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Malaria and urbanization in Central Africa: the example of Brazzaville.

Part V: Pernicious attacks and mortality

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Summary

The current incidence of pernicious attacks and of mortality due to malaria were studied in Brazzaville. The results of this study, which concerned all the medical units of the town, were analysed in terms of previous studies on the epidemiology of malaria transmission in the various districts of the town.

It was estimated that the annual incidence of pernicious attacks in children in Brazzaville is 1·15 per thousand between 0 and 4 years, 0·25 per thousand between 5 and 9 years and 0·05 per thousand between 10 and 14 years. The annual mortality due to malaria was estimated at 0·43 per thousand between 0 and 4 years and 0·08 per thousand between 5 and 9 years. These values are about 30 times lower than those expected from the results of previous studies of the mortality due to malaria in intertropical Africa.

Whereas considerable differences in intensity of malaria transmission exist in the different districts of Brazzaville, the incidence of pernicious attacks and the resulting mortality are remarkably unvarying whatever the level of transmission. In particular, similar results were observed for the sector Mfilou-Ngamaba-Ngangouoni, where malaria is holoendemic with over 100 infective bites per person per year and a parasite rate of 80·95% in schoolchildren, and the central sector of Poto-Poto-Ouenze-Moungali, where malaria is hypoendemic with less than one infective bite per person every three years and a parasite rate of less than 4% in schoolchildren.

These results are discussed in terms of previous observations in urban and surrounding rural areas. The authors consider that at the present time there is a dramatic drop in mortality due to malaria despite the maintenance in rural areas and numerous urban districts of very high transmission ensuring a stable holoendemicity. This drop is attributed to the widespread use of antimalarial drugs by the population.

Introduction

Whereas all the populations residing in the rural area around Brazzaville are exposed to a very high intensity of malaria transmission, about one infective bite per night per person, the inhabitants of Brazzaville itself are exposed to variable degrees of malaria transmission intensity, according to the district where they live and, particularly, to the geographical site and the type and age of urbanization. The rate of inoculation thus varies from about 100 infective bites per person per year to less than one infective bite per person every three years, and considerable differences are also observed for the malaria prevalence which varies from 3·36% to 80·95% in schoolchildren according to the district of the town (TRAPE, see pp. 1-9, 26-32; TRAPE & ZOULANI, see pp. 10-18, 19-25).

It is generally acknowledged that in areas of high malaria endemicity the incidence of severe clinical forms of malaria and the resulting mortality are high for infants and very young children but from then on decrease considerably because of acquired immunity. For this reason, in regions where malaria eradication is not possible at the present time, the question of the advisability of taking measures to reduce transmission intensity and of systematic chemoprophylaxis for infants and young children have, for a long time, been subjects of controversy, since they could delay or prevent the acquisition of immunity and thus increase the incidence of serious forms of malaria in age groups normally spared (WILSON, 1939; SCHWETZ, 1948; SWELLENGREBEL, 1950; VISWANATHAN, 1951; WHO, 1968; KOUZNETSOV, 1979; MOLINEAUX & GRAMICCIA, 1980; WHO, 1980; ONORI *et al.*, 1982; GREENWOOD, 1984). Indeed, although numerous studies have shown an important decrease in serum gamma-globulin and malaria antibody levels during prolonged chemoprophylaxis (MCGREGOR *et al.*, 1956; MCGREGOR & GILLES, 1960; GILLES & MCGREGOR, 1959, 1961; VOLLER & WILSON, 1964; MATTERN *et al.*, 1967; CORNILLE-BRÖGGER *et al.*, 1978), the conditions have not yet been established under which this decrease would be susceptible to accompaniment by a sufficiently large or durable increase in the incidence or the gravity of clinical attacks of malaria when chemoprophylaxis is stopped, to counterbalance the positive effects previously observed. Moreover, although there is no doubt that any prolonged interruption in transmission can have very serious consequences when transmission is renewed, as is clearly shown by the examples of populations living in areas of epidemic or unstable malaria (CHRISTOPHERS, 1948; FONTAINE *et al.*, 1961), the price paid by populations residing in holoendemic areas is sufficiently high, and at least the immediate benefits of antivectorial measures are sufficiently important (HOFFMAN & VAN RIEL, 1948; DRAPER & DRAPER, 1960; PAYNE *et al.*, 1976) that the question of the advisability and the eventual choice of methods for such measures remains to be settled. In this context, during various projects of malaria control where transmission, initially very high, was interrupted or considerably decreased for several years, the observation of the populations concerned did not show any important adverse effects when measures were stopped and transmission began again (BRUCE-CHWATT, 1963; PRINGLE, 1967; MOLINEAUX & GRAMICCIA, 1980).

In the case of Brazzaville, because of the very low intensity of malaria transmission observed in various districts of the town, the first experience of malaria occurs late in childhood for most children, and the acquisition of immunity is uncertain or very slow for the whole of the population living in these districts. This specifically urban phenomenon, which appears in a region where malaria remains holoendemic, is liable to modify considerably the classical epidemiological aspects of severe forms of malaria. Furthermore, the presence of numerous populations in other districts of the town where intensity of malaria transmission remains very high, allows a detailed comparison with these sociologically and economically similar populations for whom the acquisition of immunity remains unchanged.

In the present study, we attempted, on the one hand, to estimate the present-day incidence of severe forms of malaria and the resulting mortality in Brazzaville and, on the other hand, to specify the impact of the considerable decrease in transmission intensity observed in certain districts.

