

## Cost Analysis of Snakebite Management in a Malaysian Tertiary Care Hospital

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### Abstract

**Introduction:** Snakebite is a common cause of morbidity and mortality worldwide. From 2010 to 2014, a total of 15,798 snakebite cases were reported in the country. However, the actual cost of managing snakebite is currently unknown.

**Objective:** This study aimed to estimate the cost of the management of snakebites in a tertiary care hospital in Kedah, Malaysia.

**Methods:** The cost analysis was conducted from the healthcare provider's perspective. An activity-based costing approach was used. Healthcare resources utilisation for managing patients with snake bites were obtained from the patients' medical record at Sultanah Bahiyah Hospital, Kedah in 2015. The costs were expressed in 2017 Malaysian Ringgit (RM).

**Results:** In 2015, 184 patients presented to the emergency department of HSB with snakebites. Of that, 131 patients were admitted for further treatment. Among the admitted patients, 50 patients received monovalent antivenom and 21 patients received polyvalent antivenom. The total cost involved in the management of snakebites was RM351,560.56 and the average cost of managing a snakebite patient in HSB was RM1,910.66. Medications made up the largest portion of the cost (36.25%). In the emergency department, the average cost for snakebite management was RM744.01 per patient while in the wards, the average cost was RM1,638.65. Among the patients who received antivenoms, the average treatment cost in patients who received polyvalent antivenoms (RM3,608.44) was 5.85% higher than the average treatment cost in patients who received monovalent antivenoms (RM3,408.88).

**Conclusion:** Our results highlighted considerable economic impact of snakebites management in the hospital. Further analysis on the outcome of the management with polyvalent and monovalent antivenom should be conducted to ensure the best management of snakebite envenoming.

**Keywords:** snakebite, antivenom, antivenin, cost analysis, economic

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### Introduction

Snakebite is a serious medical problem in Malaysia. According to the Ministry of Health Malaysia (MOH) Health Informatics Centre, the number of snakebites from year 2010 to 2014 was 15,798 cases. The number of deaths due to snakebites over the same period totalled to 16, averaging from three to four deaths per year. In addition, some venom has local necrotic effects that may cause prolonged morbidity or crippling deformity. In 2011, the state of Kedah recorded the highest incidents with 836 cases, and the state of Perak recorded the second highest with 576 cases (1), presumably associated with agricultural activities (2). Besides, a large proportion of their populations are living near snake habitat area such as villages near the forests.

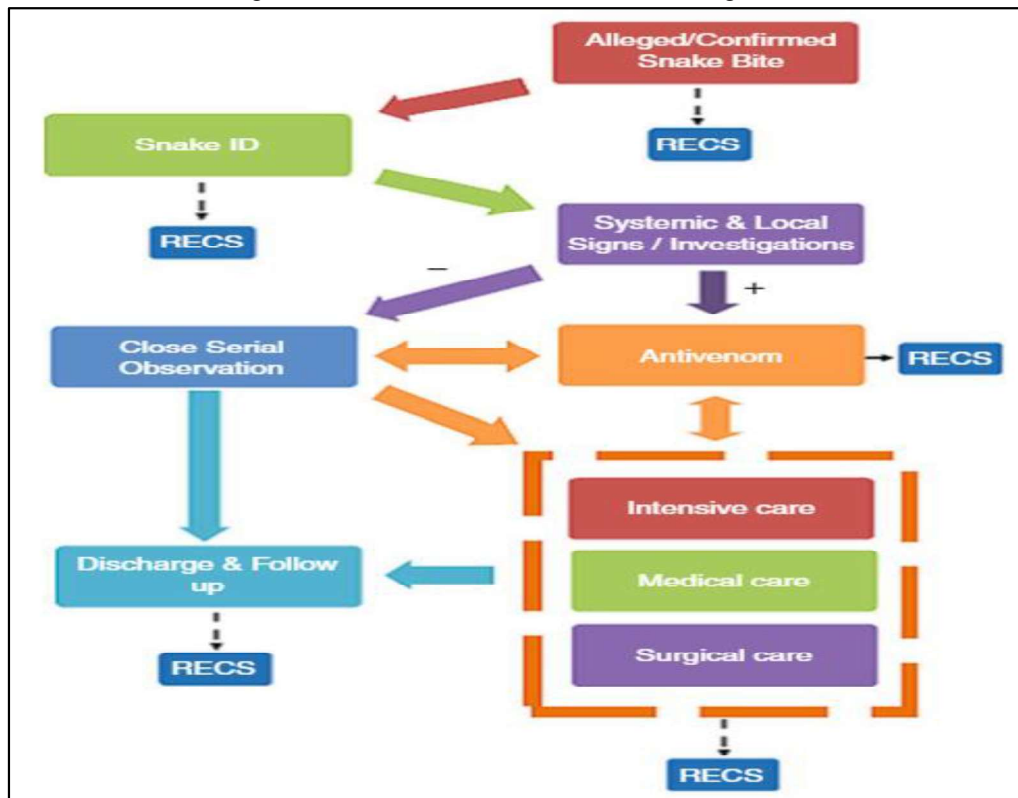
Snakebite management workflow was summarised in Figure 1. Snakebite patient who arrives at a medical centre will be reviewed in the critical zone of the emergency department. It is generally divided into general examination, wound examination, and examination for specific signs of envenoming. Therefore, all

