Analysis of Snakebite Data from Pappinisseri Vishachikilsa Society, Kannur, Kerala (India)

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Summary
Snakebite is a significant medical issue in India, and several factors influence the region-wise incidence. This paper analyzes and reports mortality and incidence figures from one medical center in Kannur district, Kerala. The gender profile of snakebite patients showed that adult males are in the highest risk group (64% of snakebite cases with envenoming), while young women and female children are in the low risk group (3.5% of snakebite cases with envenoming). Snakebite seasonality was also observed in the data, the highest incidence coinciding with the start of the paddy (rice) planting season. Based on these observations, the authors have made some recommendations on the prevention and management of snakebite.

Introduction
The most quoted figure for snakebite mortality in India comes from a reference by Swaroop and Grab [1], who estimated about 20,000 snakebite deaths per year (probably based on Joseph Fayrer’s 1874 estimate [2]). The most recent nationwide study (carried out by sampling) extrapolated a mortality of about 10,000 per year [3] (Sawal and Homma, 1974). This study also estimated that around 90% of the persons bitten never came to hospital, preferring to rely on local remedies.

The vast majority of snakebite deaths in India have been attributed to the four common, medically important species of snakes known as the Big Four. Though their ranges overlap, each has unique microhabitat and prey preferences. The Russell’s viper (Daboia russelii) is nocturnal, lives in rocky areas with dense thickets (like agave and pandanus) interspersed with small open spaces, and feeds largely on gerbils (Tatera indica). The Saw-scaled Viper (Echis carinatus) is nocturnal and prefers areas with large, open and sandy clearings, where it can be found on or just above the ground, often under rocks or on thorny bushes where it preys on mice, lizards and arthropods. The Spectacled Cobra (Naja naja) is active both by day and night, favours bushy spaces bordering agricultural land, and typically lives in rat holes and termite mounds in bunds bordering rice fields. It feeds on mice, rats, frogs and toads. The Common Krait (Bungarus caeruleus) is nocturnal, lives in holes and is partial to human-made habitats, such as stacks of tiles, granite rocks, or wood. These are good places for it to find mice, lizards and other snakes to eat. This microhabitat preference leads to a large percentage
of krait bites occurring in people's homes. One Indian study quoted a figure of 83% [4]. In and around human habitation, disturbance can compel any of these snakes to change their activity patterns and be active by both day and night. Human made habitats like rice fields, piles of rubble, haystacks, piles of firewood and rubbish (where rodents thrive) are ideal snake havens. This, together with the obvious attractions of sun-warmed paths/sealed roads to an ectothermic organism, means that human-snake interaction is inevitable. The risk is increased by a general lack of awareness (how to avoid snakes, species identification, first-aid/medical treatment), inadequate or no footwear, and minimal use of torches in low light conditions. The latter is especially important amongst the high risk segment of the population: agricultural workers, and low income groups in towns and cities. Snakebite in Kannur.District, Kerala

Kannur District is located on the northern end of Kerala State (Fig. 1), and has an annual rainfall of 3463mm, the month of July being the rainiest with about a third of the total. Topographically, the state is divided into three regions: Highlands, Midlands and Lowlands. The Highlands are on the eastern end of the district, and comprise mainly of mountains and hilly areas up to about 1500 meters where coffee, tea, cardamom, and timber trees (such as teak) are grown. The Midlands separate the low and highlands and are made up of hills and valleys with highly fertile soil which supports abundant agricultural activities. The Lowlands are comprised of drier, laterite plateau land, sea-shores, rivers, and deltas. These lowland areas support large coconut farms and paddy fields.

