients due to the inherent nature of poisons centre data.

Selection of patients

Inclusion criteria were all calls related to indigenous snakebites with medical follow-up, identification of the snake by a herpetologist, and/or with compatible symptoms and circumstances of exposure when identification was not possible. Exclusion criteria comprised non-venomous snakes or lizards, exotic snakes, calls where a snake had not been observed and the symptoms did not correspond to a potential snakebite, calls from countries other than Switzerland and Liechtenstein, and calls from Swiss citizens bitten abroad. If several callers (e.g., first members of the general public, then the hospital physician, who might call several times) reported on the same episode, all of these were aggregated into one case. Follow-up was graded according to the Poisoning Severity Score [17]. Only cases with good causality, where the temporal context and the symptoms and/or circumstances of exposure were compatible with an indigenous snakebite and thus considered probable, were included in the analysis (fig. 3). Statistical analysis were performed with IBM SPSS Statistics, Version 25 (2020) and Microsoft Excel, Version 2015. We report counts and percentages (%), mean or median values as appropriate.

Results

Within the study period, 1,516 calls related to reptile exposures were recorded at the Poison Centre (fig. 3). Of these, 1,364 (90%) were associated with snakes in general, 751 (50%) with indigenous snakes, and 466 (31%) with venomous indigenous snakes. Follow up was available in 243 (16%) patients, and sufficient causality was provided in 219 cases (14%) resulting in the final dataset for analysis. In 77 (35%) of these 219 patients *V. aspis* and in 54 (25%) *V. berus* were identified. In the remaining 88 (40%) identification of the species was not possible, but the clini-

Figure 1: *Vipera aspis*, photo by Joan Fuchs.

cal features and circumstances were compatible with an indigenous viper bite. Over two thirds of the patients were adults (155, 71%) and 64 (29%) patients were children. In both age groups, patients were predominantly male with 109 (70%) and 47 (73%), respectively. Table 1 provides the demographic characteristics of all patients. Only 2% of the bites occurred in an occupational setting, whereas 97% occurred during leisure activities. The majority of first calls came from hospital doctors (79%) and general practitioners (13%). Only a low proportion of direct calls were made by members of the general public (6%).

Figure 4 shows the seasonal distribution of bite events, with the highest incidence predictably in the summer months, with peaks in the hot months of June (40, 18%), July (51, 23%) and August (43, 19%).

The main site of bites was the hand (72%), followed by the foot (11%) in adult patients, with comparable results (65% and 19%) in paediatric patients (table 2). Of 109 adult

Figure 2: *Vipera berus*, photo courtesy of Daniel Blaser.

males, 89 (81.6 %) were bitten in the hand, whereas of the 46 adult women only half sustained a bite in the hand (23; 50 %). Of the 47 boys, 34 (72.3%) were bitten in the hand, whereas of the 17 girls only 8 (47 %) sustained a bite in the hand. Only a small proportion of the patients (8%) remained asymptomatic, with most patients exhibiting mild (43%) or moderate (36%) symptoms. Severe symptoms occurred in 13% of the patients. No fatalities were observed during the study period.

Table 3 gives an overview of symptoms and other effects experienced by the patients.

Overall, 625 symptoms were reported in 219 patients. The most frequent symptoms were local effects at the bite site with mild (100, 46%) to moderate (56, 25%) swelling, pain (65, 30%) and redness (51, 23%). Gastrointestinal symptoms including nausea (31, 14%), vomiting (mild 47 (22%) and moderate 14 (6%)) and abdominal pain (25, 11%) were also frequently reported. Other systemic symptoms included cardiovascular effects, such as hypotension 20 (9%), shock 6 (3%), neurotoxicity, such as visual impairment 5 (2.3%) and haematotoxicity including coagulopathy 14 (6.5%).

Figure 3: Selection of cases.