Material and Methods

General Considerations

Although there are numerous varieties of pernicious malaria with different symptoms (GALLAIS, 1945; REY *et al.* 1966; MARSDEN & BRUCE-CHWATT, 1975) sooner or later cerebral symptoms (alterations in the level of consciousness) are observed. These enter into the definition of cerebral malaria, whereas they are secondary symptoms accompanying severe involvements in other systems. These symptoms are considered by the parents to be sufficiently serious to justify a visit to the dispensary or hospital, and then by the doctor or nurse to justify immediate admission into hospital. Unlike simple attacks of malaria which are treated at home by the parents or in a dispensary by the nurse, we consider that in Brazzaville very few cases of pernicious malaria are not brought to the hospital. In particular, the importance of traditional medical practices does not seem to delay admittance into hospital for this type of clinical picture. Only in the case of certain religious sects, few in number but becoming more popular in urban areas, are such delays probably frequent.

Even in a hospital survey a precise estimation of the incidence of severe forms of malaria and the resulting mortality is always difficult in areas of high endemicity. Diverse methodological problems arise, as stressed by numerous authors (GARNHAM, 1949; WILSON *et al.* 1950; BRUCE-CHWATT, 1951, 1952). The health statistics are difficult to exploit, because they are usually incomplete and the information is of unequal reliability. Based on the hospital records, the problem of record-keeping and of the value of the information in these records arises. It is usual in areas of high malaria endemicity to attribute to malaria all febrile syndromes for which another aetiology is not clearly evident, especially when the thick blood film is positive. In the same way, death or coma in a child with a positive thick blood film is easily attributed to malaria especially as there are usually few possibilities for further tests. Finally, another difficulty results from the high frequency in hospitals of cases of simple malaria attacks complicated by hyperthermic convulsions with no cerebral significance (SENGA *et al.*, 1985). Convulsions are infrequent in a simple attack, but they worry the parents and usually lead to hospital admittance. They may or may not be followed by a period of lethargy, always of short duration, and their prognosis is excellent (REY *et al.*, 1966). However, these forms are often confused with cerebral malaria, which often presents inaugural convulsions, and are found under this name in the hospital records.

In order to limit the risk of errors in either direction in the enumeration of cases of pernicious malaria and the estimation of their annual incidence in Brazzaville, the study undertaken by us concerned the four hospitals in this town, and several types of survey were associated.

Methods

General Hospital and Military Hospital

A longitudinal survey was carried out from December 1982 through February 1984 in the Paediatrics ward of the General Hospital and from December 1983 through February 1984 in the Paediatrics ward of the Military Hospital and the Paediatrics clinic of the General Hospital. On the one hand, we recorded the number of cases of pernicious attacks observed during the given period: on the other hand, we studied the diagnostic references used by each medical team, the feasibility and the place of biological tests, the keeping of patients' notes and hospital records, and the reliability of the information contained in them. At the end of the longitudinal survey, a retrospective survey was carried out for the period October 1982 through February 1984 using the hospital notes and the records of admittance and discharge from the hospital. From the observations made during the longitudinal survey, we considered:

For cases of recovery: all the patients' notes in which the diagnosis of pernicious malaria appeared to be probable (typical clinical picture and normal lumbar puncture).

For fatal cases: all deaths occurring within a picture of acute encephalitis or acute haemolytic anaemia (not due to drepanocytosis), and not proved to be due to a disease other than malaria.

The cases observed in children normally living outside Brazzaville were excluded from this study.

Makelekele and Talangai Hospitals

These two hospitals do not possess paediatric intensive care units. Because of this, any child presenting a coma or severe collapse is normally immediately transferred to one of the two hospitals mentioned above. In fact, the longitudinal survey which we carried out over a period of three months (December 1983 through February 1984) showed that this transfer was not systematic when loss of consciousness was only slight, and that it was therefore necessary to take into account these two hospitals even though there were only a small number of pernicious attacks. However, a retrospective survey was not possible because of the absence of patients' notes and the unreliability of hospital records. The enumeration of cases of pernicious malaria therefore covered a period of three months only, from which we estimated the number of cases per year in these two hospitals.

