Malaria in Papua New Guinea Implications for the British Army

Major A Henderson,
MRCP, RAMC, Consultant Physician

*British Military Hospital, Hong Kong, BFPO 1

SUMMARY: Malaria poses the greatest health threat to British soldiers engaged in jungle training in Papua New Guinea. This paper provides detailed epidemiological information gained following a visit to the Papua New Guinea Malaria Research Unit in January 1986.

Introduction and Background

Papua New Guinea extends from the equator to Cape Baganowa at latitude 11.4° south, and from the border with Irian Jaya at 141° east longitude to 160° east longitude. The territory comprises a central land mass with many small islands. The population in 1980 was a little over 3 million.

The climate is tropical. In the lowland coastal areas the temperature ranges between a maximum of 32°C and a minimum of 21°C. The annual rainfall varies from 1000 mm near Port Moresby, to more than 6000 mm in the Huon peninsula. In the lowland jungles, the annual rainfall is about 4000 mm. There is no dry season, but relatively less rain falls between May and October.

The British Army holds company strength exercises in the jungles of the Sepik district near Wewak (Map I), and in the hinterland of Port Moresby. In the last 3 years, 42 cases of malaria have occurred in Gurkha soldiers involved in these exercises. As Papua New Guinea is likely to be the venue for future exercises, it has become imperative to review the malaria situation so that rational decisions can be made regarding protective measures.

Malaria Epidemiology

Malaria is endemic in all areas below 5000 feet, with only occasional *Plasmodium vivax* transmission at higher altitudes. In the coastal jungles the high temperatures and humidity favour malaria transmission throughout the year¹. In the Sepik and Madang districts mosquito biting rates are enormous. An unprotected man might expect more than 100 bites in one night³. As the prevalence of mosquitoes harbouring malarial parasites may approach 4%, the malaria risk to soldiers is therefore also enormous⁴. The area around Port Moresby is less malarious because of the drying effect of the South East Trade winds¹.

Plasmodial Species

All four human plasmodia are found in Papua New Guinea. Until 10 years ago, *P. vivax* and *P. falciparum* were dominant and equally represented^{3,5}. Considerable changes have occurred since then however, and the current distribution is, *P. falciparum* 70%–80%, *P. vivax* 15%–20%, *P. malariae* 5% and *P. ovale* 1%². Mosquitoes harbouring both *P. falciparum* and *P. vivax* are common, and in the Sepik district, mixed human parasitaemia accounts for just under half of all infections⁵. Recent British Army experience confirms the high prevalence of mixed *P. falciparum* and *P. vivax* infections^{6,7}.

Map I. Malaria Distribution in Papua New Guinea

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* British Military Hospital Rinteln BFPO 29

Malarial Vectors

Of the 20 potential vector mosquitoes found in Papua New Guinea, only three are important. They are *A. punctulatus*, *A. farauti* and *A. koliensis*. These mosquitoes are long-lived and strongly anthropophilic^{3,4}. *A. punctulatus* favours river valleys but feeds indoors, with a peak biting period around midnight^{3,4}. *A. farauti* favours the coastal areas. It bites indoors with a peak biting period before midnight^{3,4,8,9}. *A. koliensis* is common around Wewak and feeds indiscriminately throughout the night⁴.

The vector control programme has failed and has now been abandoned².

Plasmodial Resistance to Anti-malarial Drugs

Chloroquine. *P. vivax*, *P. ovale* and *P. malariae* remain fully sensitive. In 1976 chloroquine resistant *P. falciparum* was confirmed in Papua New Guinea¹⁰ and has since been widely reported. Currently, about 70% of *P. falciparum* is chloroquine resistant, but mostly at the RI level (RI 85%, RII 6% RIII 9%)^{11,12}.

Amodiaquine. Non-falciparum plasmodia remain sensitive, but amodiaquine resistant *P. falciparum* was reported from the Madang district in 1981¹³. Although amodiaquine may be superior to chloroquine in areas of chloroquine resistance,¹⁴ the drug has recently proved too toxic for large scale prophylaxis¹⁵.

Proguanil. This drug was introduced during World War II and initially proved very effective^{16,17}. Resistance however soon appeared, and in 1960 *P. falciparum* was reported to be breaking through a dose of 200 mg daily, mirroring the situation in Vietnam¹⁷⁻²⁶. The strains of *P. vivax* and *P. malariae* found in Papua New Guinea seem also to have reduced sensitivity to proguanil^{20,22}. There has been renewed interest in proguanil-chloroquine combinations for prophylaxis of chloroquine resistant malaria²⁷. Recent British Army experience has shown this to be relatively ineffective in Papua New Guinea⁷.

Pyrimethamine. Little information is available from Papua New Guinea although a report from 1961 suggested resistance was present¹⁹.

Fansidar. There have been no formal prophylaxis studies, but in a test of therapeutic efficacy, a failure rate of 10% was noted against *P. falciparum*²⁸. Fansidar is intrinsically weak against *P. vivax*^{29,30}.

Maloprim. Like fansidar, maloprim is weak against *P. vivax*^{30,31}. It is however, extremely effective against chloroquine sensitive and chloroquine resistant *P. falciparum* in Papua New Guinea³¹.

Primaquine. The Chesson strain of *P. vivax* found in Papua New Guinea is tolerant to primaquine, requiring higher than usual dosage for radical cure³².

Prophylactic Options for the British Army

1. Reducing man mosquito contact

Strict anti-mosquito discipline can greatly reduce malaria casualties³³. Insect repellents incorporating

diethyltoluamide should be applied every 3-4 hours, long sleeves and trousers should be worn between dusk and dawn and mosquito nets used within the limits of the tactical situation. An interesting new development is net impregnation with Permethrin, which is effective against tsetse fly and probably against malaria vectors³⁴⁻³⁶. Trials with this agent in the military context are urgently required.

2. Chemoprophylaxis

Proguanil and proguanil-chloroquine seem ineffective^{6,7}. Fansidar is too toxic and may be inadequate in Papua New Guinea^{28,37}. Maloprim has proven efficacy against *P. falciparum* in Papua New Guinea³¹ but should be combined with chloroquine to give protection against non-falciparum malaria. A chloroquine-maloprim combination is recommended by the Australian Government for visitors to Papua New Guinea³⁸ and by a local expert¹¹. Maloprim has toxic potential. Given twice weekly it causes agranulocytosis with a frequency of about 1:2000³⁹. Given once weekly, agranulocytosis appears to be rare, although at the expense of a slight degradation of efficacy^{40,41}. Proguanil plus dapsone is another possibility. This proved successful in Vietnam but there remains a definite risk of agranulocytosis^{26,42} and in Papua New Guinea protection against *P. vivax* is uncertain. Unlike maloprim, the regimen is not proven worth in Papua New Guinea³⁰.

On return from Papua New Guinea, a course of primaquine should be given to all men with normal levels of red cell G6PD to destroy *P. vivax* hypozoites²⁵.

Conclusions

The jungles of Papua New Guinea are intensely malarious. Prophylaxis is complicated by multiple resistance to anti-malarial drugs. The best prophylaxis appears to be rigorously enforced anti-mosquito discipline combined with chloroquine base 300 mg weekly plus maloprim one tablet weekly, starting one week before an exercise and continuing for 6 weeks after its end. On return, primaquine 7.5 mg thrice daily should be given to all men with normal levels of G6PD, for 14 days. As proguanil is used routinely for long-term prophylaxis in Hong Kong, this could be continued for administrative convenience, at little cost in side-effects.

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