unidentified snakebite patients, especially those without symptoms, must be admitted for serial monitoring and observation for at least 24hours. Management of snakebite is standardised for all healthcare facilities in Malaysia. In situations where expert consultation is required, the Remote Envenomation Consultation Services (RECS) is available. RECS was established in 2012 to provide 24-hour “on-call” consultation service for Malaysian healthcare providers (1).

The management of snakebite envenomation may range from outpatient treatment for mild cases to hospitalisation and treatment with antivenom for more severe cases. Antivenoms are effective in reducing mortality and remain as the mainstay of therapy in snakebites (3). There are specific systemic and local indications and strict protocol for antivenom administration (4,5). Antivenom administration should be based on the clinical and laboratory evidence and the severity of systemic and local envenomation. The choice of antivenom will depend on the snake identity. If the snake species can be positively identified, monovalent antivenom is preferable, and if the snake species could not be identified, polyvalent antivenom is recommended (1). Antivenoms are very expensive and their administration requires close patient monitoring. Few safety issues need to be considered when antivenom is used. There is a need for anaphylaxis protocol to be in place prior to the provision of antivenom and ventilation support should be made available (1).

In Sultanah Bahiyah Hospital, they are five types of antivenom for snakebite envenoming which are, antivenom polyvalent, hemato polyvalent, neuro polyvalent antivenom, cobra monovalent and Malayan pit viper monovalent. In the MOH healthcare facilities, the treatment costs are highly subsidised. To date, no study has addressed the treatment burden associated with snakebites and the cost of snakebite management. Given the potential financial implications associated with snakebite management, this study sought to examine the resource utilisation in the management of the snake bites from the perspective of MOH hospitals in Malaysia. Our objective was to estimate the cost of the management of the snakebites in a tertiary care hospital in Kedah, Malaysia. This information was hoped to draw policy maker’s attention to the financial burden of snakebite management and thus allocating more budget towards improving the care and management of snakebite victims.

Figure 1: The workflow of snakebite management



Source: Ismail 2015 (pp.81) (1)

Abbreviation: RCS - Remote Envenomation Consultation Services; ID – identity

**Methods**

Sultanah Bahiyah Hospital (HSB) is a tertiary care hospital located in the state of Kedah, one of the states with the highest number of snakebite cases in Malaysia. Most of the snakebites in the state will be referred to HSB due to its expertise. This study included all patients who visited the emergency department of HSB due to snakebites injuries in 2015 regardless of the ability to identify the identity of snake types and whether antivenoms were received.

The cost analysis was conducted from the MOH healthcare provider’s perspective. Activity-based costing method was used. Activities of the snakebite management starting from the point patients presented at the emergency department until discharge were recorded. The activities and healthcare resource utilisations in the snakebite management activities were identified retrospectively from the patient medical records and Electronic Hospital Information System (e-HIS). The resources consumed to manage antivenom-associated adverse drug reactions (ADR) were also included and costed. A data collection form was used to collect information about the main activities and resources consumption in snakebite management of every patient such as laboratory test, diagnostic test, consumables, fluid management, medication, length of hospitalisation, and other related activities. The data collection form was divided into three sections: Section A: Socio-demographic characteristics, Section B: Data for observation / emergency department management, and Section C: Data for inpatient management. The collected data was then cross-checked among data collectors to ensure the accuracy and completeness of the data.

The unit cost of the resource items were collected from the respective departments in HSB (Table 1). The costs were inflated to 2017 Malaysian Ringgit (RM) using gross domestic product (GDP) deflator. Data collected were analysed using Microsoft Excel.

