

N° 8739

It is unsurprising that older patients and those with lower serum albumin at admission had the worst outcome. Of greater interest was the poor outcome of patients referred with intestinal failure due to sepsis and/or fistulation developing after complications of peptic ulceration or pancreatitis. Earlier transfer to a specialised unit might improve outcome in these cases.

That 90% of our patients were discharged after a median of 28 days attests to the success of our treatment; by contrast, the median inpatient stay that preceded admission to our unit of patients from outside the health district of Hope Hospital was 43 days. Similar results have been achieved in units in France¹³ and the USA.¹⁴ Moreover, patients with intestinal failure are often young (median age 43 years) and have dependents, and may return to gainful employment. We recommend that units be established for the management of chronic intestinal failure.

We acknowledge the skill and dedication of Sister Oldfield and her nurses, without whom none of these results could have been obtained. We also thank our biochemist, pharmacist, and dietician colleagues for their support.

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EPIDEMIOLOGY

× Tick-borne borreliosis in West Africa

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Reported cases of tick-borne relapsing fever due to the spirochaete *Borrelia crociduræ* are rare in West Africa, and few epidemiological data are available. To see how common relapsing fever is in Senegal thick blood smears from cases of fever of unknown origin and from randomly selected clinic outpatients from a rural dispensary were examined for *Borrelia*. The prevalence of *Borrelia* infections in small mammals was also assessed. *Borrelia* was seen in smears of 12 (0.9%) of 1340 children. All children who tested positive had complained of acute fever. Prevalence was 0% (0/496), 0.5% (2/417), 1.6% (5/308), and 4.2% (5/119) at ages 0-1, 2-4, 5-9, and 10-14, respectively. 26 other instances of borreliosis were seen in patients from different regions of Senegal. Blood samples from 7 of these patients were inoculated intraperitoneally into white mice; serious infection developed in all mice. *Borrelia* was seen in thick smears from 65 of 461 wild rodents or insectivores. Six rodents species were infected. From a sample of 93 rodents, 33.3% were infected, as judged by intraperitoneal inoculation of white mice,

compared with 14.1% by direct smear examination. The findings suggest that borreliosis has a wide distribution and a high incidence in Senegal. This disease may be a major cause of morbidity in rural areas throughout much of West Africa.

Lancet 1991; 337: 473-75.

Introduction

The spirochaete, *Borrelia crociduræ*, was first described from the blood of a musk shrew from Dakar, Senegal,¹ and was later identified as the cause of relapsing fever (borreliosis) in West Africa.² The only known vector is the tick, *Alectorobius sonrai* (formerly *Ornithodoros erraticus sonrai*).³ Various species of rodents and insectivores may be reservoirs for the infection.⁴

B. crociduræ has remained poorly studied. Case reports are rare, no epidemiological surveys of this spirochaete have been done in rural areas, and, according to the World Health Organisation's distribution map of endemic tick-borne

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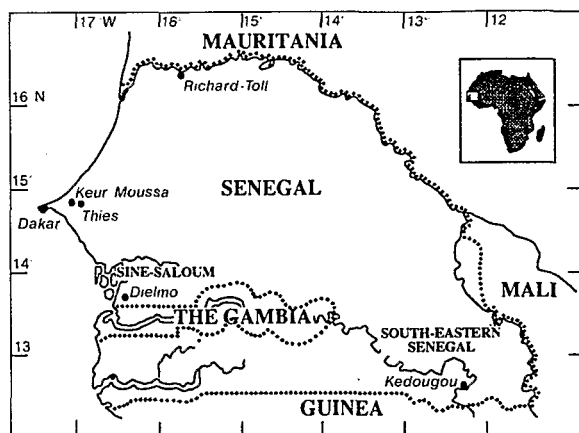
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Map of Senegal showing the study areas.

relapsing fever, the disease is present in only three West African countries—namely, Guinea Bissau, Ivory Coast, and Togo.⁵

In 1989, a French child living in Senegal had seven consecutive febrile episodes over a three-month period before the diagnosis was made. The history of this patient suggested that *Borrelia* infections in other individuals may remain undiagnosed. We therefore decided to do an epidemiological survey of tick-borne relapsing fever in Senegal.

Subjects and methods

Clinic outpatients

Children (0–14 years old) visiting the rural Catholic Mission dispensary at Keur Moussa, Senegal—about 50 km east of Dakar and 15 km west of Thiès—were studied. This dispensary is the largest in the area, and deals with about 70 000 patients annually. The study was originally designed to assess the importance of malaria. Children were randomly selected from numbers issued to them on arrival at the dispensary. From June, 1989, to May, 1990, 1340 patients were enrolled in the study. These children had a clinical examination and were interviewed. A thick blood smear from each child was prepared, stained with Giemsa, and 200 oil immersion fields ($\times 1000$) were systematically examined for *Borrelia* (equivalent to about 0.5 μ l blood).

