

**Incidence, case fatality rate and treatment - seeking behaviour
of the snakebite victims from two townships of Myanmar**

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A community-based study of incidence, case fatality rate and treatment-seeking behaviour of snakebite victims was carried out in Taungdwingyi (TDG) and Kyaukpadaung (KPD) townships. A house-to-house visit was conducted by an assigned midwife and a structured questionnaire was asked to the victims or next of kin if the victim was dead. The incidence of snakebite for 4 yrs (1999-2002) is 1381 (746TDG +635KPD) with yearly incidence increases from 29 to 100/100000 in KPD and in TDG from 76 to 115/100000 (1999 to 2001) and 72/100000 in 2002. The average case fatality rate remains high in both townships (12.9%KPD and 19.3%TDG). Age specific morbidity and mortality is highest in age group 21-30yrs in TDG. High morbidity and mortality of snakebites is observed during ploughing and harvesting seasons. The snakes responsible for most bites are Russell's viper, cobra and green pit viper. Occasional bites by king cobra, kraits and nonpoisonous snakes were recalled. Conjunctivitis following spitting of venom into eyes by a spitting cobra in TDG was also recalled. Majority of them were farmers and bitten on lower limbs (79%) while engaged in farming. No longer recommended wound treatments are still in practice. Majority (64%) of the victims sought treatment from traditional healers in KPD and that of TDG at hospital (79%). Among the hospital admissions, primary cases had a better prognosis compared to secondary and no hospital admissions in TDG ($p < 0.001$). Pre hospital antivenom was given in 31% of the victims from TDG. In spite of health education, only a few (25/1381) wore boots as a prophylaxis. The high mortality and morbidity rates of snakebite could be attributed to lack of use of prophylaxis against snakebite, incorrect treatment seeking behaviour and attitude of the victims, which call for further implementation of the health education programme.

INTRODUCTION

Snakebite occurs throughout 14 States and Divisions of Myanmar and yearly incidence based on hospital data from the whole country collected by the Department of Health Planning [1] accounts for 7710 (6529-8994). There is a decreasing trend of incidence from 1998 to 2000 (7684 to 6529) and upward trend from 2001 to 2003 (7877

to 8994). The case fatality rate varies between years (1998-2003) from 4.9% to 8.5% (mean 7.1%). Snakebite occurs throughout the year in some localities with the introduction of multiple cropping. However, Russell's viper bite occurs during harvesting and ploughing seasons [2,3]. It is an occupational hazard of farmers and plantation workers. Although many species of poisonous snakes are around, hospital

records show bites by three common species of snake namely Russell's viper (*Daboia russelii siamensis*), cobra (*Naja kaouthia*) and green pit vipers [4,5]. Bites by many important species are not on hospital record but bites by king cobra (*Ophiophagus hannah*) [6], Chinese krait (*Bungarus multicinctus*) [7], common krait (*Bungarus fasciatus*) [7], Malayan pit viper (*Calloselasma rhodostoma*) [8,9], and venom ophthalmia following spitting venom into eyes by spitting cobra (*Naja mandalayensis*) [10] have been reported earlier. It appears that there is under reporting of snakebite cases as well as bites by important species of snake. A community-based study of epidemiology of snakebite may reveal true prevalence of snakebite and has been carried out in some countries [11-13]. It is high time that a community-based study of epidemiology of snakebite and treatment-seeking behaviour of the snakebite victims needs to be conducted in order to reveal the true incidence and magnitude of the problem. Such study was conducted in two townships, Taungdwingyi (TDG) and Kyaukpadaung (KPD) where snakebite is endemic.