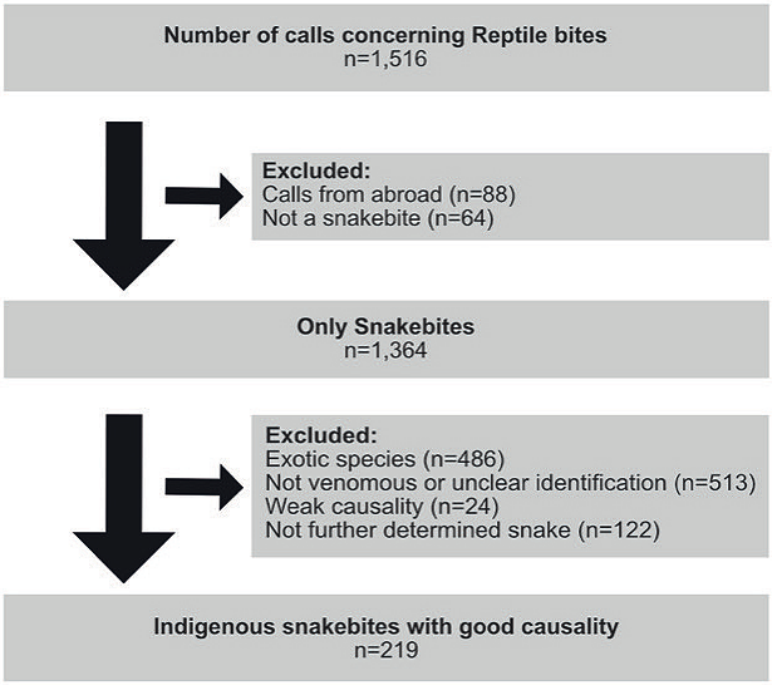


Table 1:
Demographics and characteristics of patients (n = 219).

	Adults (≥16 years), n = 155	Children (<16 years), n = 64	Total, n = 219
Age			
Median age (range)	43 (16–90)	11 (1.3–15.9)	31 (1.3–90)
<6 years, n (%)	–	7 (10.9)	7 (3.2)
6–15 years, n (%)	–	57 (89.1)	57 (26)
16–25 years, n (%)	27 (17.4)	–	27 (12.3)
26–50 years, n (%)	71 (45.8)	–	71 (32.4)
>50 years, n (%)	53 (34.2)	–	53 (24.2)
Unknown, n (%)	4 (2.6)	0 (0)	4 (1.8)
Sex			
Male, n (%)	109 (70.3)	47 (73.4)	156 (71.2)
Female, n (%)	46 (29.7)	16 (25)	62 (28.3)
Unknown, n (%)	0 (0)	1 (1.6)	1 (0.5)
Situation			
Work, n (%)	5 (3.2)	0 (0)	5 (2.3)
Leisure / at home, n (%)	149 (96.1)	64 (100)	213 (97.3)
Unknown, n (%)	1 (0.6)	0 (0)	1 (0.5)
Caller			
Ambulance, n (%)	4 (2.6)	0 (0)	4 (1.8)
Hospital, n (%)	115 (74.2)	58 (90.6)	173 (79)
General physician, n (%)	23 (14.8)	5 (7.8)	28 (12.8)
General public, n (%)	13 (8.4)	1 (1.6)	14 (6.4)

Antivenom was administered in 20% of the patients (43 patients, 24 with moderate and 19 with severe symptoms) with good resolution of symptoms, although 4% of the patients required multiple doses. Available antivenoms during the study period were ViperaTab® (MicroPharm, Great Britain), an ovine antivenom manufactured with the venom of *V. berus*, Viperfav® (Sanofi Pasteur MSD France), an equine antivenom manufactured with the venoms of *V. aspis, berus* and *ammodytes*, and the European Viper Venom Antitoxin (Institute of Immunology Inc, Zagreb, Croatia), an equine antivenom made with *V. berus* and *ammodytes*. Of the 155 adult patients, 25 (16%) received a single dose and two (1.3%) received multiple doses of antivenom. Of the 64 children, 10 (16%) received a single dose and six (9%) multiple doses of antivenom. Nine (32%) of the patients with severe symptoms did not receive any antivenom. Most patients (80%) recovered without antivenom administration and symptomatic therapy only. Twelve (5.5%) patients developed anaphylactic reactions such as angioedema or urticaria (two cases and one case, respectively) to the venom (seven cases with severe symptoms such as anaphylactic shock). Two children developed mild symptoms after antivenom administration (urticaria or shivering, without need for symptomatic or specific treatment). One child suffered from hypotensive shock, but documentation did not show if symptoms occurred before or after antivenom administration. The mean duration of hospitalisation was 2 days (range 0–12), with longer hospitalisations associated with the severity of the symptoms (fig. 5).

