

Assessment of knowledge about snakebite management among healthcare providers in the provincial and two district hospitals in Savannakhet Province, Lao PDR

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ABSTRACT

Snakebite is a neglected condition and a common public health problem in Lao People's Democratic Republic (Lao PDR), with a high incidence of up to 1,105 cases per 100,000 persons per year. Snakebite patients with systemic envenoming do not receive effective treatment at local health facilities. Healthcare providers have only limited knowledge in assessing and providing the correct treatment for venomous snakebites. A cross-sectional study was conducted among 119 healthcare providers in Savannakhet Province, Lao PDR, with respect to their socio-demographic characteristics, knowledge of snake identification, and management of snakebite. Data was analyzed using SPSS. Logistic regression was performed to estimate the odds ratios (OR) and 95% confidence intervals (CI) of adequate knowledge for treating snakebites among the healthcare providers. Among 119 participants, 27.7% and 45.4% had an adequate knowledge of snake identification and management of snakebites, respectively. Approximately 59% could correctly identify symptoms of envenomation, and 19.3% expressed confidence in treating snakebites. Study participants who had received training achieved significantly better snake identification results compared to those without training, with an OR of 2.54 (95% CI: 1.02–6.28). In particular, physicians achieved significantly better results compared to nurses in knowing how to manage snakebites, with an OR of 2.31 (95% CI: 1.04–5.12). Given the level of inadequate knowledge of snakebite management among healthcare providers in the province, more training in snakebite management is needed. University and Health Science Colleges should include snakebite management into the curriculum, to ensure that medical graduates have the appropriate knowledge and skills to treat snakebites.

Keywords: knowledge, assessment, venomous snakebite, Savannakhet, Lao PDR

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INTRODUCTION

Lao People's Democratic Republic (Lao PDR) is a landlocked country between China, Myanmar, Vietnam, Cambodia, and Thailand. Approximately 6.5 million people live within 236,800

Received: September 16, 2016; accepted: April 20, 2017

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square kilometers, with a population density of 27 inhabitants per square kilometer.¹⁾ According to the World Bank, Lao PDR belongs to a group of lower middle income countries, but it is also in the list of 48 least developed countries.²⁾ The World Health Organization (WHO) has declared that snakebite is one of the most neglected tropical diseases.³⁾ In Asian countries, snakebite is a particularly important public health issue in poor tropical rural communities.⁴⁻⁶⁾

To date, 124 different snake species have been found in Laos, of which six venomous snake species are considered medically significant. These venomous snakes include both members of the viper group; the Malayan pit viper (*Calloselasma rhodostoma*), and; the green pit viper (*Trimeresurus albolabris*, *Tr. macrops*, *Tr. popeiorum*), as well as members of the elapid group: the common and spitting cobras (*Naja kaouthia*, *Naja siamensis*); the king cobra (*Ophiophagus Hannah*); the Malayan krait (*Bungarus candidus*), and; the banded krait (*Bungarus fasciatus*).^{7,8)} Envenomation from the viper group is mainly hematotoxic, while that from the elapid group is mainly neurotoxic. Envenomation can lead to further disease with high risks of morbidity and mortality.⁹⁾

Besides having a prolific snake fauna, Laos has a tropical climate, and approximately 70% of the population earn their living in agriculture, such as wet rice farming, on rubber plantations, or in cassava, banana, and watermelon production. Approximately 25% of the population live below the poverty line.¹⁾ These circumstances all favor an increased incidence of snakebites, which recent epidemiologic studies have confirmed has been the case in Savannakhet Province in Southern Laos, with up to 1,105 snakebites per 100,000 people per year.¹⁰⁾ Since Lao PDR does not record cause of death on death certificates, there are no mortality figures to determine mortality rates due to snakebites.

