Studies on Malaria in Lusaka

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SUMMARY

Species diagnosis of 692 malaria-positive blood films showed a parasite formula of F 94.65, M 7.51 O 1.59, V 0.58. P. vivax which has been rarely seen in Zambia was reported in four cases. Infection with a single species, P. falciparum being the most common, was reported in 95.81%. Mixed infections were recorded in 4.19% with P. falciparum and P. malariae being most common. The need for accurate species diagnosis for appropriate chemotherapy and the importance of such data for time-limited control and eradication programmes is stressed. Age-analysis of the data showed that children are a vulnerable group with infants harbouring 13.6% of such infections. Though malaria transmission is perennial, the most intense period is between the late rainy season and early dry season with a substantial decline thereafter when the mean minimum night temperatures are lowest.

INTRODUCTION

The past two decades have seen an intensification of time-limited malaria control and eradication programmes in various parts of the world. By 1969, malaria had been eradicated from nearly 40% of the population exposed and from 36 of 145 countries originally classified partly or wholly malarious (W.H.O., 1969). However, in countries, especially those in Africa south of the Sahara, where such programmes are not feasible due variously to the lack of funds, trained personnel or insufficient base-line data, the W.H.O. Expert Committee on malaria has recommended inter alia, research on the basic aspects of the problem, (W.H.O., 1967). Such studies that have received some attention in Zambia include the prevalence of the species of Plasmodium in man in a few areas. Thus Allen and Lowenthal (1967) have reported on the species' prevalence in Ndola while Wolfe (1968) has in addition described the substantial occurrence of P. ovale on Chilubi Island, Lake Bangweulu.

This communication reports on the Plasmodium sp. diagnosed in positive blood films seen at the Parasitology Laboratory of the University Teaching Hospital, emphasizes the importance of the need for species diagnosis, notes the preponderance of malaria in children and discusses the seasonal transmission of the parasite in Lusaka.

METHOD

Thick and thin blood smears of each patient were sent to the Parasitology Laboratory for examination. The blood films came from the hospital wards and the Out-Patient's Department. The thick blood films were stained in Giemsa and where positive for malaria, the counterpart thin film was also stained, examined, and the species diagnosis confirmed. A total of 728 patients' blood films were positive between September 1971 and August 1972; of these 692 were adequate for species identification. A record was kept of the number of positive blood films and the species diagnosed during each month of the investigation.

RESULTS

Table 1

Relative prevalence of Plasmodium species in 692 patients

	P. falciparum	P. malariae	P. ovale	P. vivax
All Age Groups	655	52	11	4
Percentage	94.65	7.51	1.59	0.58
Children	354	34	8	3
Percentage	54.05	65.38	72.73	75

Table 1 shows the relative prevalence of the four species of malaria with P. falciparum having a species prevalence of 94.65%. Note should be taken of the occurrence of P. vivax in this series, a species rarely seen in Zambia. The table also records the species prevalence in children and despite the low numbers examined, shows clearly that P. malariae, P. ovale and P. vivax are more commonly seen in children than in adults, in contrast to P. falciparum.

Table 2

Analysis of malarial infections in 692 patients.

Species	All Age Groups Total	All Age Groups Percentage	Children Total	Children Percentage
P. falciparum	630	91.04	333	52.86
P. malariae	24	3.47	12	50.00
P. ovale	5	0.72	4	80.00
P. vivax	4	0.58	3	75.00
P. falciparum P. malariae	23	3.33	19	82.61
P. falciparum P. ovale	1	0.14	1	100.00
P. malariae P. ovale	4	0.58	2	50.00
P. falciparum P. malariae P. ovale	1	0.14	1	100.00

Table 2 shows the species diagnosed in 692 malaria-positive patients. 95.81% harboured a single species with P. falciparum again being the highest. In contrast, 4.19% harboured two and in one case, three species; the most common mixed infections were P. falciparum/P. malariae. The table also notes the number of children comprising this series.

Table 3:

Age analysis of malarial infections in infants.

	0–3 Months	4–6 Months	7–9 Months	10–12 Months	Total
	5	7	11	28	51
Percentage	9.80	13.73	21.57	54.90	100

Table 3 records the number of infections seen in infants from birth to one year with parasitaemia even in the 0–3 month group .