MATERIALS AND METHODS

A community-based survey of incidence, case fatality rate and treatment seeking behaviour of the victims was carried out in Taungdwingyi (TDG) and Kyaukpadaung (KPD) townships. A house-to-house survey was carried out by an assigned midwife from February to May 2002 in TDG and from February to June 2003 in KPD. A structured questionnaire designed to cover circumstances of the bite, mortality, sequelae, treatment seeking behaviour, use of first aid and prophylaxis was asked to the victims or next of kin if the victim was dead covering a period of 4 years (1999-2002). For children, guardian or parents were asked. Coded data were entered and analysed using Epi info version (6.04D) software. Statistical analysis was carried out

using student "t" test. $P < 0.05$ was considered as significant.

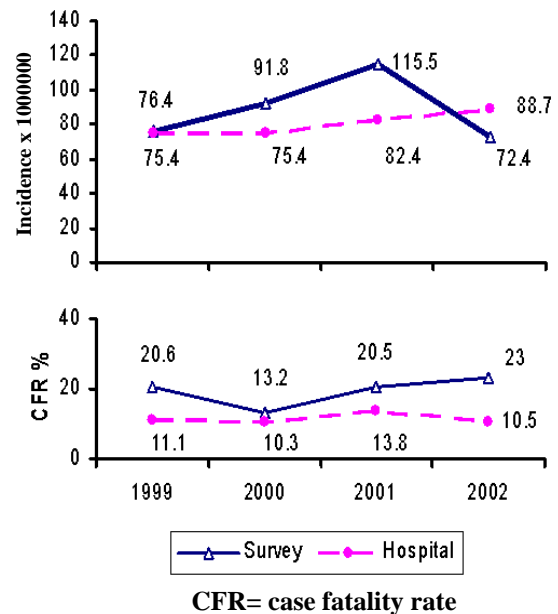


Fig. 1. Incidence and case fatality rate of snakebite cases of Taungdwingyi

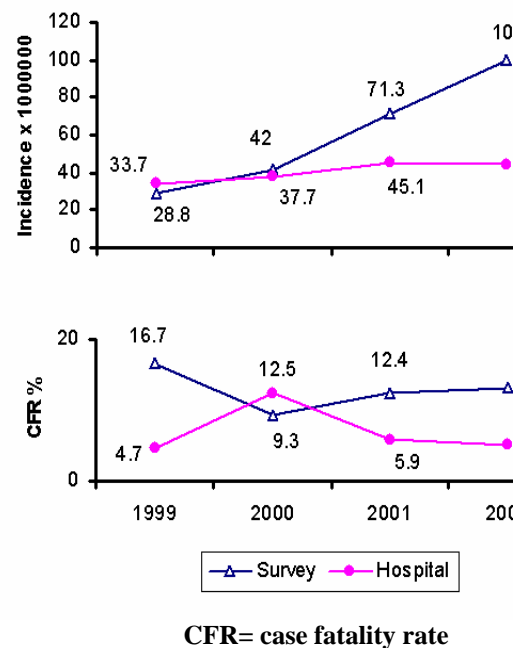


Fig. 2. Incidence and case fatality rate of snakebite cases of Kyaukpadaung

RESULTS

Incidence and mortality

A house-to-house visit by an assigned midwife was conducted on a total

population of 480020 (215312) Taung-dwingyi and 264708 Kyaukpadaung) residing in two townships. The total number of snakebite recalled by the victim in 4 years (1999-2002) is 1381 (746, TDG and 635, KPD). The yearly incidence of snakebite from 1999 to 2002 in TDG increases from 76.4 to 115.5/100000 (1999-2001) and 72.4/100000 in 2002 (Figure 1) and that of KPD is 28.8 to 100.1/100000 (Figure 2). Snakebite occurs throughout the year with peak incidence at ploughing (May) and harvesting (October) seasons in KPD and throughout the year in TDG (data not shown).

The age of the victim ranges from 3- 84 yrs (mean age 30yr) and 79% are less than 40 yrs old. Male to female ratio is 1.8:1 (895:486). Majority 1093 (79.9%) of the victims were farmers and the rest included 75 (5.5%) teachers, students and monks, 72 (5.3%) off-hand workers, 67(4.9%) street-vendors, 28 (2%) palm workers, 28 (2%) dependents and 5 (0.4%) livestock-breeders. Forty three percent (594) of the victims were alone at the time of the bites and 57% (787) had company. Majority (79%) (1090) of the bites occurred during the day (6am - 5pm) and 21% (291) after dark (6pm-5am).

