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Epidemiological studies of snake bite in French Guiana

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The incidence of snake bite and the presence of venom antibody in previous snake bite victims was investigated in French Guiana. The incidence proved to be highest (600/100 000) in inhabitants of bush regions and lowest (45/100 000) in urban areas. Of 43 sera tested for specific venom antibody 22 (51%) were positive, and most of these individuals suffered severe or moderate poisoning. The main species involved, as assessed by detection of venom antibody by ELISA, were *Lachesis muta, Bothrops brazili, B. bilineatus* and *B. atrox*. The significance of these findings is discussed.

Epidemiological data concerning the incidence of snake bite in South America are rare. To rectify the situation an attempt has been made to evaluate snake bite morbidity in French Guiana, using survey techniques combined with enzyme-linked immunosorbent assay (ELISA). The population comprises approximately 73 000 inhabitants within an area of 90 000 km^2 and is unevenly distributed in the study region; 93% inhabit the coastal area and less than 10% are involved with agriculture. Primary forest covers 95% of the territory and is inhabited by less than 5000 people. The population can be divided into three major groups consisting of (1) urban inhabitants (62 000) without any contact with primary forest areas; (2) villagers (7000) with minimal contact with forest regions; (3) inhabitants of bush regions (4000). The latter population constitutes the major group at risk from snake bite.

The major ethnic groups are Creoles, expatriate French, Indians, and various immigrant groups (e.g. Brazilians, Asians, West Indians and others).

MATERIALS AND METHODS

Seventeen localities were studied covering 97% of the total population of the territory. A retrospective study was made in all regions using details obtained from hospital records. A second prospective study was carried out in all localities using a standard questionnaire (recording name, age, sex, habitation, ethnic group, circumstances of bite, location of bite and clinical and therapeutic data) between January 1982 and May 1983. Finally, a detailed study was performed in four villages in which each inhabitant was asked to provide details of previous bites. Results obtained using the three methods were combined.

An attempt was made to trace all individuals who either reported previous bites during the surveys or who were mentioned in hospital records. Only previous snake bite victims on whom adequate clinical data were available, or those bitten during the prospective survey, were considered. Only previous victims who had had definite clinical symptoms of envenoming were invited to donate blood samples for venom antibody determination. The samples were collected at periods ranging from one month to 35 years after the bite. Fifty microlitres (50 µl) of whole blood were collected by finger-prick into capillary tubes, the contents of which were immediately expelled onto Whatman No. 1 filter paper, allowed to dry and stored in sealed polythene bags at room temperature. Samples were mailed to Liverpool and subsequently assayed using ELISA. Blood was eluted from the filter paper using PBS-Tween, pH 7·4 (Theakston *et al.*, 1981*a*) to a final dilution of 1/50. Each sample was then assayed in duplicate as described by Theakston *et al.* (1977). Because of difficulties in obtaining negative control

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samples from individuals in the same area, controls comprised 15 samples from Ecuadorians not previously exposed to snake bite. These were assayed simultaneously with the test samples and the mean control optical densities were subtracted.

RESULTS

Details of the epidemiological findings have been published elsewhere (Chippaux *et al.*, 1984). Of 210 previous snake bite cases detected during the study period only 137 were suitable because of loss of hospital records; 66 victims were not sampled because the records indicated few or no symptoms of envenoming, but 71 individuals exhibited clear clinical symptoms of envenomation as recorded by hospital staff.

Only 43 out of the 71 individuals volunteered to donate a blood sample (none in the town group, 20 in the village group and 23 in the bush region group: Table 1); the remainder refused. All 43 victims had presented with at least minimum local symptoms (e.g. pain, swelling) suggesting viper bite poisoning. Eight previous victims suffered moderate poisoning, as defined by either local bleeding and/or local necrosis, and 13 had severe poisoning comprising more generalized haemorrhage and local necrosis (Table 2).