Figure 4: Seasonal distribution of indigenous venomous snakebites in Switzerland 1997–2018.

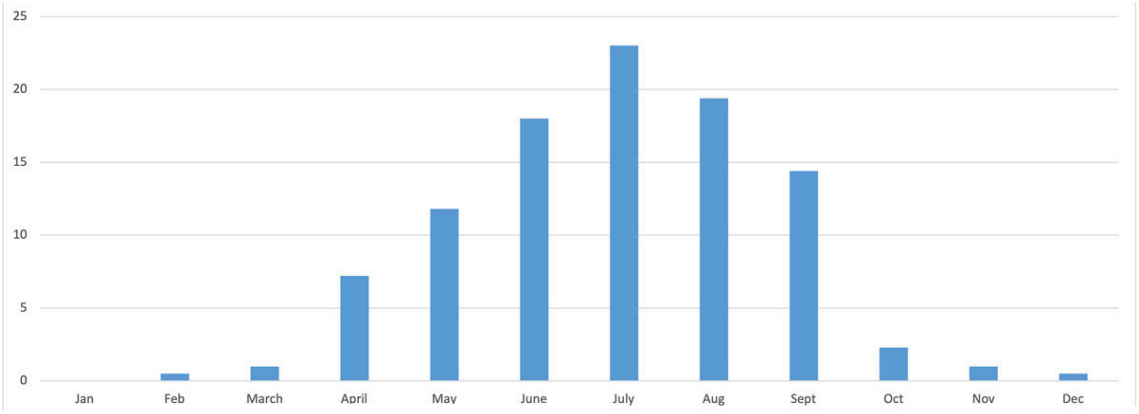


Table 2:
Clinical characteristics, antivenom administration and duration of hospitalisation of patients (n = 219).

	Adults (≥16 years)	**Children (<16 years)**	**Total**
n (%)	155 (70)	64 (30)	219 (100)
Localisation			
Arm	6 (3.9)	3 (4.7)	9 (4.1)
Hand	112 (72.3)	42 (65.6)	154 (70.3)
Leg	10 (6.5)	2 (3.1)	12 (5.5)
Foot	17 (11)	12 (18.8)	29 (13.2)
Unknown	10 (6.5)	5 (7.8)	15 (6.8)
Severity			
Asymptomatic	9 (5.8)	8 (12.5)	17 (7.8)
Mild	63 (40.6)	31 (48.4)	94 (42.9)
Moderate	64 (41.3)	16 (25)	80 (36.5)
Severe	19 (12.3)	9 (14.1)	28 (12.8)
Antivenom			
Single dose	10 (6.5)	7 (10.9)	17 (7.8)
Multiple doses	2 (1.3)	6 (9.4)	8 (3.6)
<1 dose[1]	1 (0.6)	0 (0)	1 (0.4)
Unknown quantity	14 (9)	3 (4.7)	17 (7.8)
None	128 (82.6)	48 (75)	176 (80.4)
Hospitalisation			
No information	72 (46.5)	44 (68.8)	116 (53)
0 days	19 (12.3)	3 (4.7)	22 (10)
1–2 days	41 (26.5)	10 (15.6)	51 (23.3)
3–4 days	15 (9.7)	6 (7.8)	21 (9.6)
>4 days	8 (5.2)	1 (1.6)	9 (4.1)

[1] The patient received 1 Vial (4 ml) ViperaTAb®. A full dose of antivenom consists of either 2 vials of ViperaTAb® (8 ml) or 1 vial Viperfav® (4 ml).

Available antivenoms: ViperaTAb® (MicroPharm, Great Britain), an ovine antivenom manufactured with the venom of *V. berus*, Viperfav® (Sanofi Pasteur MSD France), an equine antivenom manufactured with the venoms of *V. aspis, berus* and *ammodytes*, and the European Viper Venom Antitoxin (Institute of Immunology Inc, Zagreb, Croatia), an equine antivenom made with *V. berus* and *ammodytes*.

Table 3:
The 625 symptoms reported in 219 patients after bites by indigenous snakes (percentages calculated from 219 patients).