The case fatality rate of snakebite in TDG is 19.3% (13.2-23%) and that of KPD 12.9% (9.3-16.7%). The overall case fatality rate due to Russell's viper bite is 18% (21% TDG and 14% in KPD) and cobra 11% (16.6%TDG and 8.8% KPD). TDG has high fatality rate following Russell's viper (21%) and cobra (16.6%) bites compared to KPD. Four out of 7 King cobra bites are fatal.

The age specific morbidity and mortality (excluding 71 and above age groups) is highest in age group 21-30 yr in TDG and varies between years in KPD.

The snakes

Of total 1363 bites, Russell's viper (*D.r.siamensis*) accounts for 1122 (82%), followed by cobra (*N. kaouthia*) 104 (8%) and green pit viper 77 (6%). Cobra bite is more common in KPD (14%). King cobra

(*Ophio. hannah*) bite causes 4/7 death in TDG. Chinese krait (*B. multicinctus*) bite accounts for 5 in KPD and 2 in TDG with no fatality. Non-fatal banded krait (*B. fasciatus*) bite, one in each township was recalled. One victim suffered from venom ophthalmia following spitting of venom into eyes by a spitting cobra (*N. mandalayensis*) was recalled in TDG. Nonpoisonous bite of 16 *Hamalopsis buccata*, 8 *Ptyas mucosus* and one *Chrysopelia ornata* were also recalled (Table 1).

Site of bite

Majority of the victims were bitten on lower limb 78.3% (n=1381) and 20.9% (n=1381) on upper limb. Bites on unusual sites: 6 at buttock (three while reaping grass, on way to toilet, while preparing jaggery paste and a fatal bite on buttock of a 3-year-old girl by a Russell's viper), on eye-lid while handling a nonpoisonous snake, on head by a Russell's viper while asleep and on ear and forehead by green pit vipers were recalled. Venom ophthalmia following spitting of venom into eyes by a spitting cobra while minding livestock was recalled.

Prophylaxis and first-aid

About 46% (n=1492) of the victims used protective wear at work (the victims from KPD (71%) used it twice more than TDG 36%). However, majority (92.4%) were still wearing rubber sandals and only 17 wore local/imported boots and 8 DMR fang-proof boots (in TDG). Majority (99.9%) of non protective wear users did not use any protective measure against snakebite.

Of 17 local/imported boot users from TDG, 7/9 were envenomed and 3 died. Remaining two (one received pre hospital antivenom) and all eight fang-proof boot users did not develop signs of envenoming.

Wound treatment was carried out in 83% of the victims. Tourniquet (52%) was widely applied by the victims followed by wound incision (12.7%), application of herbal medicine to wound (10.9%) and padding of chicken breast to wound (2%). Traditional

Table 1. Snake species responsible for the bites

Activity	Russell's viper	Cobra	Green pit viper	King cobra	CK	BK	SC	H.b	Pt.mu	Ch.o	Uk	Total
Farming	584(87%)	42(6%)	26(4%)	2	3			6		1	11	675
Minding livestock	122(84%)	16(11%)	4(3%)				1		1		2	146
Looking for food*	142(84%)	2	18(11%)	3		1		1			3	170
Way to video house	178(76%)	30(13%)	13(6%)	1	2	1			3		7	235
Collecting fire wood	31(76%)		6(15%)	1				1			2	41
Domestic work	50(72%)	7(10%)	7(10%)		2			1	2			69
Palm worker	14(58%)	7(29%)	3(13%)									24
Handle snake	1								2			3
Total	1122(82%)	104(8%)	77(6%)	7	7	2	1	9	8	1	25	1363