Although many snakebites occur at the local community level, very few cases are treated in provincial and district hospitals. A retrospective study on venomous snakebites in Vientiane Province, in central Laos, reported only 21 snakebite patients admitted to the provincial hospital over a period of 18 months.⁸⁾ In Savannakhet Province, there were only 26 snakebite patients treated in provincial and district hospitals in 2012. It appears that few snakebite victims approach hospitals, for which there are several possible reasons. First, there is a strong belief among local people in the value and benefit of traditional treatment, and snakebite victims often visit traditional healers or practice self-treatment in their villages. This has been demonstrated by a knowledge, attitude, and practice (KAP) survey performed in Champhone District, Savannakhet Province in 2013. Secondly, transport infrastructure is underdeveloped and it is difficult for people to reach a hospital from remote villages. Finally, many people cannot afford treatment costs.¹¹⁾

Furthermore, in treating and managing snakebites victims, it can be difficult to identify precisely the venomous snake species involved, because of the overlapping clinical symptoms of envenomation.^{12,13)} In conjunction with this, a further important contributing factor to snakebite morbidity and mortality, particularly in sub-Saharan Africa and parts of Asia, is the limited set of antivenom and management skills.¹⁴⁾

It is likely that the most important reason for limited attendance at hospitals is that snakebite patients with systemic envenoming do not get effective treatment in the local health facilities. Antivenom is not available there, and thus healthcare personnel have no experience in its use. Venomous snakebite management is not yet taught at the medical university in Laos, and medical knowledge on how to treat snakebites appears inadequate.

However, treating snakebites does not require sophisticated laboratory tests or medical equipment; it requires only antivenom, essential drugs, and a good knowledge of assessing and treating snakebite patients, which are the key factors in successfully treating snakebites. The introduction of antivenom at Savannakhet Provincial Hospital, and continuous training of their medical personnel, led to an increased number of snakebite patients treated at the hospital, from 4 in 2012,

to 158 between July 2013 and December 2015.¹⁵ This outcome highlights the importance of two key factors in treating snakebites, namely the availability of antivenom and the presence of trained personnel. The present cross-sectional study evaluates the level of knowledge possessed by healthcare providers on venomous snakes in Laos, and on the management of snakebite patients at Savannakhet Provincial Hospital and two district hospitals (DHs) in the eastern part of Savannakhet Province.

MATERIALS AND METHODS

Study design and study sites

A cross-sectional survey was carried out from August to September 2015, to assess the level of knowledge existing about venomous snakes and in the management of snakebite, among healthcare providers in 2 district hospitals (DHs) in Phine and Sepon District and in Savannakhet Provincial Hospital in Savannakhet Province, Lao PDR. Savannakhet Province was selected because a recent survey had recorded a high incidence of snakebites in this region.¹⁰ Savannakhet Province consists of 15 districts with 187 health facilities, including one provincial hospital and 14 DHs. The province has 132,301 households with 969,700 inhabitants, of whom women represent 50.4%. The literacy rate of the population aged fifteen and above is 68%. About 80% of the population live in rural areas. The main source of income for people living in rural areas derives from small-scale agricultural activities. Sepon District is located 196 km east of the Savannakhet provincial capital. The district covers 2,580 square kilometers, with 88 villages and 56,100 inhabitants. Phine District is located 161 km east of the Savannakhet provincial capital and shares a border with Sepon District. The district covers 3,434 square kilometers, with 100 villages and 65,100 inhabitants. A village is considered poor if more than 50% of households are living under 1.90 US dollar per day; in these districts, approximately 40% of villages are poor according to this criterion. Both districts are principally mountainous, and approximately 50% of the villages in the two districts do not have electricity.¹¹ There are two types of DHs in Savannakhet Province: type A and type B. Sepon DH is a type A hospital with 30 beds and provides a higher level of care, with anesthesiology and basic general surgery alongside gynecology and obstetrics, internal medicine and pediatrics. Phine DH is a type B hospital, with 15 beds where only minor surgery, basic gynecology and obstetrics, internal medicine and pediatrics available. Convenience sampling was used for this study. Also for this study, Savannakhet Provincial Hospital has been defined as an urban hospital, while Phine and Sepon District Hospitals have been defined as rural hospitals, based on their geographical location and the local population size.

Questionnaire

The questionnaire consisted of two parts. The first part focused on socio-demographic characteristics of the respondents, including age, sex, education, place of work, and working experience. The second part of the questionnaire consisted of 23 multiple choice questions with a single correct answer, including questions about two case scenarios. The questionnaire covered knowledge in identifying snake species, snake venom effects, first aid after snakebites, the treatment of snakebite patients including antivenom administration, and the side effects of antivenom.

The questionnaire was based on WHO guidelines for the treatment of venomous snakebites in Southeast Asia,¹⁶ recent publications on snake fauna in Lao PDR,⁷ and personal patient care experiences at Savannakhet Provincial Hospital.