Symptoms	Severity		
	Mild, n (%)	Moderate, n (%)	Severe, n (%)
Local effects (n = 339)			
Pain	60 (27.4)	5 (2.3)	
Swelling	100 (45.6)	56 (25.6)	17 (7.8)
Paraesthesia	12 (5.5)		
Redness	51 (23.3)		
Necrosis[1]		2 (0.9)	
Skin, others[2]	25 (11.4)	10 (4.6)	1 (0.5)
Muscle (n = 11)			
Rhabdomyolysis[3]	7 (3.2)	1 (0.5)	
Compartment syndrome			3 (1.4)
Pulmonary (n = 15)			
Oxygen saturation[4]	2 (0.9)	3 (1.4)	1 (0.5)
Dyspnoea	8 (3.6)	1 (0.5)	
Gastrointestinal (n = 114)			
Nausea	31 (14.2)		
Vomiting	33 (15.1)	14 (6.4)	
Bellyache	22 (10)	4 (1.8)	
Diarrhoea	2 (0.9)	8 (3.6)	
Neurological (n = 41)			
Somnolence	11 (5)		
Coma[5]		1 (0.5)	
Confusion		1 (0.5)	
Vertigo	13 (5.9)		
Visual impairment	5 (2.3)		
Speech disorder	1 (0.5)		
Agitation	3 (1.4)	2 (0.9)	
Stupor		1 (0.5)	
Paralysis[6]		1 (0.5)	
Hyperreflexia	2 (0.9)		
Cardiovascular (n = 59)			
Hypertension[7]	3 (1.4)		1 (0.5)
Hypotension[8]	6 (2.7)	14 (6.4)	
Tachycardia[9]	13 (5.9)	3 (1.4)	
Bradycardia[10]		5 (2.3)	1 (0.5)
Syncope		1 (0.5)	
Shock			6 (2.7)
ECG[11]	1 (0.5)		
Cardiovascular, other[12]	2 (0.9)	3 (1.4)	
Haematological (n = 38)			
Quick/INR[13]	3 (1.4)	8 (3.6)	1 (0.5)
Thrombocytopenia[14]	3 (1.4)	2 (0.9)	
Leucocytosis[15]	2 (0.9)	8 (3.6)	
Haemolysis	1 (0.5)	1 (0.5)	
Anaemia		2 (0.9)	
Hypopotassaemia	3 (1.4)	3 (1.4)	
Blood, other[16]	1 (0.5)		
Other (n = 32)			
Headache	5 (2.3)		
Eye, inflammatory	1 (0.5)		
Immune system, other[17]		4 (1.8)	1 (0.5)
Anaphylactic shock			7 (3.2)
Kidney injury	6 (2.7)	1 (0.5)	
Kidney, other[18]	2 (0.9)		
Metabolic acidosis	3 (1.4)	1 (0.5)	
Hyperthermia	1 (0.5)		

[1] Moderate: less than 2 % body surface. [2] Mild: lymphangitis, dysaesthesia, local ecchymosis/haematoma/discoloration, skin lesions, pruritus, local epidermolysis. Moderate: regional suffusions/haematoma/discoloration. Severe: threatening compartment syndrome. [3] Mild: creatine kinase (CK) 250–1500 U/l. Moderate: uncomplicated rhabdomyolysis, CK 1500—10,000 U/l. [4] Mild: pO_2: 8.13–9.33, pCO_2: 3.01–3.4; Moderate: pO_2: 7.33–8.00/ pCO_2: 1.87–3.00 or 6.00–7.33; Severe: pO_2: <7.33/ pCO_2: <1.87 or >7.33. [5] Moderate: Coma Glasgow Coma Scale 8–9 [6] Paralysis of the cranial nerves III, IV and VI. [7] Mild: systolic blood pressure 150–189 mm Hg (adult) and 121–139 mm Hg (child). Severe: systolic blood pressure >190 mm Hg (adult) and >160 mm Hg (child).[8] Mild: syst. blood pressure 50–59 mm Hg (child). Moderate: systolic blood pressure 55–79 mm Hg(adult) and 40–49 mm Hg (child). [9] Mild: >100/min (adult). Moderate: 140–179/min (adult) and 160–190/min (child). [10] Moderate: 40–50/min (adult) and 60–80/min (child). Severe: <40/min (adult) and <60/min (child). [11] Partial bundle branch block. [12] Mild: thoracic pain. Moderate: collapse. [13] Mild: Quick <70% or INR >1.25. Moderate: coagulopathy without bleeding, Quick <50% or INR >1.55. Severe: venom-induced consumption coagulopathy (VICC). [14] Mild: 31,000–70,000/µl. Moderate: 11,000–30,000/µl. [15] Mild: 15,000–19,000/µl. Moderate: 20,000–39,900/µl. [16] No further information. [17] Anaphylactic reaction. [18] Mild: urgency to urinate