* Catching frogs, rats, birds, snakes and plugging vegetables

CK= Chinese

SC=Spitting cobra krait

H.b=*Hamalopsis buccata*

BK= Banded krait

Pt.mu = *Ptyas mucosus*

Ch.o=*Chrysopelia ornata*

belief of swallowing snake's tail accounts for 1.5%. Practice of harmful wound incision (23.3%), tattooing (6%) and application of herbal extract to the site of bite (14.4%) were more common in KPD and application of chicken pad to the site of bite (2.9%) and swallowing of snake's tail (2.6%) in TDG. Only 17% of the victims from TDG applied local compression immobilisation first aid technique and in contrast only 4/635 (0.7%) victims applied the first-aid in KPD.

Circumstances of bite

Majority 686 (50%) were bitten while at farming. Some were bitten on way to video house and visiting friends (18%). More people were bitten while looking for food (26.5%) and minding live stock (12.7%) in TDG compared to KPD. Bites within house premises (4%) in TDG and while doing domestic work (6.1%) in KPD account for few instances. Bite among toddy palm workers accounts for 3.8% in KPD. Three were bitten while handling non poisonous snakes.

The snakes responsible for most bites in all circumstances are Russell's viper (82%), cobra (8%) and green pit viper (6%) (Table 1). Cobra bite was frequent in people visiting video house and friends and while minding livestock. King cobra,

Chinese krait and banded krait bites were encountered while at farming, looking for food, visiting video house and friends, among toddy palm workers and while minding livestock. Venom ophthalmia following spitting of venom into eyes by a spitting cobra while minding livestock was recalled.

Treatment seeking behaviour

Treatment seeking behaviour of the victims of two townships differs from each other (Table 2). Majority 63.6% of the victims from KPD compared to 15.6% in TDG prefer local healers' treatments. About twice the number of victims from TDG (79.2%) compared to KPD (43.3%) sought hospital treatment and at rural health centre and clinic. About three times more victims from KPD (54%) prefer to remain in villages after taking local treatment. Primary and secondary hospital admission seekers in KPD are about two times less than that of TDG. It is interesting to note that all victims [24] from Sanmyint village of KPD sought treatment at Duwon monastery.

Majority of the victim (55%) sought hospital treatment soon after the bite in TDG compared to 27% in KPD and 70 to 88% within 4hr after the bite. Traditional healers' treatments consist of either ingestion of herbal extracts or local application of

Table 2. Treatment seeking behaviour of the snakebite victims

	Taung-dwingyi	Kyauk-padaung	Total(%)
Treatment sought	451(60%) n 745	517(81%) n 635	968 (70)
Traditional healer	116 (15.6%)	329 (63.7%)	445(46.5)
Rural health centre	239 (53%)	140 (27.1%)	379(39.6)
Unspecified	53 (7.1%)	2	55 (5.7)
Monastery		24 (4.6%)	24 (2.5)
Clinic	16 (2.1%)	6 (1%)	22 (2.3)
Traditional clinic	13 (2.9%)	12 (2.3%)	15 (1.6)
Voluntary health worker	10 (1.3%)		10 (1.0)
Other hospitals	1	4 (0.7%)	5 (0.5)
Home treatment	1		1 (0.1)
Hospital treatment	590 (79.2%) n 745	275 (43.3%) n 635	865 (62.7)
Primary	283 (38%)	102 (16.1%)	385 (27.9)
Secondary referrals	307 (41.2%)	173 (27.2%)	480(34.8)
No hosp. adms.	142 (19%)	344 (54.2%)	486 (35.2)
No treatment	13 (1.8%)	16 (2.5%)	29 (2.1)

meditated edible oil or herbal extract or wound incision and suction.