Study population, sample size and data collection

A total of 119 healthcare providers out of 132 were included into the survey, with 13 excluded. The respondents numbered 30, 21, and 68 from Sepon, Phine, and Savannakhet Hospitals, respectively. The data were collected using face-to-face interviews. Each interviewee was informed about the purpose of the survey and gave written informed consent before answering the questionnaire. External assistance from the internet, books, or other colleagues was not allowed, and the time limit for the questionnaire was 30 minutes per respondent.

Data entry and Analysis

Data from the questionnaires were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) for windows, version 22.0 software (SPSS Inc., Illinois, USA). Descriptive statistics analyses were performed to describe frequencies, percentages, mean, and standard deviations for socio-demographic characteristics. To evaluate the level of knowledge, a knowledge score was assigned by giving “1” for a correct answer and “0” for an incorrect answer for each of the 23 questions. The total score was calculated for each respondent with a score from 0 to 23. The questions were divided into two thematic areas. Eight questions covered snake identification and 15 questions covered snakebite management. Adequate knowledge was defined as giving correct answers to more than 80% of the questions in each thematic area, corresponding to more than 6 out of 8 questions about snake identification and more than 12 out of 15 questions about snakebite management. Logistic regression analysis was used to estimate odds ratios (ORs) and 95% confidence intervals (CI) of adequate knowledge for treating snakebites among the healthcare providers. A p-value of less than 0.05 was considered statistically significant.

Ethical clearance

Approval for this study was obtained from the National Ethical Committee for Health Research at the National Institute of Public Health in Vientiane, Ministry of Health, Lao PDR. Permission to collect data in this area was also approved by the board of directors at Savannakhet Provincial Health Department. All participants were informed about the purpose of the study and were assured that their responses would be treated anonymously and confidentially. Written informed consent was obtained from all participants and they were free to withdraw from this study at any time without prejudice.

RESULTS

Background characteristics of healthcare providers from rural and urban hospitals

Of the 119 healthcare providers (herein after referred to as “study participants”) who took part in this study, 68 (57.1%) were from the urban hospital and 51 (42.9%) from the rural hospitals, as shown in Table 1. Most of them were female (n=87, 73.1%). The mean age (\pm SD) of the study participants was 37.0 (\pm 10.9), ranging from 22 to 56 years. Sixty-two (52.1%) study participants belonged to the 20 to 35-year age group, 36 (30.3%) were aged between 36 to 50 years and 21 (17.6%) were aged over 50 years. More than half were physicians (n=62, 52.1%), while 57 (47.9%) were nurses. In terms of experience among the study participants, 62 (52.1%) had less than 10 years, 18 (15.1%) had 10 to 20 years, and 39 (32.8%) had more than 20 years. The majority, 79 (66.4%), had never received training about snakebite management, while 40 (33.6%) reported that they had received training. Nearly half study participants 57 (47.9%) reported experience in treating snakebite patients, and 23 (19.3%) answered that they felt confident in treating snakebite patients.

Table 1 Characteristics of study participants from rural and urban hospitals

Characteristics	Rural (n=51) ^{a)}		Urban (n=68) ^{b)}		Total (n=119)	
	n	%	n	%	n	%
Gender						
Male	11	21.6	21	30.9	32	26.9
Female	40	78.4	47	69.1	87	73.1
Age (years)						
20–35	30	58.8	32	47.1	62	52.1
36–50	13	25.5	23	33.8	36	30.3
>50	8	15.7	13	19.1	21	17.6
Profession						
Nurse	25	49.0	32	47.1	57	47.9
Physician	26	51.0	36	52.9	62	52.1
Working experience (years)						
<10	32	62.8	30	44.1	62	52.1
10–20	4	7.8	14	20.6	18	15.1
>20	15	29.4	24	35.3	39	32.8
Training received						
No	34	66.7	45	66.2	79	66.4
Yes	17	33.3	23	33.8	40	33.6
Treatment experience						
No	36	70.6	26	38.2	62	52.1
Yes	15	29.4	42	61.8	57	47.9
Confidence to treat snakebite patient						
No	51	100.0	45	80.7	96	80.7
Yes	0	0.0	23	19.3	23	19.3

^{a)} The rural hospitals were Sepon Hospital (n=30) and Phine Hospital (n=21)

^{b)} The urban hospital was Savannakhet Provincial Hospital (n=68)

Knowledge regarding envenomation symptoms and providing treatment following snakebite