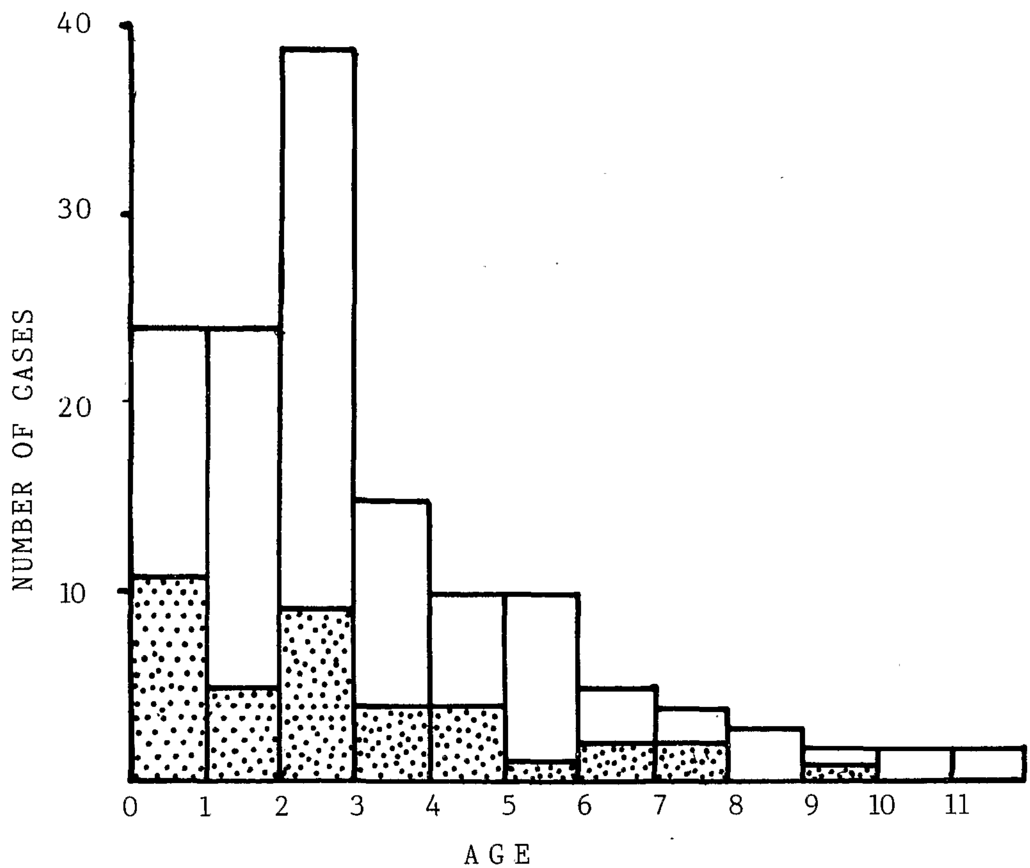

Fig. 1. Age distribution of 140 cases of pernicious attack, of which 39 were fatal, in Brazzaville hospitals. The dotted areas correspond to fatal cases.

Results

Results of the Hospital Survey

Results for each hospital

General Hospital

For the 17 months of the period October 1982 through February 1984 we took into account 112 patients' notes as being probable cases of pernicious attacks (61 in the Paediatric Ward and 51 in the Paediatric Clinic). Of these, 39 cases (34·8%) died. For the year 1983 only, 68 pernicious attacks were recorded and 29 of these patients died.

Military Hospital

For 17 months of the period October 1982 through February 1984, we took into account 25 patients' notes as being probable cases of pernicious attacks, of which two were fatal. For the year 1983 only, 21 cases were observed, of which two were fatal.

Talangaï and Makelekele Hospitals

During the three months' study, five pernicious attacks were observed (four cases in Talangaï and one in Makelekele). They were relatively mild clinical forms (two cases of lethargy and two of stupor). In all cases the evolution was rapidly favourable.

Length of development

Out of 101 cases which had a favourable outcome, the precise length of hospital stay was known for 90. It was less than three days in five cases (5·6%), between three days and one week in 64 cases (71·1%) and more than one week in 21 cases (23·3%).

For the 41 cases which had a fatal outcome, death occurred less than 24 hours after admittance into hospital in 26 cases (63·4%), between 24 and 48 hours in 40 cases (24·4%) and between 48 hours and 10 days after admittance into hospital in five cases (12·2%).

Seasonal occurrence

No seasonal variations in the frequency of pernicious attacks were observed. For the year 1983, 35·9% of the cases observed at the General Hospital and the Military Hospital occurred during the four months of the dry season (June to September), 31·5% during the first half of the wet season (January and October to December) and 32·6% during the second half of the wet season (February to May).

Age of patients

Fig. 1 shows the distribution by age of 140 cases of pernicious attacks for which the age was known.

Table I—Estimated distribution of the population of Brazzaville by age groups according to the intensity of malaria transmission in the district of residence

Transmission intensity	Population				
	0-4 years	5-9 years	10-14 years	≥15 years	Total
High	15,169	13,629	11,479	40,656	80,933
Moderate	19,179	17,241	14,127	58,802	109,349
Low	35,183	34,955	29,241	121,118	220,497
Very low	13,511	13,786	11,715	50,970	89,982
Total	83,042	79,611	66,562	271,546	500,761

Table II—Incidence of pernicious attacks in children during the period October 1982—February 1984 according to age and intensity of malaria transmission

Transmission intensity	Age groups (years)			
	0-4	5-9	10-14	Total
High	0·99‰ (15/15,169)	0·07‰ (1/13,629)	0‰ (0/11,479)	0·40‰ (16/ 40,277)
Moderate	1·41‰ (27/19,179)	0·29‰ (5/17,241)	0·07‰ (1/14,127)	0·65‰ (33/ 50,547)
Low	1·34‰ (47/35,183)	0·31‰ (11/34,955)	0‰ (0/29,241)	0·58‰ (58/ 99,379)
Very low	0·88‰ (12/13,511)	0·29‰ (4/13,786)	0·09‰ (1/11,715)	0·44‰ (17/ 39,012)
Total	1·22‰ (101/83,042)	0·26‰ (21/79,611)	0·03‰ (2/66,562)	0·54‰ (124/229,215)

62·1% of the cases were children from 0 to 2 years and 84·6% children under 5 years.

Epidemiological Analysis

Distribution of the population of Brazzaville according to the malaria transmission intensity

In a previous article (TRAPE & ZOULANI, see pp. 19-25) we drew up a map of the intensity of malaria transmission in Brazzaville, in which four levels of transmission were considered:

Very low transmission: less than one infective bite per person per half-year;

Low transmission: from one infective bite per person per half-year to one infective bite per person per month;

Moderate transmission: from one infective bite per person per month to one infective bite per person per week;

High transmission: at least one infective bite per person per week.