TABLE I—PREVALENCE OF SMALL MAMMALS POSITIVE FOR *BORRELIA* IN TWO RURAL AREAS OF SENEGAL

Species	Areas	
	Dakar/Thiès	Richard Toll
Rodents		
Gambian gerbil (<i>Tatera gambiana</i>)	1/5 (20%)	..
Taterilline gerbil (<i>Taterillus</i> sp)	0/3	0/6
Giant Gambian rat (<i>Cricetomys gambianus</i>)	0/6	..
House mouse (<i>Mus musculus</i>)	0/5	3/14 (21%)
Black rat (<i>Rattus rattus</i>)	0/3	..
Nile rat (<i>Arvicanthus niloticus</i>)	10/67 (15%)	26/131 (20%)
Shaggy rat (<i>Dasymys incommisus</i>)	0/1	..
Dalton's mouse (<i>Myomys daltoni</i>)	0/12	..
Multimammate rat (<i>Mastomys erythroleucis</i>)	22/143 (15%)	..
Hubert's multimammate rat (<i>Mastomys huberti</i>)	0/7	3/31 (10%)
Insectivores		
West African hedgehog (<i>Atelerix albiventris</i>)	0/15	..
Musk shrew (<i>Crocidura</i> sp)	0/5	0/7
Total	33/272 (12%)	32/189 (17%)

Values are no of animals positive/no of animals trapped (%).

Small mammals

From September, 1989, to September, 1990, small mammals were trapped in the region of Dakar-Thiès (near the villages of Keur Moussa, Niaga, Mbaouane, and Sindia) and in northern Senegal—near Richard Toll on the Mauritanian border (figure).

A thick blood smear was collected from each of the captured mammals and 200 oil immersion fields were systematically examined. This method of detection was compared with another method in a sample of 93 rodents captured near Thiès in which 500 μ l of blood from each animal was inoculated intraperitoneally into white mice. Blood smears from these mice were examined for *Borrelia* after three to seven days, as described above.

Other investigations

Occasionally, other patients with fever of unknown origin were tested for *Borrelia* by examination of blood smears. Personnel of various medical units in Senegal were informed of our research on relapsing fever. Further observations of cases were obtained in this way. Samples of blood from 7 patients were inoculated intraperitoneally into white mice, blood smears of which were examined as described above.

Burrows of rodents in the region of Thiès were opened and examined for ticks.

Results

Clinic outpatients

Borrelia was found in smears from 12 (0.9%) of the 1340 children. These 12 children were from ten villages. By age, the proportion of positive smears was 0/496 for children younger than 2 years old, 2/417 (0.5%) for those between 2 and 4, 5/308 (1.6%) for those between 5 and 9, and 5/119 (4.2%) for those between 10 and 14. All patients who were positive complained of acute fever. However, at the time of consultation, 8 patients were afebrile, 3 had temperatures over 39°C, and 1 was mildly febrile (38.4°C). In 9 patients, illness had been developing for between four days and two weeks; symptoms were generally described by the patient or family as severe. 8 patients had conjunctival anaemia and 2 had jaundice.

Small mammals

461 animals (434 rodents, 27 insectivores; twelve species) were collected (table 1). Smears were positive for *Borrelia* from 65 of the 461 captured animals. Five rodent species (see table 1) were infected as judged by direct examination of blood—namely, *Arvicanthus niloticus*, *Mastomys erythroleucis*, *Mastomys huberti*, *Tatera gambiana*, and *Mus musculus*. *Borrelia* was found in a sixth species, *Cricetomys gambianus*, by intraperitoneal inoculation of a white mouse. More animals were found to be infected by the inoculation

TABLE II—COMPARISON OF TWO METHODS FOR DETECTION OF *BORRELIA* IN THE BLOOD OF NATURALLY INFECTED WILD RODENTS

Species	No examined	No positive	
		Direct smear	Inoculation*
Nile rat (<i>Arvicanthus niloticus</i>)	35	5 (14%)	13 (37%)
Multimammate rat (<i>Mastomys erythroleucis</i>)	45	8 (18%)	15 (33%)
Hubert's multimammate rat (<i>Mastomys huberti</i>)	7	0	1 (14%)
Giant Gambian rat (<i>Cricetomys gambianus</i>)	6	0	2 (33%)
Total	93	13 (14%)	31 (33%) †

*Intraperitoneal inoculation of white mice
†p < 0.0001 (McNemar's test).

method than by the direct method (33.3% vs 14.1%; $p < 0.0001$) (table II). All infections found by the direct method were re-identified by the inoculation method.