Table 1: Resources consumed in snakebite management the sources of their unit costs

Category	Resource items	Source of unit cost data
Laboratory <sup>a</sup>	Vital signs	Pathology Department
	20-minute whole blood clotting factor	
	Full blood count (FBC)	
	Blood urea serum electrolytes (BUSE)	
	Liver function test	
Radiology Department	Coagulation profile (APTT/PT)	Radiology Department
	Computerised tomography (CT) Scan	
	X-ray	
Consumable Item <sup>a</sup>	Magnetic resonance imaging (MRI)	Pharmacy Department
	Branula	
	Nasal prong	
	Bladder irrigation	
	Oxygen face mask	
	Ice pack	
Medication <sup>a</sup>	Needle	Pharmacy Department
	Dextrose strip	
	Analgesic	
	Antivenom	
Fluid Management <sup>a</sup>	Antibiotic	Pharmacy Department
	Other medications	
	IV Normal saline (NS)	
	IV Dextrose (D5%)	
Hospitalisation <sup>b</sup>	IV 1/2NS D5%	Finance Department
	IV 1g potassium chloride (KCl)	
Other Interventions <sup>c</sup>	Ward charges (depends on the class of ward)	Finance Department
	Intervention charges (price stated by HSB)	Finance Department

<sup>a</sup> Cost = number of items consumed x unit cost; <sup>b</sup> Cost = cost per day x duration of stay; <sup>c</sup> Cost = cost per session x total number of sessions

Abbreviation: IV - intravenous

**Results**

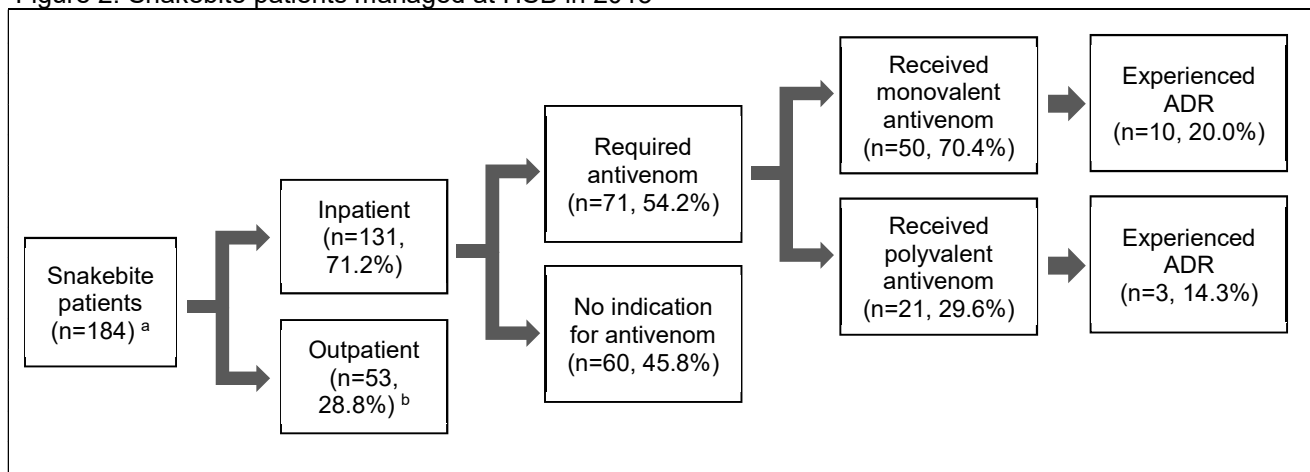
*Patient Demography*

In 2015, a total of 184 patients presented to the emergency department of HSB with a primary diagnosis of snakebites. The mean age of the patients was 39.35 years old (standard deviation (SD) 24.43 years, ranged from one to 86 years of age). The demographic characteristics of included patients were presented in Table 2. Most of them were Malay and lived in rural area. Slightly more than half of the patients (55.43%) were bitten by vipers and 16.85% were bitten by cobras. It was unable to identify the types of snake in 29.9% of the patients. The average duration of hospitalisation was one day (SD 0.29 days) in the emergency department and three days (SD 3.07 days) in the ward.