From census results for 1974 (D.S.C.E., 1976) and 1983 (GONDZIA, 1983) as well as aerial observations and photographs (IGN, 1978; TRAPE, unpublished observations) we estimated the population living in each of the four regions defined above. Furthermore, by incorporating the results of a previous study (URBANOR, 1980) on the age pyramid in each administrative district, we also estimated the number of children from 0 to 4 years, 5 to 9 years and 10 to 14 years living in each of these regions (Table I).

Incidence of pernicious attacks according to degree of exposure

Of 142 patients' notes on pernicious attacks collected during the hospital survey, 124 included the exact address of the patient and each was localized on a map of Brazzaville (Fig. 2), thus allowing a comparison of the incidences of pernicious attacks in the four areas of malaria transmission intensity.

The results are shown in Table II. It can be seen that during the survey the incidence of pernicious attacks in children is 0·40 per thousand in the high transmission area, 0·65 per thousand in the moderate transmission area, 0·58 per thousand in the low transmission area and 0·44 per thousand in the very low transmission area. For each transmission area, the incidence of pernicious attacks is at a maximum in the age group 0-4 years: it is 0·99 per thousand in the high transmission area, 1·41 per thousand in the moderate transmission area, 1·34 per thousand in the low transmission area and 0·88 per thousand in the very low transmission area. Over the age of four years, the incidence of pernicious attacks is considerably lower in each of the areas: 0·07 per thousand in high transmission areas, 0·36 per thousand in moderate transmission areas, 0·31 per thousand in low transmission areas and 0·38 per thousand in very low transmission areas. The proportion of pernicious attacks occurring before the age of five years is thus 93·8%, 81·8%, 81% and 70·6% in each of these areas, whereas the average ages for pernicious attacks are

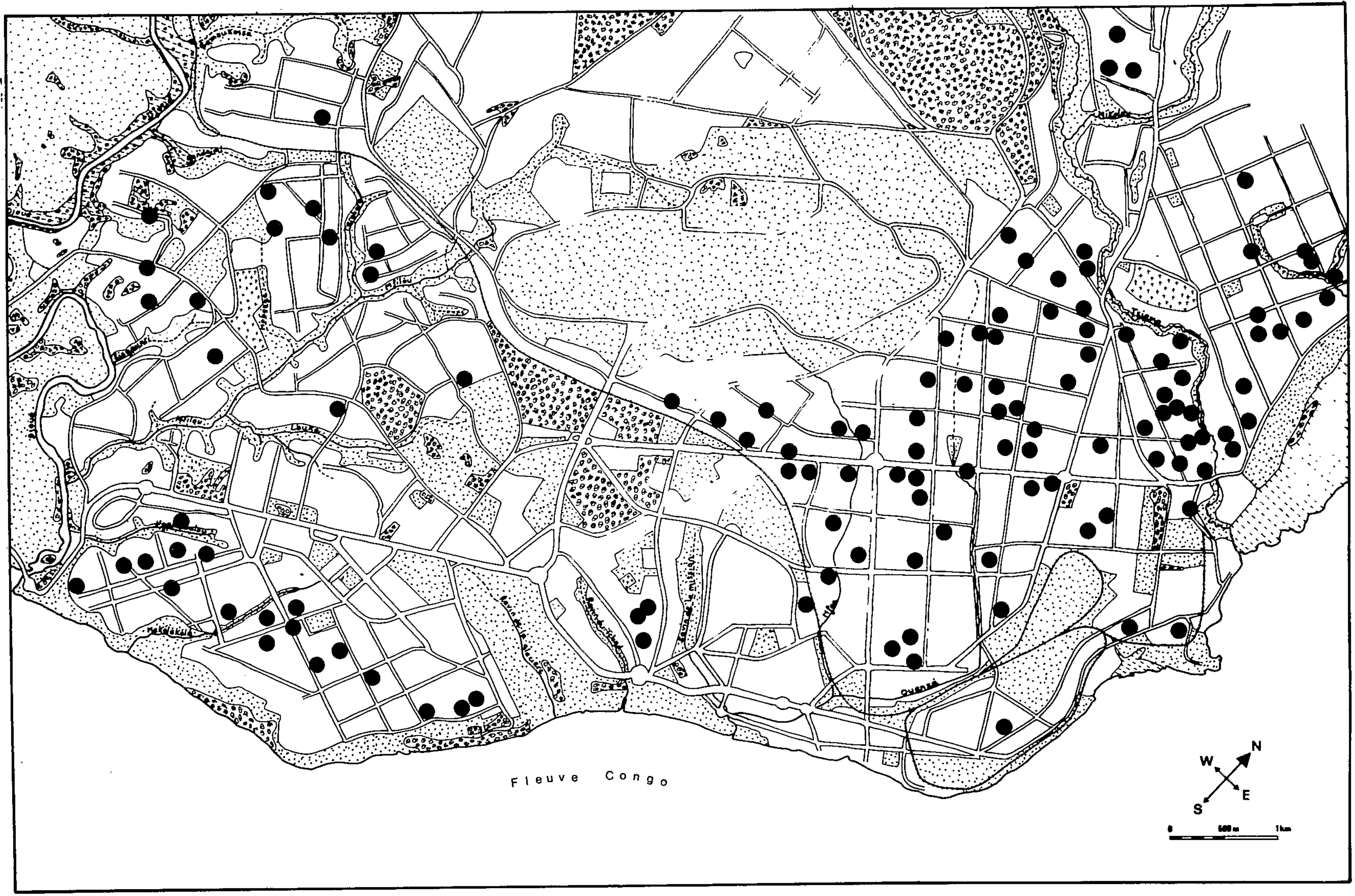

Fig. 2. Map of Brazzaville showing the localization of pernicious attacks.

respectively 27 months, 36 months, 33 months and 39 months.

