

## ORIGINAL ARTICLE

# Most adder bites in Finland's Lake District caused mild symptoms and severe poisoning was rare

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**Abstract**

**Aim:** This study investigated the incidence, clinical picture and treatment of paediatric adder bites in Finland's Lake District.

**Methods:** Data were retrospectively collected on all children aged 0–15 years who were bitten by adders from 2006 to 2015 and treated at Tampere University Hospital. The severity was evaluated with the five-level Poisoning Severity Score.

**Results:** We found that 109 children were treated following an adder bite, which was an incidence of 13 per 100,000 children from 0 to 15. Of these, 75 were under 8 years of age, with a median age of 3.5 years, and 34 were 8–15 years, with a median age of 10.3 years. The gender distribution was similar in both ages. Younger children were more likely to be bitten in their yards at home, whereas older children were more likely to be bitten in a forest. Older children reported more pain than younger patients. Most children were bitten on a lower limb, with minor symptoms such as localised redness and swelling, and received conservative treatment. Antivenom treatment was rarely administered and then only in severe cases or if symptoms progressed.

**Conclusion:** Adder bites mostly caused mild symptoms, severe poisoning was rare and antivenom was rarely given.

**KEYWORDS**

adders, antivenom, poison, severity, snakebite

## 1 | INTRODUCTION

Adders are the most common poisonous snake in Europe and the only poisonous snakes in Finland. They can be found across the country, excluding its northernmost areas.<sup>1</sup> Adder bites are rare but may lead to critical conditions, especially in paediatric patients.<sup>2</sup> There are limited data about the incidence of adder bites, but it has been estimated that there are approximately 100 cases in Finland each year.<sup>3</sup>

The symptoms of an adder bite are, in most cases, localised and may include redness, pain, cyanosis and swelling.<sup>2,4</sup> However, in

some cases, a bite may lead to a more severe clinical picture, including vomiting, nausea, tachycardia and paleness. In the most severe cases, kidney failure or anaphylaxis is possible.<sup>4–6</sup> The location of the bite also plays a significant role, since bites to the face or neck may cause serious swelling of the respiratory system.<sup>7</sup> Bites to the upper body and in younger patients often lead to more severe cases, but otherwise, the factors associated with severe clinical pictures are poorly known.<sup>4</sup> Bites to the head are rare and adders mainly bite children on a lower or upper limb.<sup>4,6</sup>

The treatment for an adder bite is mostly based on observation, stabilising the child's vital functions and providing pain relief and

**Abbreviations:** IQR, interquartile range; PSS, poisoning severity score.

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intravenous fluids.<sup>8,9</sup> Corticosteroids and antibiotics are also used, but antivenom is the definitive treatment, although it only tends to be used in severe cases.<sup>2,9</sup> Symptoms often progress slowly and previous studies have indicated that the time from a bite to antivenom treatment varied from under 6 h to more than 24 h.<sup>2,6</sup> Paediatric patients are typically hospitalised and observed for at least 1 day.<sup>10</sup>

Previous studies have reported that antivenom treatment could decrease hospitalisation time and relieve pain. However, antivenom may also cause severe side effects, such as anaphylaxis. Therefore, it is crucial to understand the risks and benefits of that treatment.<sup>10,11</sup> At the moment, there are only limited data about the effectiveness of corticosteroid, antibiotic and antivenom treatments, which makes decision-making difficult. The severity of an adder bite can be classified with a validated Poisoning Severity Score (PSS), which can be used in hospitals to evaluate the need for antivenom treatment.<sup>12,13</sup> However, there have been reports where patients with severe symptoms, with a PSS score of 3, have not received antivenom.<sup>2</sup>

The aim of this study was to investigate the incidence of adder bites in children in Pirkanmaa, Finland, from 2006 to 2015, including the clinical picture and the use of antivenom and other treatments.

## 2 | MATERIALS AND METHODS

### 2.1 | Patients and study design

This retrospective study was conducted at Tampere University Hospital. Data were collected on all patients up to the age of 15, who were diagnosed with the International Classification of Diseases, 10th Revision code, T63.0, namely the toxic effect of snake venom, from 1 January 2006 to 31 December 2015. The data were collected from the medical records of 199 patients who received this diagnosis. The exclusion criteria were incorrect or unsure diagnoses, such as no clear bitemarks, and this meant that 109 were included patients in this study. We divided the patients in two groups, 0–7 years and 8–15 years, based on their age at the time of the bite. We did this because we wanted to compare the clinical picture and treatment of children who have not started school with schoolchildren. In Finland, children start school in the year that they have their seventh birthday. The data we collected included the children's age, sex and primary diseases and details of the bite and any treatment they received.