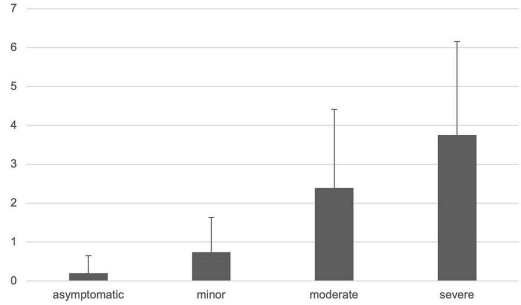
Discussion

Bites by indigenous venomous snakes lead to moderate and severe symptoms in half of the patients, necessitating symptomatic treatment or antivenom. Fatal cases in adults or children were not reported within the study period. The distribution of severity of the symptoms in our patients was similar to three previous studies [7, 8, 16]. The majority of the patients experienced mild or moderate symptoms, and a small number remained asymptomatic or had a severe course. The frequent local symptoms can be explained by the venom components and the maximum concentration at the site of the bite. The composition of the venoms of V. *aspis* and *berus* is similar, although there are interregional and interspecies differences in venom composition [11, 14]. There are indications that *V. aspis* venom phospholipase A2 is neurotoxic, whereas *V. berus* venom phospholipase A2 is more haematotoxic [4, 10–13, 15], even if a level of neurotoxicity has been detected in some *V. berus* populations [14]. Table 4 shows some of the venom components found in both *V. aspis* and *berus*.

With an average of 10 bites per annum in a population of over 8 million inhabitants, indigenous snakebite has a low incidence. Yet because there is no mandatory reporting requirement, it is entirely possible that not all cases have been recorded.

The majority of patients bitten by indigenous venomous snakes were adults. The age distribution of affected patients (30% children, 70% adults) remained very comparable to two earlier studies from Switzerland [7, 18]. Results from other European countries have shown a higher proportion of children among bite victims (40–50% [16]). The reason for this difference remains unknown.

Figure 5: Mean duration of hospitalisation.



Over two thirds of the patients were male. The results in the present study related to gender distribution were similar to other epidemiologic studies [2, 7, 12, 19–21]. Males account for double of the bite victims compared with females in all age groups. The reasons for the higher proportion of men vs women as potential bite victims remain speculative. Increased outdoor activities or different risk behaviours might play a role. The median age of the patients in our study was 31 years, which was also similar to the previous study in Valais [7].

The risk of bites is increased in the summer months with the peak in July. Swiss indigenous vipers hibernate during the winter months when their habitat is usually covered with snow. Depending on the weather and the temperature, the animals become active and the risk of an encounter with humans increases [3]. Most bites happened during leisure activities, only very few were occupational exposures. These results are in contrast to data from other countries such as Kenya, where most bites happen during occupational exposure such as animal husbandry or horticulture [22].

The hand as primary site for snakebites was also observed in other studies in Switzerland [18]. In addition, our data confirmed previous data that more males than females were bitten in the hand [18, 23]. Reasons for this finding might be that males are more likely to intentionally grab the snake, try to play with it or point at it, as has been described in another study [24], although in most cases contact was unintentional (e.g., during climbing or field work). Only a smaller number of patients stepped on or too close to the snake and were consequently bitten in the foot. This is contrary to the prevalence of bites in the foot in some Nordic countries [16].