Fatality among hospital and non-hospital admissions

There is a significant difference in case fatality rate between primary hospital admissions 10.6% (n=283), secondary referrals 15.9% (n=307) and non-hospital admissions 42.2% (n=154) in TDG (P<0.001). A similar difference is observed between primary 8.8% (n=102) and secondary referrals 23.1% (n=173) of KPD (p<0.001), however no difference is observed between primary 8.8% (n=102) and non hospital admissions 7.3% (n=344) (p=0.63)

Wound treatment on prognosis of hospital admissions

Although first-aid/wound treatment practiced by the victims are not ideal, there is a difference in fatality rate among primary admissions with or without wound treatment (p<0.05) and that of secondary referrals (p<0.05) in TDG and in secondary

referrals of KPD (P<0.05), however, no difference in fatality rate is observed among primary admissions with or without wound treatment of KPD (p=0.7).

Symptoms following the bites

Majority (75%) of the victims developed local and systemic symptoms following the bites, however these symptoms are more marked in cases from KPD (Table 3).

Table 3. Symptoms recalled by the snakebite victims

	Taungdwingyi	Kyaukpadaung	Total (%)
Systemic symptoms			
Developed in	564(75%) n 746	116(75%) n 154	680(75)
Oliguria	132(23.4%)	48(41.4%)	180(26.5)
Haematemesis	45(7.9%)	34(29.3%)	79(11.6)
Shock	44(7.8%)	32(27.6%)	76(11.2)
Haematuria	37(6.6%)	37(31.9%)	74(10.8)
Renal failure	25(4.4%)	13(11.2%)	38(5.58)
Haemoptysis	21(3.7%)	19(16.4%)	40(5.88)
Local features			
Developed in	584(78%) n 746	485(77%) n 634	1069(77)
Pain	488(83.6%) n584	362(57.1%)	850(62)
Swelling	428(75%)	376(59.3%)	804(58)
Blister	62(10.6%)	13(2.1%)	75(5.4)
Ulcer	57(9.7%)	12(1.9%)	69(5.0)

History of previous snakebite was recalled in 9% of the victims. The common species of snake responsible for most bites were Russell's viper, cobra and green pit viper.

Only 11% of the victims from KPD and 31% from TDG recalled receiving prehospital antivenom in villages. Majority (55%) of the victims killed the inflicted snakes for identification.

Knowledge on use of prophylaxis and first-aid

In general, the victims acquired health information from basic health workers (57.6%), family/village elders (16.1%), television educational programme (15.9%) and educational pamphlets (10.4%). Forty

three percent of the victims have knowledge on use of prophylactic fang-proof boots of DMR against snakebite and 80% of the victims from TDG and 27% of KPD know local compression (with cotton pad) and immobilisation first-aid used in snakebite.

Majority (77%) of the victims from KPD and 42% from TDG recalled acquiring health education on prophylaxis and first-aid in snakebite from basic health workers and 25% in TDG and 5% in KPD from family/village elders and 24% in TDG and 6% in KPD from television educational programme and 9% in TDG and 12% in KPD from health educational pamphlets. Majority (55%) of the victims saw the snakes before the accident. Forty four percent of the victims believed that all snakes were poisonous.

DISCUSSION

Incidence

Epidemiological study of snakebite based on hospital returns in early 1970 and 1980 [14] shows that incidence of snakebite in Magwe Division drops from 46.1/100000 (1970) to 20.4/100000 (1980) and in Mandalay Division it remains fairly stable (35.5 to 35.1/100000) for respective years. Recent epidemiological study of snakebite based on 87 hospital statistics of six divisions of Myanmar (1998-2000) [4] also shows decrease in average yearly incidence of snakebite (37.2 to 20.2/100000) in Magwe and 38.26 to 29.05/100000 in Mandalay Division. It is supported by hospital-based data collected from the whole country by the Department of Health Planning [1] that yearly incidence of poisonous snakebite decreases from 1998 to 1999 in Magwe and Mandalay divisions. However, its incidence increases from year 2000 to 2003. The present community-based studies of snakebite carried out in Taungdwingyi (Magwe Division) and Kyaukpadaung (Mandalay Division) (1998-2002) also show a similar rising trend of incidence of snakebite.