### 2.2 | Epidemiology

We also recorded where the bite occurred, for example, at a summer cottage, beach, forest or in a yard at home. Information on the location and type of bitemarks on the child was also collected, together with whether the snake was seen or not. We also recorded how long it took the children to present to the hospital after the bite. In Finland, non-prescription 50-mg hydrocortisone tablets are commonly available in pharmacies, although they are not officially

### Key Notes

- We investigated the incidence, clinical picture and treatment of paediatric adder bites in Finland's Lake District from 2006 to 2015 and analysed 109 cases aged 0–15 years.
- Most children were bitten on a lower limb, with minor symptoms such as localised redness and swelling, and older children reported more pain than younger patients.
- Antivenom treatment was rarely administered and then only in severe cases or if symptoms progressed.

recommended as first aid for adder bites. However, we did gather data about whether or not patients had taken them before arriving at the hospital.

### 2.3 | Symptoms and PSS scores

Data related to redness, cyanosis, swelling, diuresis and pain were collected. The severity of the poisoning was retrospectively graded using the PSS, which is based on several data points from 12 different organ systems. The PSS grades severity as 0 for asymptomatic, 1 for minor symptoms, 2 for moderate symptoms, 3 for severe symptoms and 4 for death.<sup>12</sup>

### 2.4 | Hospitalisation

We collected data on the hospitalisation times and the treatments: intravenous fluids, corticosteroids, antibiotics, analgesics and/or antivenom. The antivenom used in our hospital was ViperATAB (MicroPharm Limited).<sup>14</sup>

### 2.5 | Ethics

None of the patients in this retrospective study were contacted, as all data were drawn from existing medical files. The study did not require approval from the hospital's ethics committee, but the study protocol was approved by the Chief Medical Doctor of Tampere University Hospital. All the information in the analyses was anonymised. The patients' information was held by the Pirkanmaa Hospital District in line with the general data protection regulations.

### 2.6 | Statistical analysis

Statistical analyses were carried out with SPSS version 26 for Mac (IBM Corp). The results are presented as numbers with upper and lower quartiles. The study groups were compared using Pearson's

chi-square test and Fisher's exact test. The Mann–Whitney U test was used for non-parametric comparisons. Stepwise regression analyses were performed to evaluate factors that could have affected the PSS. A  $p$ -value of  $<0.05$  was considered statistically significant.

### 3 | RESULTS

Between 2006 and 2015, 109 children aged 0–15 years were treated at Tampere University Hospital following an adder bite, at a median age of 4.7 years. This was an annual incidence of 13 per 100,000 in this age group. Of these, 75 were 0–7 years, with a median age of 3.5 years and an incidence of 17 per 100,000. The other 34 were 8–15 years, with a median age of 10.3 years and an incidence of 8 per 100,000. Most of the snakebites occurred during the late spring or summer, from May to October (Figure 1).

The gender distribution was similar in both groups. There was a statistically significant difference between the groups with regard to where the bite happened ( $p = 0.012$ ). Children under 8 years of age were more likely to be bitten in their yard at home (51%), whereas children aged 8–15 years were more often bitten in the forest (50%). No statistically significant differences were observed about the time of the bite, the time it took to get to the hospital, the bite location or their visual observation of the snake. The median time spent in the hospital was 1 day in both groups. The bites mainly happened between 6 am and 6 pm. Most children reached the hospital within 5 h of the bite, but 13% presented 12 or more hours after the bite. Most children were bitten on the lower limbs, although children under 8 years of age were more likely to be bitten on the upper limb or body. Only two of the children were bitten more than once. (Table 1).

Patients over 8 years of age were more likely to report pain the younger children and this difference was statically significant. No differences were observed in redness, swelling, cyanosis or diuresis between the two groups. Furthermore, there were no statistically significant differences in the treatment provided for the groups and the laboratory findings were within age-specific reference ranges. Patients with moderate symptoms, indicated by a PSS score of 2,