Other investigations

Borrelia was demonstrated in the blood of 26 patients with fever from various regions of Senegal. The place of contamination was believed to be Richard-Toll (7 cases), Dakar-Thiès region (11), southern Sine-Saloum (5), south-eastern Senegal (1), and was unknown in 2 cases. Meningeal signs and jaundice were seen in each of 3 patients. All patients recovered after treatment with tetracycline. Blood samples taken before treatment from 7 patients caused *Borrelia* infection in mice when inoculated intraperitoneally.

Of 73 burrows opened near Thiès (Keur Moussa and Sindia villages), 40 contained *A sonrai* nymphs or adults.

Discussion

We believe that the infections in the patients and small mammals in our study were due to *B crocidurae*. Several features lead us to this conclusion: (1) the clinical characteristics of our patients; (2) the high prevalence of infection in rodents; (3) the constant receptivity of white mice to strains isolated from patients; and (4) the abundance of the tick *A sonrai* in rodent burrows.

We have found that relapsing fever is a common cause of morbidity in the rural villages of west-central Senegal. For children under 5 years old the relative importance of this disease is low, probably because of the high incidence of many other infections in this age group. For older children, relapsing fever becomes one of the main reasons for visiting the dispensary; for children aged 10-14, the incidence of relapsing fever was second only to malaria. Adults were originally excluded from this study, but later observations suggest that relapsing fever is at least as common in adults as in older children (unpublished). The high incidence of disease in human beings probably reflects the close association with the vector tick and with the rodent reservoir since burrows are frequently found inside or near the houses. Whether a large proportion of the population acquires a protective immunity remains to be investigated. The lack of in-vitro cultivation methods for *B crocidurae* limits the development of serological tests.

Diagnosis of relapsing fever is often difficult.^{6,7} Of the 12 cases diagnosed in our clinic outpatients, thick smears of 7 had fewer than five *Borrelia* in 200 fields; only 1 sample showed more than twenty *Borrelia* in 200 fields. Moreover, in the case that prompted our study, two thick smears were negative (1600 oil immersion fields examined during two febrile episodes) despite a clinical record suggestive of borreliosis. Positive diagnosis of the infection was made only after inoculation of a white mouse. Thus, the absence of *Borrelia* in thick smears does not rule out the presence of infection. Since thick smears alone were used for diagnosis in our clinic outpatients, the true number of relapsing fever cases was probably higher than the recorded number.

How important is tick-borne relapsing fever in West Africa? Our findings suggest that *B crocidurae* is endemic in most regions of Senegal and neighbouring countries: documented cases were obtained from areas bordering Mauritania and Nali, and preliminary results of a continuing study in a village near The Gambia (Dielmo) also point to a very high incidence rate in that village (unpublished). Owing to research at the Pasteur Institute of Dakar after 1917, relapsing fever was well known in Senegal in the

1940s.⁸ However, the disease has since been forgotten almost completely. For example, medical personnel at our study dispensary were not aware of this infection.

We believe that the true geographic distribution of tick-borne relapsing fever is probably very large, and that this disease may be a major cause of morbidity throughout much of West Africa.

We thank Mother Prioress and Sister Pascale from the Servantes des Pauvres Congregation in Keur Moussa for their invaluable assistance. We also thank Dr Mark Wilson for helpful review of the manuscript and discussion of the findings.

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From The Lancet

Neglected biographies

Biography is a branch of literature which has assuredly not languished for want of cultivation. Yet there is one department of it which has hardly been touched. We should like to have the biographies of compensated sufferers from railway accidents. What becomes of them? How far is prophecy fulfilled in their case? Medicine is constantly called to perform a difficult and dubious task on their behalf. It has to dissect the impressions, the symptoms, and the statements of the sufferers; to investigate the objective conditions and the subjective feelings of these unfortunate and often sadly injured patients; to appreciate the actual injury; to detect occasional imposture; to prophesy future conditions. The task is one of immense difficulty, and yet further complicated by the fact that medical practitioners are called under circumstances which of necessity affect their judgment; they are summoned by the one side or the other, and are impressed with one-sided statements from the first. They are never called as assessors to the Court, having the benefit of the careful sifting of evidence; but are engaged as advocates to perform duties which are really judicial. The differences of opinion which arise under such circumstances are not confined to medical experts; chemists, engineers, surveyors, scientific experts of all kinds, are equally liable to such differences. This has been going on for a considerable time; and we can but feel that very useful information would be afforded to all of us if we could now review the past, and learn what has become of the compensated victims. Who of them are worse; who are better? Have any of them suddenly recovered after receiving their cheques? Have any whom the railway advocates and the physicians and surgeons who gave evidence "on that side" described as impostors, or pooh-poohed as hysterical hypochondriacs, fallen gradually into paralytic decadence? These are questions which we are all interested in solving.

(Jan 6, 1866)