Figure 1: Kannur District map (not to scale)
Pappinisseri Vishachikilsa Society

The Pappinisseri Vishachikilsa (venom treatment) Society (PVS) is located in Pappinisseri Town, Kannur District. It keeps relatively detailed records of snakebite mortality and morbidity. These records comprise a total of 48,770 cases (venomous and “non-venomous” bites) and cover the period from 1964 to the year 2000. The data recorded for “non-venomous” bites is assumed to include “dry” bites by venomous snakes, a common phenomenon (“non-venomous” bites are hereafter referred to as bites without envenomining, while venomous bites as bites with envenomining). PVS’s treatment of snakebite comprises a combination of polyvalent antivenom serum to combat systemic effects of the snake venom, and ayurvedic treatment for local effects such as necrosis. The success of this treatment has improved the confidence of people in antivenom serum, and helped turn them away from quack remedies such as the snake stone and unproven herbal “preparations”. PVS is associated with and supported by the Parassinikkadavu Snake Park which is situated nearby. This association gives a degree of relevance and credibility to the data collected through positive identification of snake species and the distinction between snakebites with and without envenomining (by recognition of species and symptoms). At other clinics in Kerala it has been noticed that the potentially dangerous Hump-nosed Pit Viper (Hypnale hypnale) is often mistaken for Echis carinatus [5].

An eleven year period (1990-2000) of PVS snakebite data has been chosen to focus on, for two reasons: a) data from this period distinguishes between the vipers (D. russelli, E. carinatus), and pit-vipers (no genus or species recorded but the two most common species in the region are Trimeresurus malabaricus and Hypnale hypnale) and b) age groups (adults and children) are separated in the data from this period. Due to these distinctions, records from the two periods 1964-2000 and 1990-2000 are being treated as two different data sets.

Results
According to data collected by PVS, 73% (35,726) of all 48,776 snake bites recorded from 1964 and 2000 were bites without envenomining while 27% (13,050) were classified as bites with envenomining; overall mortality for bites with envenomining during the 36 year period was 2% (279 deaths). Snakes represented in the data are D. russelli, E. carinatus, B. caerulus, N. naja, ‘sea-snakes’ (species not given, common species include Enhydrina schistosa, Hydrophis sp.) and ‘pit-vipers’ (species not given). A small percentage of patients brought the dead snake responsible for the bite, thus the PVS staff have to rely on the description given and by observation of symptoms for species identification. This leaves room for considerable error; however, similar observations gleaned from local doctors
and findings on relative species abundance by Snake Park staff indicate that the figures have a fair degree of accuracy.

![Graph showing snake species abundance.](image)

**Figure 2**: Extrapolated data showing relative percentages of snakes responsible for bites with envenoming during a 34 year period (1964-2000) in Kannur District, Kerala (data courtesy PVS)

Note: As pre-1990 PVS data classed all viper and pit viper bites together, relative percentages of Daboia, Echis and pit-viper bites from 1990-2000 were applied to the total number of viper bites for the 1964-2000 period (12,580). The numbers obtained were each converted to percentages against 13,050, the total number of bites with envenoming from 1964-2000. While this extrapolation is not statistically accurate, it provides a good indicator as to the prevalence of bites from vipers and pit vipers in Kannur District.

Gender of patients has been differentiated in data collected by PVS from 1964 onwards; however, the distinction between children and adults was only made from 1990 onwards (Fig. 3).
Figure 3: Gender and age group of patients admitted for bites with envenoming, over an 11 year period (1990-2000) in Kannur District, Kerala (data courtesy PVS)

Seasonality
Seasonality of snakebites with envenoming has been reported in several snake bite studies. For example, a study of snakebite incidence in Bambur, Nigeria showed that peaks were reached in May-June 6 while a similar study in Jammu showed incidence peaks in July-August 7. In Bambur, the increase in snakebite frequency coincided with a rise in farming activity which anticipated the coming rains. In Kannur District, over an 11 year period (1990-2000), the month of May (typically the hottest month coupled with early monsoon showers) had the highest incidence of snakebite, while April (the hottest and driest month, when many snakes aestivate) had the lowest (Fig. 4). These findings contradict those reported by Sawai and Homma, who stated that they found no characteristic seasonal pattern of snakebites in Kerala state [8]. Interestingly, mortality for all bites with envenoming over the 11-year period (1990-2000) showed a marked increase during the cool dry months. The period from January through to early March had the highest mortality (1.9%). That of November and December was also comparatively high (1.4%), compared to the average mortality for the rest of the year (0.61%).

Similar findings were reported in a study of E. carinatus bites in Nigeria (Warrell et al, 1976), as well as in a study of snake envenomation in Sudan [9]. It is reported in another study by the same author that in addition to an increase of mortality in the cool-dry season (in Sudan), the proportion of haemorrhagic bites also seemed to increase. The author hypothesized that
the patient’s poorer nutrition in the dry season could be a reason for their increased susceptibility to snake venoms.