The differences observed between the areas of transmission in the incidence of pernicious attacks are not significant, neither generally nor in any age group. Likewise, the incidence of pernicious attacks is remarkably similar in the central sector of Poto-Poto-Ouenze-Moungali and in the sector of Mfilou-Ngamaba-Ngangouoni whereas the malaria transmission intensity is at least 300 times superior in the latter sector (TRAPE & ZOULANI, see pp. 10-18): respectively 0·35 per thousand (estimated number of children from 0 to 14 years = 25,584, number of pernicious attacks: 9) and 0·38 per thousand (estimated number of children from 0 to 14 years: 23,800, number of pernicious attacks: 9).

All deaths from pernicious attacks occurred before the age of 10 years. For the whole of the 0 to 9 years age group, the incidence of death per thousand was 0·24 in the high transmission area, 0·30 in the moderate transmission area, 0·20 in the low transmission area and 0·15 in the very low transmission area.

The fact that the duration of the survey was considerably shorter in the Makelekele and Talangai Hospitals is only liable to modify the above results slightly. These two hospitals receive other patients coming from all over Brazzaville and the number of patients admitted with pernicious attacks is very low. However, the number of pernicious attacks is higher in Talangai Hospital than in Makelekele Hospital; this would cause an underestimate in this study of the incidence of pernicious attacks which is higher in the moderate transmission area, whence most patients admitted into Talangai Hospital originate, than in the other transmission areas.

Annual incidence of pernicious attacks in Brazzaville

During 1983 we recorded 68 cases of pernicious attacks in the General Hospital and 21 cases in the Military Hospital. We also estimated the annual number of pernicious attacks treated in the Makelekele and Talangai Hospitals to be about 20. Finally, it would appear that children who were already dead or who died on arrival at the hospital were not included in this type of survey. We thus estimated that each year in Brazzaville hospitals, about 10 more cases of pernicious attacks, all fatal, should be added to the total number.

On a base of 119 cases in 1983, of which 42 were fatal, and of the age distribution previously calculated for 140 patients, the annual incidence of pernicious attacks in children in Brazzaville is 1·15 per thousand between 0 and 4 years, 0·25 per thousand between 5 and 9 years and 0·05 per thousand between 10 and 14 years.

The annual incidence of death from pernicious attacks is 0·43 per thousand between 0 and 4 years and 0·08 per thousand between 5 and 9 years.

Discussion

Although considerable differences in malaria prevalence and intensity of transmission exist between the different districts of Brazzaville, the differences observed in this study of the incidence of pernicious attacks are small and insignificant. It is particularly noteworthy that the incidence of pernicious attacks is not higher in the Mfilou-Ngamaba-Ngangouoni sector, where malaria is holoendemic with more than 100 infective bites per person per year and a parasite rate of 80·95% in schoolchildren, than in the central sector of Poto-Poto-Ouenze-Moungali, where malaria is hypoendemic with less than one infective bite per person every three years and a parasite rate less than 4% in schoolchildren. Moreover, although the average age of pernicious attacks is higher in very low transmission areas than in high transmission areas, we nevertheless observe that pernicious attacks are very rare in children over four years old whatever the level of exposure.

Finally, we also observed that the annual incidence of pernicious attacks and the annual mortality rate due to malaria in children reported in this study are much lower than those generally reported up to the present in Central Africa and in the other regions of Africa where malaria is holoendemic.

Whereas we observed an annual mortality of 0·43 per thousand between 0 and 4 years and 0·08 per thousand between 5 and 9 years, a review of studies on mortality due to malaria in Zaire (DUREN, 1937, 1951) reported rates between 12 and 24 per thousand each year in children from 0 to 3 years. Likewise, JANSSENS *et al.* (1966) in the Ituri reported an annual mortality due to malaria of 40 per thousand in infants and 22 per thousand in all children. These high values observed in Central Africa were similar to those observed in other regions of Africa where malaria is holoendemic. Thus, in the urban area of Lagos, BRUCE-CHWATT (1952, 1963) estimated the rate of mortality due to malaria to be about 12·5 per thousand in infants, seven per thousand between one and four years and one per thousand between five and ten years. This author added: "Compared with similar estimations in other regions of Africa, the values found in the region of Lagos in Nigeria are lower in infants and children. It is probable that the values for Nigeria, if they were available for rural areas, would be superior by about a third to a half". In Accra, COLBOURNE & EDINGTON (1954) reported an annual mortality from malaria of 15·7 per thousand in children under five years of age.

In 1972, a WHO inter-regional conference proposed an estimation of the death rate due to malaria in Africa (WHO, 1974): "On the basis of a few past studies, it can be estimated that malaria is directly responsible for about one million deaths annually of infants and children below the age of 14 years". For a total exposed population of about 200 millions in 1972, and taking into account the much lower rate of mortality between 5 and 14 years than under 5 years, this estimation infers an annual mortality rate due to malaria of more than 15 per thousand for children from 0 to 4 years.

Thus, the rates of mortality due to malaria observed in this study are about 30 times lower than those expected from the results of previous studies, most of which, however, date back a long time or concern remote rural areas. In the districts of Brazzaville where transmission is low or very low, these results might be explained by the very low malaria incidence. It must be noted, however, that the low incidence of pernicious attacks in young children is not compensated by a higher incidence in older children.