An earlier study carried out at Taungdwingyi hospital in 1994 [3] shows a high incidence of snakebite (126.1/100000) with a mortality rate of 8.95%. However, the present community-based study (1999-2002) shows that the yearly incidence of snakebite in Taungdwingyi (Magwe Division) is on increase from 76.4 to 115.5/100000 for (1999-2001) and decreases to 72.4/100000 in 2002. However, a similar rising trend is observed in Kyaukpadaung (Mandalay) (29 to 100/100000). Results indicate that incidence of snakebite in two townships is on increase in contrast to earlier observations [4]. The yearly incidence of snakebite recalled by the victims from TDG and KPD (1999 to 2002) compared to that of respective hospital statistics (Figure 1 & 2) are high, suggesting that the true incidence of snakebite is grossly underestimated.

Increase in incidence of snakebite may be due to increased contact between human and snake with the introduction of multiple cropping as well as failure of taking prophylactic measures against snake bite at work. The rising trend of incidence of snakebite calls for review of effectiveness of snakebite control programme and needs for implementation of effective health education since snakebite is a preventable disease. Decrease in incidence of snakebite in TDG in 2002 (although hospital records show increasing trend of snakebite) could be attributed to population movement or increased number of snakebite cases coming from neighbouring townships seeking treatment at TDG in that year.

Case fatality rate

The case fatality rate of snakebite for the whole country based on hospital data [14] drops from 6.7% (1981) to 3.9% (1988). Recent hospital-based study (1998-2000) [4] also shows decrease in the rate from 5.8% to 3.75%. Case fatality rate of snakebite in Magwe (1998-2000) drops from 13.4% to 5.2% and 5% to 3.8% in Mandalay. The present community-based study (1999-2002) shows that the rate remains

high in Taungdwingyi 19% (range 13.25% to 23%) and 13% (9.3% to 16.7%) in Kyauk-padaung. Moreover, it is observed that the case fatality rate of hospital statistics (1998-2000) is about 50% less than the survey data, suggesting that the true case fatality rate is also grossly underestimated.

The high fatality rate of the victims could be attributed to failure of using prophylaxis against snakebite and correct first-aid, incorrect treatment seeking behaviour of the victims and late referrals.

Snakebite is an occupational hazard of our farmers where majority are bitten during ploughing and harvesting seasons with high morbidity and mortality. Age specific morbidity and fatality is highest in age group of 21-30 yr in TDG, which represents the working force of the country. Similar observations were made in our earlier studies on snakebite cases admitted to township hospitals [5].

The snakes

The study confirms that Russell's viper, cobra and green pit viper are responsible for most bites [2, 3, 5]. Venom ophthalmia following spitting of venom into eyes by spitting cobra (*N. mandalayensis*), King cobra and krait bites recalled in the survey were not recorded in hospital data but similar accident/bites occurring in townships through enquiry have been reported earlier by our groups [6,7,10,15]. The study highlights that there are many unreported bites by important species of snake and hospital data grossly underestimates the true incidence of snakebite.

Majority of king cobra bites are fatal because of severe envenoming. However, it is emphasized that lives of neurotoxic envenomed cases could be saved by providing artificial or assisted ventilation in the absence of specific antivenom [6, 15].

Circumstances of the bites

Snakebite is an occupational hazard of farmers and most (60%) are bitten while engaged in farming and others in various

circumstances. Since all living in the community are at risk, it is suggested that all out wearing of prophylactic boots will safeguard the community against snakebite [16].

The study confirms the earlier observation made on Russell's viper bite cases [2, 3, & 5] that legs (79%) and upper limbs (21%) are common sites of bite. Bites on ear, forehead and buttock are uncommon.

First-aid

Applying tourniquet is still widely practiced among the victims in spite of its ill effects [17]. Wound incision ± application of herbal extract, widely practiced in KPD, is prone to get infection and bleeding from the wound in systemic envenomed Russell's viper bite cases. Swallowing snake's tails and application of chicken breast to wound have no scientific value. Such harmful and unscientific practices should be discouraged. Since only a few victims applied local compression immobilisation first-aid, it calls for review of the effectiveness of dissemination of the health education programmes to the community.