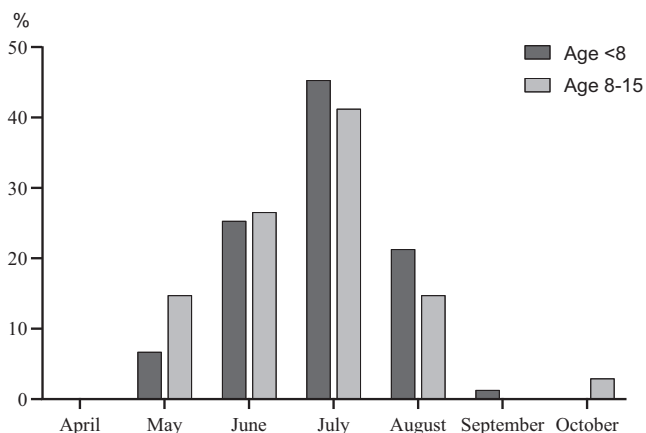


FIGURE 1 The months when the 109 paediatric patients were bitten by adders

had a significantly lower median haemoglobin value (91 vs. 124 g/L,  $p < 0.001$ ) and higher leucocyte values (23.3 vs. 8.85  $10^9/L$ ,  $p < 0.001$ ) than those with minor symptoms and PSS scores of 0 or 1, respectively. Antivenom and antihistamines were rarely used in either age group. Most patients, in both groups, were treated with intravenous fluids, corticosteroids and/or antibiotics. Fewer than half of the patients in both groups received analgesics (Table 2).

There was no significant difference between the groups in terms of the PSS scores. Most cases had scores of 1, indicating minor symptoms. Only three children had moderate symptoms and a PSS of 2 and all of them were under the age of 8 years. None of the patients had severe symptoms, defined as PSS 3, and none died (Table 3). Linear regression analyses were used to evaluate factors that could have affected the PSS. This showed that 21% of the variances in the PSS could be accounted for by three predictors (collectively  $F 3, 91 = 9.22, p < 0.001$ ). These PSSs were the number of leucocytes ( $\beta = 0.26, t = 2.64, p = 0.01$ ), local redness ( $\beta = 0.31, t = 3.16, p = 0.002$ ) and bruising or cyanosis ( $\beta = 0.32, t = 3.11, p = 0.003$ ).

### 4 | DISCUSSION

Most of the snakebites occurred during the late spring or summer, from May to October. This was to be expected because adders hibernate during the winter and are only active for a short time in southern Finland.<sup>1,15</sup> The annual incidence of 13 adder bites per 100,000 children aged 0–15 years was higher than in previous studies from Sweden and France. The higher incidence amongst younger children has also been reported by other studies.<sup>4,16</sup> Environmental factors and differences in adder populations amongst countries may partly explain these differences. In addition, children who are bitten by snakes in Finland are usually treated by hospitals, but there may be different practices in other countries.

Most of the patients in this study arrived at the hospital quickly, within 5 h of the bite, but 13% presented more than 12 h after they were bitten. This was often because their parents did not realise they had been bitten. These timescales were similar to other studies.<sup>6,8</sup> Young children may not be able to talk about the incident, whilst others tell quite colourful stories. In this study, most of the children were bitten on the lower leg, which was similar to other studies.<sup>2,6,8</sup> Only two of the children were bitten more than once. A 4-year-old child was bitten twice and presented with bitemarks on both legs and a PSS score one of 1, with no need for antivenom. The other was an 8-year-old child, who was bitten three times in the same upper limb and was given antivenom twice.

Children can face high risks for severe complications after a snakebite, due to their smaller body mass, and should receive low threshold observation in the hospital for at least of 24 h.<sup>17</sup> Most of the children in our study presented with minor symptoms, with PSS scores of 0 or 1, as in previous studies.<sup>2,8</sup> The clinical picture was also similar to other studies, with local oedema, redness and cyanosis and pain.<sup>2,8,16</sup> Children under the age of 8 reported significantly less frequent pain and were less likely to be treated with analgesics

**TABLE 1** Demographic data and epidemiology of envenomation for 109 paediatric snakebite patients

	<i>n</i>	Age 0–7	<i>n</i>	Age 8–15	<i>p</i> Value
Age, median (IQR), years	75	3.5 (2.3, 5.3)	34	10.3 (9.4, 13.1)	
Boys, %	40	53.3	20	58.8	0.593
Place where the bite happened %	75		34		0.012 (f)
Home yard		50.7		17.6	
Forest		29.3		50.0	
Field		2.7		5.9	
Beach		8.0		14.7	
Summer cottage		9.3		11.8	
Time of bite %	70		34		0.285
6 am–5.59 pm		80.0		70.6	
6 pm–5.59 am		20.0		29.4	
Time from bite to hospital %	71		34		0.605 (f)
<1 h		15.5		11.8	
1 to <2 h		25.4		29.4	
2 to <5 h		33.8		38.3	
5 to <12 h		8.4		14.7	
12 to <24 h		4.2		2.9	
>24 h		12.7		2.9	
Time in hospital, median (IQR), days	75	1 (1, 1)	33	1 (1, 2)	0.217
Bite location %	75		34		0.184 (f)
Upper limb		22.6		8.8	
Lower limb		72.0		91.2	
Body		2.7		0	
Several bite locations		2.7		0	
Snake seen	73		33		0.535 (f)
Yes		19.2		27.3	
No		76.7		66.6	
Unsure		4.1		6.1	