Figure 1: *Photomicrograph of P. vivax showing the young, actively ameboid trophozoite with the cytoplasm an irregular ring and the chromatin a single, circular, dark bead.*

Figure 2: *Phtomicrograph showing the macrogametocyte of P. vivax.*
Note the large, rounded parasite occupying almost the whole host cell, the single, well-defined nuclear chromatin mass at its periphery and the Schuffner's dots.

Figures 1 and 2 are photomicrographs of an ameboid trophozoite and a female gametocyte of P. vivax respectively, showing the typical features of a species reported as uncommon in man in Zambia.

Figure 3: *Graph showing the seasonal occurence of the Plasmodium species diagnosed in Lusaka.*

Key: = P. falciparum
= P. malariae, P. ovale, P. vivax
= Rainfall
= Mean minimum night temperature

Figure 3 shows the great number of P. falciparum in contrast to the other three species diagnosed each month of the investigation. The data is presented in relation to the rainfall and mean minimum night temperatures for the period. Transmission is perennial though the most intense period is between the late rainy season and early dry season (April and May). Thereafter, there is a significant decline at a time when the mean minimum temperatures are lowest.

DISCUSSION

P. falciparum, the most pathogenic of human plasmodia, is by far the most important species locally, a feature not only common in Lusaka, but indeed in other parts of Zambia and in Africa south of the Sahara in general. Multiple infection of erythrocytes was common with double infections in approximately 22% and triple infections in 7% of blood films showing only malignant tertian malaria.

P. malariae, a species most common in the equatorial belt of Africa and unevenly distributed throughout East and Central Africa, had a species prevalence of a substantial 7.51%. It is of interest to note that this species is by no means rare in Zambia as Allen and Lowenthal (1967) and Wolfe (1968) have diagnosed it in significant numbers elsewhere in the country. The species prevalence of P. ovale, the endemic home of which is tropical Africa, was 1.59%. Recent work has shown that in some parts of Zambia, this species is much more common than had been previously reported (Wolfe, 1968). In most areas of Africa, P. vivax is overshadowed by P. falciparum (W.H.O., 1969). Nevertheless, in subtropical Southern and Central Africa, the species prevalence is reported as between 1 to 10% (Rhodesia, 3 to 5%; Swaziland, 4 to 10%; W.H.O., 1969) but its occurence in Zambia is not listed. However, Allen and Lowenthal (1967) and Wolfe (1968) do report its absence in their studies. The prevalence relative to other species in this investigation is only 0.55%, but since its occurrence has been recorded in neighbouring countries, it is not surprising to find occasional P. vivax infections here.

A further point that should be noted is that P. vivax shows marked variations in its incidence over shorter or longer periods tending to prosper briefly in limited foci (Clyde, 1967). Thus more attention should be given to this point to elucidate in which areas of Zambia it could attain a substantial prevalence to be locally important. The indications thus far point to the southern areas of Zambia being ideally suited to the ecological requirements for the transmission of the species.

From tables 1 and 2 it is obvious that a substantial proportion harbour malaria other than malignant tertian. The need to identify the species with accuracy has very important implications for the chemotherapy of afflicted individuals, a point already remarked on by Allen and Lowenthal (1967). It is necessary to emphasize once again that P. falciparum undergoes only one generation of pre-erythrocytic forms. P. malariae, P. ovale and P. vivax give rise to further generations of exo-erythrocytic parasites with quartan malaria relapsing even years after the intitial attack. In Zambia, the commonly used chloroquine is a blood schizonticide and is thus ineffective against such exo-erythrocytic forms. P. malariae, the second most important species in Zambia, is radically cured (complete elimination of the parasite so that no replases occur) only with a combination of chloroquine (or other 4-aminoquinolines) with a full fourteen day course of primaquine (Peters, 1970). Failure to appreciate the need for correct species diagnosis and the appropriate chemotherapy may have serious consequences. In some instances the blame for the failure of a particular course of treatment has been erroneously laid at the door of "drug resistance" and all that it implies (Bruce-Chwatt, 1970). Aside from the obvious benefit to the patient, species diagnosis has

important implications for time-limited malaria control and eradication. This is especially so since the various species "show wide differences in behaviour in the pattern of infection they cause in man, in their sensitivity to drugs and in their persistence in man" (W.H.O., 1969).

A total of 29 of the 692 harboured mixed infections, the most common being *P. falciparum* and *P. malariae*. Past records at the University Teaching Hospital Laboratory show a conspicuous lack of such infections. Failure to diagnose mixed infections is most often due to reporting the first organisms seen and discarding the slide thereafter. No doubt insufficient laboratory staff and poorly prepared blood films submitted for examination have also led to this attitude.