Treatment seeking behaviour

The number of victims (31%) receiving pre hospital antivenom in TDG is doubled since our last study in 1994 [3], however it accounts for only 11% in KPD. It has been shown that early administration of adequate dose of antivenom soon after the bite in village carries a better prognosis and less complication [18]. A large-scale study on feasibility and efficacy of early adequate dose of antivenom given in villages should be made.

The study highlights that majority of the victims from TDG are health conscious and two times more victims from TDG compared to KPD have perception on seeking early treatment at hospital. In contrast, majority (63.6%) of the victims of KPD believed in local healers' treatments suggesting that traditional belief has much influence on treatment seeking behaviour of the victims of KPD. It is supported by the

fact that 54% of the victims after receiving local treatment remain at home and numbers of primary/secondary hospital admission seekers are two times less than that of TDG. Wrong treatment seeking in KPD resulted in development of more systemic cases with complications (data based on symptoms recalled 30% vs. 10%) compared to TDG. It is likely that traditional belief rather than accessibility to health centres is responsible for high morbidity in KPD.

It is high time that health education leading to behavioural change in concept on treatment seeking behaviour including seeking early medical treatment at hospital, discouraging unscientific traditional healers' treatments and home remedy which give a false sense of security should be aimed at in imparting health education to the communities.

It is observed that primary hospital admissions carry a better prognosis compared to secondary referrals and no admissions. However, in KPD no significant difference in prognosis is observed between primary admissions and no hospital admissions probably the latter received mild envenoming compared to that of TDG (reflected in case fatality rate of 7.3% and 42.2% respectively).

Moreover, wound treatments practiced in KPD (wound incision \pm application of herbal extract to wound) do not influence the prognosis of primary admission in contrast to that of TDG. The study highlights that victims should be encouraged to seek early hospital admission and unscientific treatment of local healers should be discouraged. The study reveals that pattern of treatment seeking behaviour and perception of the victim influence the outcome of the victim. Health education should be directed toward achieving change in attitude of the community in treatment seeking behaviour.

Knowledge

Although majority of the victims acquired knowledge on snakebite prophylaxis and the

first-aid from basic health workers (77% in KPD and 42% in TDG), in practice, only a few cases used it. It is high time that health education leading to behavioural change should be aimed at in future dissemination of health information on prevention and use of correct first-aid in snakebite.

Efficacy of fang-proof boots

The study highlights that none (8/8) of fang-proof boots (innovated by Department of Medical Research, Lower Myanmar) users were envenomed further supporting fang proof efficacy of DMR (LM) boots [16]. Two local/imported boot users were probably not envenomed or may receive trifle envenoming that was neutralised by early antivenom in one. It has been observed that rubber or canvas materials could not withstand penetration of Russell's viper fangs (personal observation).

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REFERENCES

1. Personal communication. Yearly incidence and case fatality rate of snakebite cases from 14 States and Divisions of Myanmar (1998-2003). Statistics Division, Department of Health Planning, Ministry of Health, Myanmar.
2. Myint Lwin, Warrell, DA., Phillips, RE., Tin Nu Swe, Tun Pe, and Maung Maung Lay. Bites by Russell's viper (*V.russelli siamensis*) in Burma: Haemostatic, vascular and renal disturbances and response to treatment. *Lancet* 1985; ii, 1259-1264.
3. Sann Mya, Tun Pe, Aye Aye Myint, Nu Nu Aung, Khin Aye Kyu & Tin Oo. Russell's viper bites in Taungdwingyi hospital: clinical features and response to antivenom. *Myanmar Health Sciences Research Journal* 1998;10:26-30.
4. Aye Aye Myint, Tun Pe and Tin Zar Maw. An epidemiological study of snakebite and venomous snake survey in Myanmar. In *Management of Snakebite and Research*, WHO/SEARO publication 2002; p12-16, 2002.