Table 2: Demographic data of snakebite patients (N = 184)

Variable	n (%)	Variable	n (%)
Gender		Marital status	
Male	121 (65.76)	Single	75 (40.76)
Female	63 (34.24)	Married	103 (55.98)
Ethnicity		Divorced / widowed	6 (3.26)
Malay	166 (90.22)	Type of snake	
Chinese	3 (1.63)	Viper	102 (55.43)
Indian	1 (0.54)	Cobra	31 (16.85)
Others	14 (7.61)	Unknown	55 (29.89)
Location		Bitten area	
Rural	152 (82.61)	Leg	100 (54.35)
Urban	32 (17.39)	Hand	76 (41.30)
Educational level		Abdomen	1 (0.54)
Primary	49 (26.63)	Head	1 (0.54)
Secondary	75 (40.76)	Wrist	1 (0.54)
No formal education	43 (23.37)	Buttock	1 (0.54)
College	13 (7.07)	Not available	4 (2.17)
Not available	4 (2.17)		

Figure 2: Snakebite patients managed at HSB in 2015



<sup>a</sup> patients with snakebites presented in the emergency department, <sup>b</sup> managed in the emergency department  
Abbreviation: ADR - adverse drug reaction

*Antivenom for Snakebite Envenoming*

Of the 184 patients with snakebite, 131 patients were admitted to the hospital for further treatment and observation, while the other 53 patients were managed in the emergency department as outpatient (Figure 2). Among the admitted patients, 71 of them received antivenom after confirming the specific systemic and local symptoms and fulfilled the protocol for antivenom administration. Another 60 patients were admitted for observation and monitoring as there was no indication for antivenom. 50 patients received monovalent antivenom and 21 patients received polyvalent antivenom. Polyvalent antivenoms were given to the patients when it was unable to identify the types of snakebite based on the haematological or neurological symptoms.

Among these patients, ADRs occurred in 20.0% and 14.3% in the patients who received monovalent antivenom and polyvalent antivenom respectively. The cost of managing the adverse effects of antivenom was also included in the cost analysis.

**Cost Analysis**

The total cost involved in the management of snakebites in HSB in 2015 was RM351,560.56 (2017 RM) and the average cost of managing a snakebite patient in HSB was RM1,910.66 (Table 3). Medications (36.25%) made up the largest portion of the cost, followed by hospital stay cost (29.33%) and laboratory cost (25.59%). When the costs were broken down, it was found that the cost incurred in the inpatient was more than two folds compared to the emergency department. In the emergency department, the average cost was RM744.01 per patient while in the wards, the average cost was RM1,638.65 per patient. Among the patients who received antivenoms, the average treatment cost in patients who received polyvalent antivenoms was 5.85% higher than the average treatment cost in patients who received monovalent antivenoms (Table 4).

Table 3: Estimation of cost of snakebite management in HSB

Category	Emergency department (RM) (n=184)	Inpatient (RM) (n=131)	Average cost per patient (RM) (n=184)	Percentage (%)
Laboratory	47,481.00	42,500.00	489.03	25.59
Consumable item	9,870.34	4,479.30	77.99	4.08
Medication	79,337.76	48,095.99	692.57	36.25
Fluid management	208.97	291.20	2.72	0.14
Hospitalisation	0	10,3100.00	560.33	29.33
Other interventions	0	16,196.00	88.02	4.61
<b>Total cost</b>	<b>136,898.07</b>	<b>214,662.49</b>		
<b>Average cost</b>	<b>744.01</b>	<b>1,638.65</b>	<b>1,910.66</b>	

Table 4: Cost of snakebite management in patients who received antivenoms

Category	Monovalent antivenom (RM) (n=50)	Polyvalent antivenom (RM) (n=21)
Laboratory	582.54	649.76
Consumable item	108.00	110.00
Medication	1,805.26	1,803.83
Fluid management	5.40	4.85
Hospitalisation	808.00	788.57
Other interventions	99.68	251.43
<b>Total cost</b>	<b>3,408.88</b>	<b>3,608.44</b>

**Discussion**

Snakebite is not a notifiable disease in Malaysia. Therefore, the reported data about snakebites may not be accurate and it should not be assumed that snakebite is uncommon or treated as an unimportant medical issue in Malaysia. Existing literature and our study highlighted the significant burden of snakebites and envenomation (1). In this study, we found 184 cases of snakebite injuries within one year in Sultanah Bahiyah Hospital. Of these, more than half of the cases involved venomous species and were indicated for antivenoms. This finding was higher compared to previous study. It has been reported that less than 50% of cases were venomous snakebites which resulted in envenoming (12,13). However, one study conducted in India found 67% of the bites were suspected to be caused by venomous snakes and were treated with polyvalent or monovalent antivenoms (13). This may be due to the expertise of the healthcare facility itself. The higher incidence of snake envenoming in HSB could be due to its expertise in identifying the signs and symptoms of envenomation and most of the cases involved with snakebite in the state of Kedah were referred to HSB.