Seventy-one study participants (59.7%) correctly answered the question as to whether a coagulation disorder is a symptom of envenomation following green pit viper (GPV) and Malayan pit viper (MPV) bites, and 72 participants (60.5%) correctly answered that muscle paralysis with respiratory failure is a symptom of envenomation following cobra and krait bites. Ninety-seven participants (81.5%) correctly answered that ptosis is a sign of muscle paralysis and a criterion for antivenom administration, and 70 participants (58.8%) knew that there is no local sign following krait bites. Most study participants correctly answered that incision, suction, and massage of the bite site, the application of tourniquets, and intramuscular injection of analgesics, are not recom-

Table 2 Knowledge of study participants in correctly answering questions regarding symptoms of envenomation and first aid management

Knowledge of study participant	Rural (n=51) ^{a)}		Urban (n=68) ^{b)}		Total (n=119)	
	n	%	n	%	n	%
Symptoms of envenomation						
Coagulation disorder is a symptom envenomation after GPV ^{c)} and MPV ^{d)} bite	26	51.0	45	66.2	71	59.7
Muscle paralysis with respiratory failure is a symptom of envenomation after cobra or krait bites	35	68.8	37	54.4	72	60.5
Ptosis is a sign of muscle paralysis and criterion for antivenom administration	42	82.4	55	80.9	97	81.5
Local signs are minimal or absent after krait bites	39	76.5	31	45.6	70	58.8
First aid management						
Incision of the bite site should not be performed for first aid	49	96.1	65	95.6	114	95.8
Tourniquet method should not be performed for first aid	47	92.2	59	86.8	106	89.1
Immobilization of the victim and the bitten limb should be performed for first aid	49	96.1	56	82.4	105	88.2
Suction of the bite site should not be performed for first aid	49	96.1	66	97.1	115	96.6
Massage of the bite site should not be performed for first aid	48	94.1	68	100	116	97.5
Intramuscular injection of analgesics should not be performed for first aid	37	72.5	54	79.4	91	76.5

^{a)} The rural hospitals were Sepon Hospital (n=30) and Phine Hospital (n=21)

^{b)} The urban hospital was Savannakhet Provincial Hospital (n=68)

^{c)} GPV, Green pit viper.

^{d)} MPV, Malayan pit viper.

mended as treatment for snakebite patients. One hundred and five participants (88.2%) answered correctly that immobilization of the victim and the bitten limb, and transport to the nearest health facility as fast as possible, are the correct treatment procedures following snakebites (Table 2).

Knowledge regarding antivenom, its side effects, and the treatment of side effects

Ninety-nine participants (83.2%) knew that intravenous injection is the appropriate route for antivenom administration, and 98 participants (82.4%) knew that anaphylactic shock is the most serious side effect of antivenom. One hundred and eight participants (90.8%) correctly answered that adrenaline is the drug of choice for the treatment of an anaphylactic shock, 5 (4.2%) would use antihistamine, 4 (3.3%) prednisolone and 2 (1.7%) benzodiazepam as the first drug of choice for an anaphylactic reaction.

Knowledge regarding snake identification and the management of snakebites in relation to different characteristics

Eighty-six participants (72.3%) had an inadequate knowledge regarding snake identification.

Knowledge in relation to the management of snakebite patients was inadequate for 65 participants (54.6%). Inadequate knowledge characterized all groups, with the exception of those belonging to the 50 years or more age group, the physician group, the group who had received training, and the group who declared confidence in treating snakebites: 13 (61.9%), 34 (54.8%), 21 (52.5%) and 14 (60.9%), respectively (Table 3).

Table 3 Adequate and inadequate knowledge of study participants in snake identification and management of snakebites with regard to different characteristics (n=119)