5. Tun Pe, Aye Aye Myint, Sann Mya, Khin Aye kyu, Kyaw Than, Aung Myint, Tint Lwin, Myint Soe and Min Than. Clinical features of Russell's viper (*Daboia russelii siamensis*) bite cases admitted to six township hospitals of snakebite endemic divisions of Myanmar. In *Management of Snakebite and Research*, WHO/SEARO publication 2002; p34-40.
6. Tin Myint, Rai-Mra, Maung Chit, Tun Pe and Warrell, D.A.. Bites by the King cobra (*Ophiophagus hannah*) in Myanmar: successful treatment of severe neurotoxic envenoming. *Quarterly Medical Journal* New series 80, 1991; 293, 751-761.
7. Tun Pe, Tin Myint, Aung Htut, Aye Aye Myint and Nu Nu Aung. Envenoming by Chinese krait (*Bungarus multicinctus*) and banded krait (*Bungarus fasciatus*) in Myanmar. *Transactions of Royal Society of Tropical Medicine and Hygiene* 1997; 91: 686-688.
8. Chit Pe, Tun Pe, Aye Aye Myint and Nu Nu Aung. Snakebite in Loikaw with special reference to Malayan Pit Viper (*Calloselasma rhodostoma*) bite. *Myanmar Health Sciences Research Journal* 1997; 9, 89-92.
9. Tun Pe, Win Lwin and Aye Aye Myint. A Malayan pit viper (*Calloselasma rhodostoma*) bite in Myanmar. *Myanmar Health Sciences Research Journal* 2003; 15, (1-3) 22-24.
10. Tun Pe, Than Htut, Aye Aye Myint, Khin Aung Cho, Maung Chit and Myo Tint Tun. Venom ophthalmia caused by spitting cobra (*Naja siamensis*) in Myanmar. *Myanmar Health Sciences Research Journal* 2002; 14 (1-3):42-44.
11. Hati, AK. Mandal, M., De, MK., Mukherjee, H and Hati, RN. Epidemiology of snakebite in the district of Burdwan, West Bengal. *Journal Indian Medical Association* 1991; 90:145-147.
12. Snow, RW. Bronzan, R., Roques, T., Nyamawi, C., Murphy, S., and Marsh, K. The prevalence and morbidity of snakebite and treatment seeking behaviour among a rural Kenya population. *Annals of Tropical and Parasitology* 1994; 88:665-671.
13. Coombs, M D., Dunachie, SJ. Brooker, S., Haynes, J., Church. and Warrell, DA. Snakebites in Kenya: a preliminary survey of four areas. *Transactions of Royal Society of Tropical Medicine and Hygiene* 1997; 91:319-321.
14. Thein Hlaing. Epidemiology of snakebites. Proceeding of National Seminar on Prevention and Management of Russell's viper bite, Department of Medical Research, Yangon, 1990.
15. Tin Myint and Tun Pe Chinese krait (*Bungarus multicinctus*) bite: need for 45 days ventilatory support. *Myanmar Health Sciences Research Journal* 2002; 14(1-3):45-47.
16. Tun Pe, Aye Aye Myint, Khin Aye Kyu and Maung Maung Toe. Acceptability study of the fang proof protective boots among farmers of Taungdwingyi Township. *Myanmar Health Sciences Research Journal* 1998; 10:57-60.
17. Tun Pe, Tin Nu Swe, Myint Lwin, Warrell, DA., and Than Win. The efficacy of tourniquets as a first aid measure for Russell's viper bite in Burma. *Transactions of Royal Society of Tropical Medicine and Hygiene* 1987; 81: 403-405.
18. Tun Pe, Aye Aye Myint, Khin Aye Kyu and Sann Mya. Evaluation of prehospital antivenom in management and outcome of Russell's viper (*Daboia russelii siamensis*) bites cases admitted to Taungdwingyi Hospital. *Myanmar Health Sciences Research Journal* 2003; 15: 1-5.