Severe symptoms occurred with adults and children in similar proportions (12% in adults and 14% in children), although a higher percentage of children (25% as opposed to 17% of the adults) received antivenom. The reason for this discrepancy remains unclear, because the indication for the administration of antivenom remains the same regardless of the age of the patient. However, the percentage of severe symptoms is comparable to other studies where the Poisoning Severity Score was used [16, 17]. Comparisons with studies using a different grading system are not feasible (for example [8, 25]). There was no difference in severity between adults and children, which was comparable to other studies [26, 27], so we suppose that factors other than age influence the outcome [27]. Yet some authors advocate a special paediatric regimen for snakebite [28]. The symptoms mostly presented as extensive regional swelling. However, severe anaphylactic reactions in 3% (seven patients, six adults and one teenager), with severe hypotension, tachycardia and angio-oedema, requiring rapid resuscitation were reported. *De-novo* anaphylactoid reactions have been described after snakebite possibly through autopharmacological effects [5].

Table 4:
Venom composition of *V. aspis* and *berus* (selection, adapted from [4, 14, 15]).

Venom component	Vipera aspis	Vipera berus
Kininogenase	x	x
Prothrombin-activating factor	x	x
Metalloproteinases (snake venom metalloproteinase, SVMP)[1]	x	x
Serine proteases (snake venom serine protease, SVSP)[1]	x	x
Hyaluronidases	x	x
Phospholipase A2 (PLA2)	x	x
Neurotoxic PLA2 (ammodytoxin A, B, C)[2]	x	-
Neurotoxic PLA2 (vaspin)[2]	x	-

[1] hematotoxic compound, [2] neurotoxic compound; the table shows a selection of compounds. In *V. aspis,* a total of 64 proteins were identified in transcriptomic and proteomic analyses [15]. *V. berus* venom has predominantly proteolytic, haemolytic and cytotoxic properties. Geographic venom variations occur within the species.

Treatment was mostly symptomatic with hydration, elevation of the bitten limb, analgesia and tetanus vaccination in accordance with the internal and international guidelines [9]. The use of acetylsalicylic acid should be discouraged owing to its possible haematological interference, and prophylactic antibiosis or manipulation of the wound is not recommended [9]. Clinical surveillance is recommended in asymptomatic patients for at least 3–6 hours [9]. There were three children treated with fasciotomy with suspected compartment syndrome, albeit without measurement of the intracompartmental pressure, but with (repeated) administration of antivenom in all three cases. The two adults with suspected compartment syndrome did not receive antivenom before fasciotomy. In current guidelines the necessity of repeated antivenom use and measurement of intracompartmental pressure before fasciotomy is stressed [19].

Antivenom was administered to 20% of the patients. Its local availability directs the choice of antivenom. In another study from the United Kingdom, similar criteria for antivenom administration were applied, i.e., mainly refractory hypotension, protracted severe gastrointestinal symptoms, rapid extension of oedema (also of mucosae), neurological symptoms and compartment syndrome [5, 23]. Overall, 4% of the patients in the current study required multiple doses of antivenom, which was consistent with an older study [16]. In yet another study, 20% of the patients required at least a second dose [29]. The reason for this difference remains unclear, as the proportion of children was comparable.

Our study is limited by the data and data collection within a Poison Centre and the self-reporting by the physicians to the centre. As information is voluntarily reported, some clinical details may be incomplete or specific data may be subjectively reported by doctors treating the patients. The retrospective design of the study and the lack of long-term follow-up are further limitations. Prolonged injuries, adverse effects or permanent disabilities could not be tracked. Moreover, not all bites might have been reported to our centre. Especially hospital physicians, who are familiar with indigenous snakebites in various areas of Switzerland, can judge the clinical symptoms and decide on symptomatic or specific treatment options and thus might not contact the Poison Centre. However, with regard to the small annual numbers, even the expertise in local hospitals might be very limited.

Conclusion

Our study is the largest study conducted in Switzerland concerning national data on snakebite, distribution of severity and administration of antivenom. Our data corrob-

orate the data of a previous study set in Switzerland in as much as half of the patients suffering a bite by an indigenous viper have an asymptomatic or mild clinical course, whereas the other half suffers from moderate or severe symptoms. There were no fatalities during the study period. In conclusion, we can say that although the situation in Switzerland can in no way compare to the massive global burden of morbidity and mortality caused by snakebite, even our indigenous vipers have the potential to cause relevant morbidity.

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Disclosure statement
All authors have completed and submitted the International Committee of Medical Journal Editors form for disclosure of potential conflicts of interest. No potential conflict of interest was disclosed.

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