TABLE 1

Population distribution, incidence of snake bite, and venom antibody assay results in 43 previous snake bite victims

Geographical group	*Ethnic group*	*Population*	*Incidence/ 100 000*	*No. of sera collected*	*No. of sera positive*
Urban	—	62 000	45	0	—
Rural	Creole	4000		15	6
(Village)	Indians	1500	150	3	3
	Others	1500		2	1
Inhabitants	Creole	1000		2	1
of bush	Indians	1000	600	17	9
areas	Others	2000		4	2

TABLE 2

Number of samples positive for venom antibody at different times following envenoming in relation to the severity of poisoning in 43 previous bite victims

Time from bite (years)	*Severe viperine poisoning*		*Moderate viperine poisoning*		*Mild viperine poisoning (swelling)*	
	No. sera	*No. positive*	*No. sera*	*No. positive*	*No. sera*	*No. positive*
<5	9	7	4	3	9	3
5–15	2	2	3	3	12	4
>15	2	0	1	0	1	0
Total	13	9	8	6	22	7

The overall incidence of venom antibody is approximately 50% (22 out of 43 victims had ELISA-positive samples). The incidence did not appear to be affected by either ethnic or ecological factors (Table 1). Antibodies against *Lachesis muta* venom were detected in 15 victims (five Creoles, eight Indians and two others), against *Bothrops brazili* venom in three (one Creole and two Indians), against *B. bilineatus* venom in two (one Indian and one Laotian

refugee), and against *B. atrox* venom in two (one Creole and one Indian). Occasional slight cross reactions were detected between different species of *Bothrops*, and in these cases the highest antibody titre was considered to reflect the biting species.

DISCUSSION

These findings are in agreement with recent publications. The extent of ELISA venom antibody positives in individuals claiming previous snake bite experience changes from area to area. Positivity was 35% in a survey carried out in Nigeria (Pugh and Theakston, 1980) and 78% in Waorani indians of eastern Ecuador (Theakston *et al.*, 1981*b*). Differences can be explained by variation in ecological situations and epidemiological methods. South American Indians certainly appear to be frequently exposed to snake bite, and this is confirmed by a higher snake bite incidence and mortality rate than so far recorded in any other population studied.

The method of selection of individuals used in this study probably results in a better response in the ELISA test, although it is not quite as subjective as methods used previously (Theakston *et al.*, 1981*a*). We consider that in this survey all subjects tested had suffered mild to severe poisoning by venomous snakes, as the selection of individuals was based on medical records in which accurate clinical symptoms had been reported. The degree of positivity of the ELISA and the intensity of the response is influenced by the amount of venom introduced at the time of the bite and the time from bite to sample collection. Up to 15 years after the bite well-documented victims who suffered severe to moderate systemic poisoning by vipers showed an 83% (15/18) positive venom antibody reaction in the ELISA test. In mild poisoning seven out of 22 (32%) of victims had detectable venom antibody. In this survey no antibody was discernible at periods greater than 15 years after envenomation. Elsewhere, Theakston *et al.* (1981*a*) and Pugh *et al.* (1980) have reported the occasional persistence of venom antibody up to 40 years after systemic envenoming.

Only about 10% of envenomed individuals show a specific response to *B. atrox* antigens, which is surprising as this is the most common venomous species found in the study area (Chippaux, 1987). *Bothrops brazili* and *B. bilineatus*, which are relatively difficult to find in the study area, accounted for about 20% of the positives on the ELISA (10% each), and this figure appears to be a genuine reflection of their frequency. Finally, *L. muta* constitutes almost 70% of the positive responses, and this species represents less than 10% of the venomous snakes collected. In an earlier study (Chippaux and Bressy, 1981) a method was proposed for the evaluation of species of medical importance to man in the region; during the prospective study all snakes encountered in the work area were collected, and it was shown that the number of different species collected appears to be related to the species responsible for bites. In French Guiana the two methods (ELISA and snake collection) show a wide variation, which may be explained by the following hypotheses. First, snake collection may be selective in that some species (e.g. *L. muta*) may be more difficult to catch, possibly because of the temerity or size of the individual species. Second, snake collection may be reliable in terms of bites but not in terms of actually causing envenomation. For example, *B. atrox* may be less aggressive than, or may not inject venom as frequently as, other species such as *L. muta*.

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