Characteristics	Knowledge of snake identification				Knowledge of management of snakebites			
	Inadequate		Adequate		Inadequate		Adequate	
	n	%	n	%	n	%	n	%
Gender								
Male	25	78.1	7	21.9	20	62.5	12	37.5
Female	61	70.1	26	29.9	45	57.7	42	48.3
Age (years)								
20–35	46	74.2	16	25.8	38	61.3	24	38.7
36–50	24	66.7	12	33.3	19	52.8	17	47.2
>50	16	76.2	5	23.8	8	38.1	13	61.9
Hospital location								
Rural	42	82.4	9	17.6	28	54.9	23	45.1
Urban	44	64.7	24	35.3	37	54.4	31	45.6
Profession								
Nurse	45	78.9	12	21.1	37	64.9	20	35.1
Physician	41	66.1	21	33.9	28	45.2	34	54.8
Working experience (years)								
<10	45	72.6	17	27.4	35	56.5	27	43.5
10–20	11	61.1	7	38.9	9	50.0	9	50.0
>20	30	76.9	9	23.1	21	53.8	18	46.2
Training received								
No	63	79.7	16	20.3	46	58.2	33	41.8
Yes	23	57.5	17	42.5	19	47.5	21	52.5
Treatment experience								
No	46	74.2	16	25.8	35	56.5	27	43.5
Yes	40	70.2	17	29.8	30	52.6	27	47.4
Confidence to treat snakebite patient								
No	74	77.1	22	22.9	56	58.3	40	41.7
Yes	12	52.2	11	47.8	9	39.1	14	60.9

Odds ratio of knowledge regarding snake identification in relation to different characteristics

As shown in Table 4, an unadjusted analysis showed a significant association between an adequate knowledge of snake identification, hospital location, training received, and confidence to treat a snakebite patient. However, after mutually adjusting for hospital location, profession, training received, experience in providing treatment and confidence to treat a snakebite patient, no significance was observed except for the group of those who had received training. Study participants with training had significantly better knowledge of snake identification compared to

Table 4 Odds ratio (OR) and 95% confidence interval (CI) of adequate knowledge on snake identification for the characteristics of study participants (n=119)

Characteristics	Adequate n (%)	Unadjusted			Adjusted ^{a)}		
		OR	95% CI	P-value	OR	95% CI	P-value
Gender							
Male	7 (21.9)	1	Reference				
Female	26 (29.9)	1.52	0.58–3.98	0.389	–	–	–
Age (years)							
20–35	16 (25.8)	1	Reference				
36–50	12 (33.3)	1.43	0.58–3.52	0.428	–	–	–
>50	5 (23.8)	0.89	0.28–2.84	0.856	–	–	–
Hospital location							
Rural	9 (17.6)	1	Reference		1	Reference	
Urban	24 (35.3)	2.54	1.06–6.10	0.036	2.42	0.87–6.70	0.089
Profession							
Nurse	12 (21.1)	1	Reference		1	Reference	
Physician	21 (33.9)	1.92	0.84–4.28	0.121	1.81	0.74–4.45	0.193
Working experience (years)							
<10	17 (27.4)	1	Reference				
10–20	7 (38.9)	1.68	0.56–5.05	0.353	–	–	–
>20	9 (23.1)	0.79	0.31–2.01	0.627	–	–	–
Training received							
No	16 (20.3)	1	Reference		1	Reference	1
Yes	17 (42.5)	2.91	1.26–6.69	0.012	2.54	1.02–6.28	0.043
Treatment experience							
No	16 (25.8)	1	Reference		1	Reference	1
Yes	17 (29.8)	1.22	0.54–2.72	0.625	0.52	0.18–1.49	0.225
Confidence to treat snakebite patient							
No	22 (22.9)	1	Reference		1	Reference	
Yes	11 (47.8)	3.08	1.19–7.94	0.020	2.26	0.63–8.09	0.210

^{a)} Adjusted mutually for hospital location, profession, training received, treatment experience and confidence to treat snakebite patient.

those without training (adjusted OR=2.54, 95% CI: 1.02–6.28, $p=0.043$).

Odds ratios of knowledge regarding the management of snakebite patients in relation to different characteristics

Knowledge regarding the management of snakebite patients was significantly higher among the group of physicians compared to the group of nurses, after mutual adjustment for hospital location, profession, training received, experience in providing treatment, and confidence to treat snakebite patients; adjusted OR=2.31, 95% CI: 1.04–5.12, $p=0.038$ (Table 5). The adjusted OR

Table 5 Odds ratio (OR) and 95% confidence interval (CI) of adequate knowledge on snakebite management for the characteristics of study participants (n=119)