Snakebite antivenom, with their expensive price tags, could affect the overall cost of the treatment in the hospital setting. The findings of this study showed that medications, at RM692.57 per patient, made up the largest portion of the cost of managing snakebites in a tertiary care hospital, followed by hospitalisation cost and cost of laboratory tests. The cost for antivenom for one patient was between RM360– RM5,390. Previous studies reported the cost of antivenom for one patient varies widely, between RM18 and RM517 (3,13). Our finding is considered high as the antivenoms available in Malaysia were imported mainly from Thailand.

The average cost of treatment in patients treated with polyvalent antivenom was 5.85% higher than the treatment cost in patients who received monovalent antivenom. This was mainly due to the higher costs in hospital stay and other interventions among patients treated with polyvalent anti-venom. Even though the cost per patient for those received monovalent antivenom is lower compared to those received polyvalent antivenom, the incident of ADR in monovalent group was higher (Figure 2). ADR related to antivenom is a common issue. It can happen immediately, for example anaphylactic reaction, or late, which are usually mild, after the administration of antivenom. Previous study reported incidence of ADRs associated with antivenom varied widely, between 3% and 54% (12,13). In our study, 18.3% of the patients who received antivenom developed an ADR. Of these, two cases developed anaphylactic reaction and the others experienced skin reactions such as urticaria rash and itchiness, and epigastric pain. Our observed ADR rate among patients treated with polyvalent antivenom was 14.3% and this was lower than previously published rates (8-10).

The management of patients with snakebite involved both the emergency department and inpatient wards. Inpatients admission rate in this study was 71.2% and this was higher compared to the data from the National Electronic Injury Surveillance System – All Injury Program (NEISS-AIP) in the United States which identified that 1.8% of the patients were admitted as inpatients whereas National Emergency Department Sample (NEDS) data from 2006 to 2008 reported an inpatient admission rate of 4.4% (10). This might be due to severity of the case that needs multiple interventions in the management of snakebite in our study population. Based on our results, treatment cost in the inpatient was more expensive compared to the emergency department. Nevertheless, since antivenoms were mainly administered in the emergency department, the total cost of antivenom was higher in the emergency department. However, because of the factor of the length of hospital stay and the use of other drugs and laboratory testing, the inpatient average cost was higher compared to the emergency department.

The cost of managing snakebite cases may be minimised by getting the correct information when the patient arrives at the emergency department. Critical information, such as body area bitten, the time of incident and the activity at the time of the incident, the geographical location of the snakebite, the identity or description of the snake, intervention done after the bite, eyewitness to the incident, and any signs and symptoms felt by the patient since the incident, are important for the diagnosis and correct treatment of snakebites. History of previous contact with the snakes (nonvenomous and venomous), previous bite and envenoming incident, and the history of allergy and comorbidities may also be helpful in choosing the correct management especially to choose between monovalent or polyvalent antivenom (1).

The main limitation of this study was that cost estimation was based on healthcare provider's perspective. Therefore, patients' perspective such as their loss in their daily income during their stay in the hospital was not taken into account. Besides, this study was conducted retrospectively, hence it had the potential of missing or conflicting data and some needed variables were not in the records, thus may affect the results.

## Conclusion

In Sultanah Bahiyah Hospital, there were 184 cases of snakebites in year 2015. More than one third of the cases involved venomous species and required antivenom treatment. The cost analysis showed that the estimated average cost of the snake bite management per patient was RM1,910.66 and the cost of medication constitutes the highest portion of the costs, followed by the cost of hospital stay and laboratory tests. It was more expensive to manage patients in the hospital inpatient setting compared to the management in the emergency department. The average cost for patients treated with monovalent antivenom was slightly lower compared to patients who received polyvalent antivenom. Critical information of the snakebite such as type of snake or location of the snakebite may help to decide the correct snakebite management thus minimising the cost of snakebite management.

Our results reported the considerable economic impact of snakebites management. This may help to draw the policy maker's attention to improve the budget allocation towards improving the patient care and management of snakebite envenomation. We recommend that antivenom should be given only under close medical supervision with full resuscitation facilities readily available, and that reassessment of the indications for antivenom use is warranted. Further analysis on outcome of the management with polyvalent and monovalent antivenom should be conducted to ensure the best management of snakebite envenoming.



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### Conflict of Interest Statement

No external funding was received and the authors declared no conflict of interest.

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