On the other hand, in the districts of Brazzaville where transmission is moderate or high, there is a considerable difference between the results expected and those observed. In these districts, a rate of mortality of 15 per thousand corresponds to 515 annual deaths due to malaria in children under five years, whereas we observed only 14 deaths in 1983. Even by adding to this total some unrecorded or unlocalized cases, the total number of annual deaths from malaria remains very low.

It is probable that a survey limited to hospitals underestimates the real number of pernicious attacks and of deaths due to malaria in the general population. However, for reasons explained above, we consider this underestimation to be very slight in the case of Brazzaville. Furthermore, due to the absence of post-mortem verification, we cannot affirm that all deaths attributed to malaria in this study are actually due to this disease. The diagnosis of pernicious attack could have been made mistakenly at times, particularly in cases when death occurred before biological tests, especially lumbar puncture, could be carried out.

The results of this study link up with those of two other studies recently carried out in Brazzaville and the surrounding rural area which used very different methods. In Brazzaville, an O.C.E.A.C. survey based on interviews with 4,267 randomly selected mothers (cluster sampling) indicated an annual mortality due to malaria of 0·6 per thousand in children below five years of age (MERLIN, 1984). In Linzolo and the neighbouring villages, where malaria is holoendemic, the study of a cohort of 548 live-born infants showed that 484 (88·3%) of these children reached their fifth birthday. Infant mortality was 71 per thousand (39 deaths, of which 34 occurred before 6 months of age) and mortality in the one to four-year age group was 49 per thousand (25 deaths out of 509 children having reached the age of one year). Malaria was not suspected as the direct cause in any of these cases (GUILLO DU BAUDAN, 1982; CARME *et al.*, 1984).

It would thus seem that at the present time there exists a considerable decrease in mortality due to malaria, in Brazzaville as well as in the surrounding region, irrespective of the modifications in the level of endemicity due to urbanization, and despite the persistence of a very high level of endemicity in rural areas as well as all the recently urbanized districts. In a previous paper (TRAPE, see pp. 26-33) we showed the unusual aspect of the graph of variation in malaria prevalence as a function of age in Brazzaville and the surrounding area, with the presence of a maximum prevalence between 10 and 14 years indicating the importance of the use of antimalarial drugs in the younger age groups. This use has two aspects: irregular prophylactic use and presumptive chemotherapy of febrile attacks. In both cases we emphasized the growing role of self-medication (TRAPE *et al.*, 1987). We attribute the present drop in mortality due to malaria in Brazzaville and the surrounding area to this important use of antimalarial drugs. This drop in mortality has come about despite the total absence of any specific anti-malarial campaign and the persistence in rural areas and in numerous districts of the town of very high transmission which maintains a stable holoendemic state.

It is well known that the onset of a pernicious attack can be very sudden, sometimes less than 24 hours after the appearance of the first clinical signs. However, such an acute development is normally very rare. Nevertheless, these forms represent two thirds of the pernicious attacks now observed in Brazzaville, probably indicating that it is becoming exceptional for a child to remain febrile for several days without receiving a presumptive antimalarial treatment, thus preventing severe complications.

The part played by malaria as a cause of death in association with other diseases has never been estimated with any certainty (WHO, 1974). However, some indication of the importance of this contribution was gained by contrasting figures of crude mortality in holoendemic areas before and after the introduction of antimalarial measures (MCGREGOR, 1960). In general, the reduction in mortality rates was much more important than expected from the results of studies investigating the importance of malaria as a direct cause of death: infant death rate fell from 308 to 132 per thousand following mass weekly chemoprophylaxis in a hyperendemic area of Zaire (JANSSENS, 1952), and malaria control by spraying insecticides was accompanied by a marked reduction in infant death rates during two control schemes in East Africa: from 165 to 78 per thousand in Pare-Taveta (DRAPER & DRAPER, 1960), and from 157 to 93 per thousand in the Nyanza province (PAYNE *et al.*, 1976). Although control projects are generally accompanied by improvement of health care facilities, such differences are impressive and suggest the importance of malaria as a contributory cause of death.

However, in Brazzaville, data collected by MERLIN (1984) do not show higher infant and child crude death rates in the most malarious districts of the town, and present figures of infant and child mortality in rural and urban areas are lower than those observed following malaria control in other regions of Africa: in urban Brazzaville, infant death rate was 64 per thousand in 1974 and 57 per thousand in 1984 (DUBOZ, 1984; MERLIN, 1984); in rural areas, infant death rates during two different studies were respectively 62 per thousand and 71 per thousand (DUBOZ, 1984; CARME *et al.*, 1984). Whatever the part played by medical services, these figures suggest that the widespread use of antimalarials contributes to the reduction of both direct and indirect mortality from malaria.

If this analysis is correct, the development of strains resistant to 4-amino-quinolines would probably have major consequences, since it would seriously affect the present process of initial treatment of febrile children by the parents. The income level of most of the populations involved in this study (URBANOR, 1980), although considerably higher than that of populations living in remote rural areas or in other regions of Africa, remains very low. It would not allow the replacement of 4-amino-quinolines in the family medicine chest by new drugs which are all much more expensive: at present, the presumptive treatment by chloroquine of a febrile syndrome in an infant only costs the family 20 CFA francs (6 US cents), which explains its general use. The start of treatment in a case with a resistant strain would thus be very much delayed, whereas it is certainly the reduction of this delay which is the basis of the present drop in incidence of pernicious attacks and mortality due to malaria.