Characteristics	Adequate n (%)	Unadjusted			Adjusted ^{a)}		
		OR	95% CI	P-value	OR	95% CI	P-value
Gender							
Male	12 (37.5)	1	Reference				
Female	42 (48.3)	1.55	0.67–3.56	0.297	–	–	–
Age (years)							
20–35	24 (38.7)	1	Reference				
36–50	17 (47.2)	1.41	0.61–3.25	0.411	–	–	–
>50	13 (61.9)	2.57	0.92–7.12	0.069	–	–	–
Hospital location							
Rural	23 (45.1)	1	Reference		1	Reference	
Urban	31 (45.6)	1.02	0.49–2.11	0.958	0.79	0.33–1.84	0.587
Profession							
Nurse	20 (35.1)	1	Reference		1	Reference	
Physician	34 (54.8)	2.24	1.07–4.70	0.032	2.31	1.04–5.12	0.038
Working experience (years)							
<10	27 (43.5)	1	Reference				
10–20	9 (50.0)	1.29	0.45–3.71	0.629	–	–	–
>20	18 (46.2)	1.11	0.49–2.48	0.798	–	–	–
Training received							
No	33 (41.8)	1	Reference		1	Reference	
Yes	21 (52.5)	1.54	0.71–3.31	0.268	1.11	0.48–2.56	0.793
Treatment experience							
No	27 (43.5)	1	Reference		1	Reference	1
Yes	27 (47.4)	1.16	0.56–2.41	0.676	0.68	0.27–1.66	0.400
Confidence to treat snakebite patient							
No	40 (41.7)	1	Reference		1	Reference	
Yes	14 (60.9)	2.17	0.85–5.52	0.101	2.84	0.86–9.32	0.085

^{a)} Adjusted mutually for hospital location, profession, training received, treatment experience and confidence to treat snakebite patient.

for hospital location, training received, experience in the management of snakebite patients and confidence to treat snakebite patients showed no significant association.

DISCUSSION

Snakebites are a significant health issue in Savannakhet Province, yet very few patients have been treated in district and provincial hospitals.¹⁰⁾ Financial constraints in a fee-for-service healthcare system may be one of the factors involved. However, a lack of trust in local healthcare and in the facilities available, among the public, is likely to play a more important role, given the non-availability of antivenom and the insufficient level of knowledge concerning the management of snakebites among healthcare providers.

This was the first study that assessed the knowledge of healthcare providers in rural and urban hospitals in Lao PDR, with respect to regional snake fauna and the management of snakebite patients. It was undertaken to understand better the knowledge levels of those providing treatment in this region, and to obtain data to improve healthcare for snakebite patients in the future. Of the participants, 73.1% were female. Based on the 2013 Annual Report on Health Personnel Distribution by the Lao Ministry of Health, the comparable proportion of female health staff in the whole country and Savannakhet Province was 60% and 66%, respectively.¹⁷⁾

Knowledge among the study participants concerning snake identification was poor as only 27.7% achieved an adequate score. An adequate score for the management of snakebites was achieved by only 45.4% of the study participants. Approximately 59% of the study participants knew that krait bites presented with an absence of local signs, or with only minimal swelling, a finding similar to a study conducted at the Medical College of Kolkata, India.¹⁸⁾ Knowledge concerning snake identification in relation to different characteristics of the study group showed that only one subgroup, those who had received training, achieved significantly better results compared to those without training. However, the significance was rather marginal, with an OR of 2.54 (95% CI: 1.02–6.28). Knowledge among the study participants concerning the management of snakebites in relation to different characteristics of the study group showed significantly better results in the subgroup of physicians compared to nurses, with an OR of 2.31 (95% CI: 1.04–5.12).

In order to reduce the mortality and morbidity of snakebite patients, effective first aid treatment methods have been introduced in many countries, particularly those with high incidences of snakebites, and the major emphasis for effective first aid treatment is to ensure the transport of the patient to the nearest health facility, operated by well trained professionals and where antivenom is available.^{19,20)} However, it appears that alternative and less helpful methods are still practiced and recommended for the treatment of snakebite patients in many countries, including Lao PDR.^{10,15,21,22)} Some misconceptions about effective treatment methods were shown in our study, although the majority of study participants demonstrated a knowledge about less helpful or harmful methods and were not recommending them to patients. This result was demonstrated by the findings that knowledge about first aid was good and approximately 90% of the study participants achieved an adequate score.