Figure 4: Seasonality of snakebites with envenoming over an 11 year period (1990 - 2000) in Kannur District, Kerala showing average rainfall data (over a 30 year period). The seasonality of all bites (bites both with and without envenoming) shows an almost identical trend.

Discussion
The large percentage of bites with envenoming attributed to Russell’s Vipers is explained by the presence of large areas of optimum habitat, and could imply a lower incidence of ‘dry’ bites by this long-fanged species. It is further implied that the other three species of medically important Indian snakes (together reported to be responsible for a remarkably low 3.49% of bites with envenoming) are not nearly as common as Russell’s viper in this area, but these hypotheses need confirmation by field studies. Regional differences in snake distribution and abundance significantly influences species specific incidence of snakebite. For example, in the desert region of Rajasthan almost all bites with envenoming are by the saw-scaled viper; cobras account for most bites in 24-Parganas District in West Bengal and so on. Field studies are needed to determine relative abundance of the Big Four venomous snakes.

The large difference in gender of the patients can be attributed to the fact that men typically work daily in the fields and may be more active at night, while women, for the most part, stay in or around their houses and
compounds. Boys tend to travel wider and play at games putting them at greater risk than girls. Snakebite incidence in Kannur District peaks at the onset of the monsoon (May-June) as well as at the start of the cooler, dry season (November-December) and is lowest in the hot dry months (March-April). The onset of monsoon is known to cause increased activity of all snake species, including, of course, the Big Four. The onset of the monsoon in South India also signals the start of the planting season (especially paddy) and farming activity is at a peak during these times. These factors combine to greatly increase human-snake conflict, and hence, the rate of all snakebites. Why there is a second peak of snakebite (and presumably snake activity) in November-December remains to be answered by field studies in the area, but it could be connected to the increased frequency of snakes basking on roads at night. Mortality for the entire period (1964-2000) is only 2% which is evidence of the success of PVCS in publicizing and effectively treating snakebite in Kannur District. Equally, there is evidence of substantial improvement in awareness and treatment protocol; 7364 bites from the period of 1964-1990 had a mortality of 2.9% (215 deaths), while 5686 bites from 1990-2000 had a mortality of 1% (62 deaths).

Conclusion

The PVS must be commended for their systematic collection of data since 1964. This is one of the few medical centers in India that has fairly detailed, long-term records of snakebite cases. Their association with the Parassinikkadavu Snake Park gives them a valuable connection with people in the surrounding areas. Centers like this are the key to disseminating up-to-date information on snakebite and its treatment. It is very important to stress proper identification of snakes in order to follow the correct treatment procedure. When possible, the dead snake responsible for the bite should be brought to hospital and preserved for positive identification.

The fact that snakebites without envenoming outnumbered those with envenoming by about three times (35,726 and 13,050 respectively) is a valuable indicator of the ratio of snakebites that require hospitalization and treatment with antivenom. The PVS uses its association with the Snake Park as an educational base for training programs to train farmers and others at high risk from snakebite in snake identification, snakebite avoidance, and treatment. These programs need to be encouraged and set up regionally, concentrating on areas of high snakebite incidence. There is also scope for involving local snake catchers/charmers in educating local people about snakes, as well as in snake rescue and release programs.

A key issue in snakebite avoidance is to identify and minimize conflict points. Man-made habitats like stacks of wood/tiles should be approached with caution, stacked with spacers, and regularly re-arranged. Most bites occur at
night while walking without adequate lighting, and while footwear is a regularly recommended deterrent to snakebite the fact is that most farmers and labourers walk barefoot or with fully open chappals (sandals). The most current first aid protocol for snakebite is to immobilize (if possible) or minimize movement of the patient, and take them straight to a hospital. Tying of a tourniquet is now not considered advisable for various reasons, including the fact that the necrotic effects of some venoms (all Indian viper and pit viper bites, as well as cobra bites) can be extremely damaging if localized. In cases of known krait bites, a pressure bandage (Sutherland method) can be applied on the bitten limb to slow the spread of venom.

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