Despite the problems which will sooner or later be caused by resistance—resistance to chloroquine appeared in Brazzaville in 1985 (LEBRAS *et al.*, 1985)—this study clearly shows that the persistence of a very high level of endemicity is compatible with a considerable decrease in mortality due to malaria. This suggests that the systematic chemotherapy of fever cases is presently the most effective strategy for reducing malaria mortality in tropical Africa. In Brazzaville and the surrounding area, the most remarkable fact is that this result is not the consequence of an antimalarial campaign strategy organized by the health authorities and international organizations, but that of a compromise, spontaneously established by the populations concerned, between the chemoprophylaxis which was recommended to them and the chemotherapy which was reserved for the medical units. It is probable that the case of Brazzaville and its environs is not isolated, and that this same phenomenon will, from now on, become frequent in intertropical Africa. In places where this does not occur, particularly in remote rural areas, this study suggests that an authentic policy of primary health care could rapidly have a considerable impact on mortality due to malaria.

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References

Bruce-Chwatt, L. J. (1951). Malaria in Nigeria. *Bulletin of the World Health Organization*, **4**, 301-327.
Bruce-Chwatt, L. J. (1952). Malaria in African infants and children in southern Nigeria. *Annals of Tropical Medicine and Parasitology*, **46**, 173-200.
Bruce-Chwatt, L. J. (1963). A longitudinal survey of natural malaria infection in a group of West African adults. *West African Medical Journal*, **12**, 141-173, 199-217.
Carme, B., Guillo Du Baudan, H., Molez, J. F. & Trape, J. F. (1984). Etude rétrospective sur la mortalité de l'enfant de moins de 5 ans dans une zone rurale de la région de Brazzaville (R.P. Congo). I. Taux et causes de mortalité. *Bulletin de la Société de Pathologie exotique*, **77**, 104-114.
Christophers, R. (1948). Endemic and epidemic prevalence. In: *Malariology*. Philadelphia and London: Saunders Company, pp. 698-721.
Colbourne, M. J. & Edington, G. M. (1954). Mortality from malaria in Accra. *Journal of Tropical Medicine and Hygiene*, **57**, 203-210.
Cornille-Brögger, R., Mathews, H. M., Storey, J., Ashkar, T. S., Brögger, S. & Molineaux, L. (1978). Changing patterns in the humoral immune response to malaria before, during and after the application of control measures: a longitudinal study in the west African savanna. *Bulletin of the World Health Organization*, **56**, 579-600.
Draper, C. C. & Draper, K. C. (1960). Assessment of the effects of malaria control upon the health of the community. In: *Report on the Pare-Taveta malaria scheme 1954-1959*. East Africa High Commission, Government Press, Dar es Salam, 57-78.
D.S.C.E. (1976). *Recensement Général de la Population de 1974. Volume I-Commune de Brazzaville. 1-Structure démographique*. Ministère du Plan, Brazzaville.
Duboz, P. (1984). Mortalité et morbidité infantile et juvénile en République Populaire du Congo. *Cahiers ORSTOM, série Sciences Humaines*, **20**, 157-169.
Duren, A. (1937). Un essai d'étude d'ensemble du paludisme au Congo Belge. *Mémoires de l'Institut Royal Colonial Belge, collection in 8e*, Tome V, fascicule 5.
Duren, A. N. (1951). Essai d'étude sur l'importance du paludisme dans la mortalité au Congo belge. *Annales de la Société belge de Médecine tropicale*, **31**, 129-147.
Fontaine, R. E., Najjar, A. E. & Prince, J. S. (1961). The 1958 malaria epidemic in Ethiopia. *American Journal of Tropical Medicine and Hygiene*, **10**, 795-803.
Gallais, P. (1945). Les aspects neurologiques du paludisme. *Médecine tropicale*, **5**, 3-53.
Garnham, P. C. C. (1949). Malaria immunity in Africans: effects in infancy and early childhood. *Annals of Tropical Medicine and Parasitology*, **43**, 47-61.
Gilles, H. M. & McGregor, I. A. (1959). Studies on the significance of high serum gamma-globulin concentrations in Gambian children in the first two years of life. *Annals of Tropical Medicine and Parasitology*, **53**, 492-500.
Gilles, H. M. & McGregor, I. A. (1961). Studies on the significance of high serum gamma-globulin concentrations in Gambian Africans. III. Gamma-globulin concentrations of Gambian women protected from malaria for two years. *Annals of Tropical Medicine and Parasitology*, **55**, 463-467.
Gondzia, A. (1983). *Recensement administratif 1983-1984. Résultats de la ville de Brazzaville du 19 juin au 30 juillet 1983*. Secrétariat Général à l'Administration du Territoire, Brazzaville.
Greenwood, B. M. (1984). The impact of malaria chemoprophylaxis on the immune status of Africans. *Bulletin of the World Health Organization*, **62**, (Suppl.), 69-75.
Guillo du Baudan, H. (1982). *Contribution à l'étude de la morbidité et de la mortalité chez l'enfant de moins de 5 ans en milieu tropical*. Thèse Médecine, Paris.
Hoffman, J. & Van Riel, J. (1948). Bilan d'un an de lutte antimalarienne par pyréthrage des habitations. *Annales de la Société belge de Médecine tropicale*, **28**, 387-394.
Institut Geographique National (1978). Couverture photographique aérienne de Brazzaville. Photothèque Nationale, Saint Mandé, 78-CONG-05/150 UA G 455.
Janssens, P. G. (1952). Quoted in McGregor, 1960.
Janssens, P. G., Vincke, I. H. & Bafort, J. (1966). Le paludisme d'Afrique centrale. Son influence sur la morbidité et la mortalité des enfants. *Bulletin de la Société de Pathologie exotique*, **59**, 665.
Kouznetsov, R. (1979). Review of past and present experience in the use of drugs for malaria control in tropical Africa. WHO/MAL/79.912. (Unpublished document.)
Lebras, J., Coulaud, J. P., Bricaire, F., Lebras, M., Roue, R., Grenier, B. & Fournon, M. (1985). Chloroquine resistant falciparum malaria in the Congo. *Lancet*, **ii**, 1071.
McGregor, I. A. (1960). Demographic effects of malaria with special reference to the stable malaria of Africa. *West African Medical Journal*, **9**, 260-265.
McGregor, I. A. & Gilles, H. M. (1960). Studies on the significance of high serum gamma-globulin concentrations in Gambian Africans. II. Gamma-globulin concentrations of Gambian children in the fourth, fifth and sixth years of life. *Annals of Tropical Medicine and Parasitology*, **54**, 275-280.
McGregor, I. A., Gilles, H. M., Walters, J. H., Davies, A. H. & Pearson, F. A. (1956). Effects of heavy and repeated malarial infections on Gambian infants and children. *British Medical Journal*, **2**, 686-692.
Marsden, P. D. & Bruce-Chwatt, I. J. (1975). Cerebral malaria. In: *Topics in Tropical Neurology*, Hornabrook, R. W. (editor). Philadelphia, Davis, USA 29-43.
Mattern, P., Michel, R., Oudart, J. L. & Pillot, J. (1967). Chimioprophylaxie antipalustre et anticorps fluorescents. WHO/MAL/67.609. (Unpublished document.)
Merlin, M. (1984). Enquête de morbidité - mortalité par maladies diarrhéiques chez les enfants de moins de 5 ans à Brazzaville en République Populaire du Congo. *Rapport O.C.E.A.C.*, Yaoundé.
Molineaux, L. & Gramiccia, G. (1980). *The Garki project*. Geneva: World Health Organization.
Onori, E., Grab, B., Ambroise-Thomas, P. & Thelu, J. (1982). Incipient resistance of *Plasmodium falciparum* to chloroquine among a semi-immune population of the