Tables 1 and 2 show the species prevalence and the type of infections seen in children compared to all other age-groups. It is pertinent to mention here that those recorded as "children" in this study range mostly from birth to 10 years with a few 11 and 12 year olds. It is striking to note the preponderance of P. falciparum infections harboured by children, a feature commonly seen in various other studies in Africa. From the tables it is also clear that this species persists in early and late adulthood. P. malariae, P. ovale and P. vivax are all common again in children and in contrast to P. falciparum, appear relatively infrequently in adults probably, as noted by Clyde (1967), due to the rapid development of a strong homologous immunity which makes their appearance rare among older people.

Table 3 further records infants (primarily those admitted to the Pediatric Ward) from birth to a year harbouring malarial infections. As has been noted elsewhere (Russel et al, 1963), the passive immunity conferred by the mother to the child in malaria endemic areas diminishes as the child grows older, a feature clearly seen again in the present investigation.

However, the immune defences break down due for example to malnutrition, thus resulting in malarial infections even in the 0 – 3 month group. Such figures again emphasize that to increase the accuracy of prevalence and incidence studies, infants should form an integral part of the survey as fully 13.6% of the children infected are in this age-group.

A further point concerning the immune status of mothers that should receive careful appraisal in the future, is the effect of sporadic malaria control programmes instituted by local authorities. In many urban areas, the councils are actively engaged in house-spraying and instituting other measures against the vectors. Though in no area has transmission been interrupted, the number of cases has shown an appreciable fall. It is thus conceivable that where such programmes are currently in practice, the immune status of mothers, especially those in urban areas, many be affected, and it is thus possible that in such areas an increase in the infant parasite rate may be much higher in future than is presently the case.

The effect of malaria on children and its impact on the community as a whole have been extensively documented elsewhere (Clyde, 1967). Suffice it to say that in Zambia too, the population most at risk are children.

Figure 3 shows the four species of malaria diagnosed during the various months of the study. From this it is quite clear that although transmission is perennial and neither season is consistently free from malaria, there is a definite fluctuation in the intensity of transmission from month to month. Such knowledge is rather important since many on prophylactic drugs tend to be lax in the dry season believing that malaria only occurs during the rains. Obviously, this seasonal pattern will vary from area to area depending amongst other factors, on the rainfall pattern, the ability of the mosquitoes to breed in diverse types of habitats and the air temperature.

The well known vectors Anopheles gambiae and A. funestus in Africa are present in Lusaka and perennial transmission is probably related to their breeding behaviour. Preliminary observations show that during the rainy season and part of the early dry season, transmission is predominantly by A. gambiae which breeds principally in collections of fresh water. As the temporary breeding places dry up, the numbers of A. gambiae diminish and transmission is predominantly by A. funestus, which favours rather shaded and permanent breeding sites like rivers, dams and fish ponds.

Temperature affects the transmission of malaria primarily by its influence on the extrinsic cycle of the parasite. In Lusaka, of the various temperature indices, the mean minimum night temperatures appear crucial and as soon as such temperatures show an appreciable fall (June 1972, figure 3), the number of malarial cases show a dramatic decline.

Needless to say, in any particular area, the combination of the three factors already outlined is more important than any one factor taken singly in the interpretation of the seasonal transmission of malaria. Furthermore, in other localities, factors other than those already described, for example humidity, microclimate and altitude, may be of equal importance.

The W.H.O. (1969) has recommended further study on the influence of seasons on the prevalence of P. malariae. Figure 3 also shows the monthly frequency of the other three species diagnosed, of which P. malariae is greatest in number. Though the low numbers of such infections seen in the current

study do not permit any definite conclusions, preliminary observations indicate that P. malariae is equally prevalent throughout the year and is not limited to any particular season.

In conclusion, the observations on the seasonal prevalence show clearly that the transmission is most intense in the late rainy season and early dry season and diminishes sharply thereafter when the night temperatures are lowest. It is pertinent to record here that the only recent work on seasonal prevalence conducted in the Luapula Province also suggested a similar pattern (McCullough and Friis-Hansen, 1961). However, no detailed comparisons are possible due to the limited nature of that survey. Future studies in other parts of Zambia should, perhaps, aim at providing comparative information on the seasonal occurrence of malaria.

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