than those aged 8–15 years. The pain was mainly treated with paracetamol. The use of nonsteroidal anti-inflammatory drugs is commonly avoided in such cases, due to their potential nephrotoxicity and prothrombotic effects. However, nonsteroidal anti-inflammatory drugs do not tend to increase bleeding after snakebites.<sup>18</sup> It is harder for young children to express pain and this means, it is frequently under-recognised.<sup>19</sup> Clinicians need to evaluate pain carefully after snakebites, especially in younger children.

Life-threatening poisoning by adders is uncommon, but it can happen and may evolve over many hours. With this in mind, all children bitten by a snake should be monitored in hospital with access to critical care facilities and antivenom. The treatment for adder bites is mostly supportive. In our study, 79% of patients over the age of 8 received intravenous fluids, even though it is not generally recommended if there are no signs of hypovolemia, vomiting or nausea.<sup>20</sup> In addition, most of our patients received antibiotics and corticosteroids, which were also used in previous studies.<sup>2,5</sup> However, no evidence has been presented to back the use of antibiotic prophylaxis,

as these are only recommended if there are clinical signs of a wound infection.<sup>21,22</sup> There has also been a lack of conclusive evidence regarding the use of corticosteroids.<sup>9,16,23,24</sup> Corticosteroids are recommended for adder bites if there are allergic reactions against the antivenom, bronchospasm or serum sickness after venom administration.<sup>16</sup> Moderate to severe poisoning needs antivenom,<sup>2,9</sup> but most of the patients in our study had minor symptoms, only 4% received antivenom and they all made a good recovery. In previous studies, 5%–17% of paediatric patients received antivenom.<sup>2,4,5</sup> We did not observe any adverse effects of antivenom in our study and adverse effects were rare in previous reports.<sup>2,5,8</sup>

#### 4.1 | Strengths and limitations

The main strength of our study was the systematic collection of data from the children's medical records. However, there were also several limitations. We may not have identified all the children bitten by

TABLE 2 Symptoms and treatments amongst 109 paediatric snakebite patients

	Age 0–7 (n = 75)	Age 8–15 (n = 34)	p Value
Symptoms %			
Redness	60.0	44.1	0.123
Swelling	62.7	55.9	0.502
Cyanosis	22.7	38.2	0.092
Pain	22.7	41.2	0.047
Normal diuresis	98.7	97.1	0.529 (f)
Treatment %			
Antivenom	2.7	5.9	0.408
Intravenous fluid	68.0	79.4	0.221
Analgesic drug			
Paracetamol	25.3	41.2	0.095
Morphine	2.7	2.9	0.935
Antihistamine	6.7	8.8	0.703 (f)
Hydrocortisone	12.0	26.5	0.059
Other corticosteroids			
Intravenous/– muscular	65.3	67.6	0.813
Per oral	4.0	8.8	0.306
Antibiotics	57.3	52.9	0.669

TABLE 3 Poisoning severity scores of 109 paediatric snakebite patients

	Age 0–7 (n = 75)	Age 8–15 (n = 34)	p Value
PSS %			
0	13.3	14.7	0.722 (f)
1	82.7	85.3	
2	4.0	0	
3	0	0	
4	0	0	

adders, due to the use of incorrect diagnosis codes or some patients being treated by primary health care sites. Also, some of the data were not available from all patients. There may also have been inaccuracies in the PSS scoring because these were applied retrospectively based on data from the medical records.

## 5 | CONCLUSION

The incidence of adder bites amongst paediatric patients was higher in our study than in previous reports, particularly amongst children under the age of 8 years. Fortunately, adder bites only cause mild poisoning in children in most cases. Antivenom treatment was rarely needed and only given to patients whose symptoms progressed, despite supportive treatments. Most of the patients were treated with

antibiotics and corticosteroids, despite the lack of evidence for this approach. Hospital emergency departments need regularly updated clinical practice guidelines to ensure the optimal treatment of snakebites. PSS scores and clinical and laboratory findings may help clinicians to decide when to use antivenom and we plan to include this advice in our hospital's clinical practice guidelines for snakebites.

## CONFLICT OF INTEREST

The authors have no conflicts of interest to declare.

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