United Republic of Tanzania. 2. The impact of chloroquine used as a chemosuppressant on the immune status of the population. *Bulletin of the World Health Organization*, **60**, 899-906.

Payne, D., Grab, B., Fontaine, R. E. & Hempel, J. H. G. (1976). Impact of control measures on malaria transmission and general mortality. *Bulletin of the World Health Organization*, **54**, 369-377.

Pringle, G. (1967). Malaria in the Pare area of Tanzania. III. The course of malaria transmission since the suspension of an experimental programme of residual insecticide spraying. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **61**, 69-79.

Rey, M., Nouhouayi, A. & Diop Mar, I. (1966). Les expressions cliniques du paludisme à *Plasmodium falciparum* chez l'enfant noir africain. *Bulletin de la Société de Pathologie exotique*, **59**, 683-704.

Schwetz, J. (1948). L'état actuel du problème paludéen au Congo belge, resp. en Afrique centrale. In: *Proceedings of the 4th International Congress of tropical Medicine and Malaria*, Washington May 10-18, 1948, U.S. Government Printing Office, Washington, Publication No. 3246, 896-902.

Senga, P., Mayanda, H. F. & Nzingoula, S. (1985). Profil des convulsions du nourrisson et du jeune enfant à Brazzaville (Congo). *Annales de Pédiatrie*, **32**, 477-480.

Swellengrebel, N. H. (1950). The parasite-host relationship in malaria. *Annals of Tropical Medicine and Parasitology*, **44**, 84-92.

Trape, J. F. (1987a). Malaria and urbanization in Central Africa: the example of Brazzaville. Part I: Description of the town and review of previous surveys. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **81**, (Suppl. No. 2), 1-9.

Trape, J. F. (1987b). Malaria and urbanization in Central Africa: the example of Brazzaville. Part IV: Parasitological and serological surveys in urban and surrounding rural area. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **81**, (Suppl. No. 2), 26-33.

Trape, J. F. & Zoulani, A. (1987a). Malaria and urbanization in Central Africa: the example of Brazzaville. Part II. Results of entomological surveys and epidemiological analysis. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **81**, (Suppl. No. 2), 10-18.

Trape, J. F. & Zoulani, A. (1987b). Malaria and urbanization in Central Africa: the example of Brazzaville. Part III: Relationships between urbanization and the intensity of malaria transmission. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **81**, (Suppl. No. 2), 19-25.

Trape, J. F., Zoulani, A. & Quinet, M. C. (1987). Assessment of the incidence and prevalence of clinical malaria in semi-immune children exposed to intense and perennial transmission *American Journal of Epidemiology*, **126**, 193-200.

Urbanor (1980). *Schéma directeur de Brazzaville. Etude socio-urbaine*. C.R.E.T.H., Brazzaville.

Viswanathan, D. K. (1951). A review of immunity and endemicity in malaria and a discussion on their relationship with malaria control. *Indian Journal of Malariology*, **5**, 251-269.

Voller, A. & Wilson, H. (1964). Immunological aspects of a population under prophylaxis against malaria. *British Medical Journal*, **2**, 551-552.

Wilson, D. B. (1939). Implications of malarial endemicity in East Africa. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, **32**, 435-465.

Wilson, D. B., Garnham, P. C. C. & Swellengrebel, N. H. (1950). A review of hyperendemic malaria. *Tropical Diseases Bulletin*, **47**, 677-698.

World Health Organization (1974). Malaria control in countries where time-limited eradication is impracticable at present. *World Health Organization Technical Report Series*, No. 537.

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