WHO has identified antivenom as an essential drug, recommending its use in primary health facilities.²³⁾ In this study, 83.2% of the participants correctly answered that the appropriate route for antivenom administration was by intravenous injection, which was similar to a study conducted in India, where 87% of doctors had obtained the same result.^{16,24)} Since antivenom may cause anaphylactic shock as a serious adverse side effect, healthcare providers need to be aware of this before administering antivenom to the patients. In our study, 82.4% of healthcare

providers knew that the most serious reaction to antivenom is anaphylactic shock, and 90.8% knew that adrenaline is the first drug of choice for treating this adverse reaction. This contrasted with findings in India and Pakistan, where only 24% of doctors identified adrenaline as the first drug of choice against this adverse reaction.²⁵⁾

Only one-third of the study participants had received a one-day training workshop about the management and treatment of snakebite patients in Savannakhet Province, conducted during a previous study between 2013 and 2014.¹⁰⁾ This workshop had covered knowledge about regional snake fauna, first aid, and the assessment and treatment of snakebite patients, and was the first time for most of them to receive training in this field. To develop skills in snakebite management, training and retraining should be provided and opportunities to develop clinical experience is necessary. In this study, it is possible that participants with training experience did not show significant OR for adequate knowledge on snakebite management, because they had only one training workshop, and that the sample size of this study was small. In September 2016, it was still the case that the management of snakebite patients was not taught at medical universities and health science colleges in Laos. Therefore, it was not surprising that the present study revealed a limited knowledge among healthcare providers with respect to the regional snake fauna and the management of snakebite patients. This knowledge gap has to be closed and a module about regional snake fauna and the management of snakebite patients' needs to be included as part of the national medical teaching program. In the meantime, one-day training can provide an initial introduction into the management of snakebites, and onsite teaching can assist in ensuring the maintenance of professional care in this field and to consolidate acquired knowledge.

Approximately 48% of the participants reported experience in the treatment of snakebite patients, which may not however include experience in administering antivenom, because antivenom was only introduced at Savannakhet Provincial Hospital in July 2013 and was not available at the two District Hospitals.¹⁵⁾ The availability of antivenom, the essential drug for snakebite treatment, is a precondition for the professional treatment of snakebites and, together with further onsite teaching, is likely to significantly improve the quality of care and raise the number of patients treated in hospitals.

None of the study participants in the two rural hospitals reported confidence in treating snakebites, and only 19.3% in the urban hospital in Savannakhet Province reported confidence. Therefore, a significant majority of healthcare providers in our study had poor confidence in treating snakebite patients, despite having experience in treating snakebite patients. Similar findings have been made in India, Pakistan, Malaysia and Hong Kong.²⁴⁻²⁷⁾

Antivenom was introduced at Savannakhet Provincial Hospital in 2013, together with onsite teaching, and these improvements most likely influenced this result. Furthermore, the numbers of those seeking treatment has increased, with the number of patients reporting snakebites increasing from 4 in 2012 to 81 in 2014. Savannakhet Provincial Hospital data from 2013 to 2015 showed that life-threatening anaphylactic reactions occurred in almost 30% of patients receiving antivenom.¹⁵⁾ Therefore, training needs to ensure the responsible use of antivenom, how to manage in intensive care and the proper use of adrenalin. Thus, onsite training is particularly important to protect the health of patients. The potentially life-threatening side effects of antivenom make the implementation of snakebite treatment in remote district hospitals more difficult, because doctors are reluctant and even afraid to use the drug. It is likely that considerable effort and time will still be required to ensure the safe and professional management of snakebites, particularly at DHs.

The present study has some limitations. It included only healthcare workers in Savannakhet Province, thus reflecting only the situation in that region. However, antivenom is not available in most provincial and district hospitals in the country, and the level of knowledge concerning the management of snakebite patients is likely to be similar in the other provinces as well. Since

13 healthcare providers refused to participate, the percentage of those with adequate knowledge may have been reduced if 132 had been the denominator.

In conclusion, the present study indicated that knowledge of snakebite management among healthcare providers in Savannakhet Province was not sufficient to ensure the professional care of snakebite patients in the province. The management of snakebite patients should be included within the curriculum of the University of Health Sciences in Vientiane and the health science colleges across the country, to ensure the provision of adequate sufficient skills. Clinical experience should then be transferred by trained physicians among healthcare providers throughout the country.

ACKNOWLEDGEMENTS

Firstly, we are grateful thanks to the staff at Savannakhet Provincial Hospital, Sepon, and Phine District Hospitals for their support and facilitation of data collection throughout the study period. Our sincere gratitude to all the respondents who participated in this study. Finally, we would like to express our sincere gratitude to the Japanese Government, all lecturers, and staff of the Young Leaders' Program, Department of Healthcare Administration, Graduate School of Medicine, Nagoya University, Japan for all their help in this study.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

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