Malaria is a serious illness caused by infection with one of five species of *Plasmodium*. There are approximately 2000 cases of malaria reported to Public Health England (PHE) and an average of nine deaths each year in the UK.\(^1\) Approximately 75 per cent of these infections are caused by *P. falciparum*, which is associated with more severe disease than other species and is responsible for almost all fatal cases.

Although malaria is easy to treat, delayed diagnosis as a result of low diagnostic suspicion and difficulty accessing testing facilities has probably contributed to the mortality that is seen in imported cases in the UK.\(^2\)\(^3\) Approximately 75 per cent of these infections are caused by *P. falciparum*, which is associated with more severe disease than other species and is responsible for almost all fatal cases.

The two main interventions aim to protect travellers by preventing mosquito bites and to kill malarial parasites with chemoprophylaxis before they can establish clinical infection.

**The risks of acquiring malaria**

Figure 1 is a world map of malaria endemicity, showing the proportion of children positive for *P. falciparum* at any one time.\(^2\) It provides an overview of the burden of disease in endemic communities, which is one of the most important factors when considering the risk posed to a traveller.

The risk of acquiring malaria, however, also varies with geography, season and type of travel. Conditions that favour mosquito breeding and therefore malaria transmission are high humidity, standing water and an ambient temperature in the range 20–30°C.\(^3\) Malaria transmission does not occur in regions with ambient temperatures below 16°C or at altitudes greater than approximately 2000 metres. Malaria is very much more common in rural rather than urban areas.\(^4\) Individuals staying in poor-quality accommodation are more likely to be bitten than those in air-conditioned hotels and the risk is increased in those outdoors between dusk and dawn.
Managing the risk of malaria
Determining the risk posed to a traveller, and balancing these risks with the cost and side-effects of prophylaxis, is an imprecise art and needs to be tailored to individual circumstances. Guidelines such as PHE’s Guidelines for Malaria Prevention in Travellers from the UK (see Resources) provide didactic, country-specific advice but it is important that these recommendations are not seen as rules and that the assessment of risk to a traveller includes consideration of all the factors discussed above.

Bite avoidance
Bite avoidance is the first line of defence against malaria. Mosquito bites can be reduced by using chemical agents that are toxic or noxious to mosquitoes (topical repellents, insecticide-containing coils or vapourisers and knock-down insecticidal sprays) or methods that physically prevent contact between mosquito and skin (nets, long clothing, closed windows).

The most effective topical repellent is DEET (N,N-diethyl-m-toluamide), which has been in use as an insect repellent for more than 50 years and is used safely by 200 million people each year. A wide variety of formulations and concentrations of DEET are available. In general, the duration of protection from bites is a function of the concentration of DEET and, as a guide, concentrations of 20 per cent will give one to three hours of protection while 50 per cent will provide up to 12 hours.

DEET has not been associated with adverse effects in pregnancies and may be used at a concentration of up to 50 per cent in breast-feeding and for infants and children aged over two months.

There is no evidence that homoeopathic or herbal medicines prevent malaria (they may actually increase the risk by providing false reassurance). Similarly, electronic buzzers (emitting high-frequency sound waves) do not repel mosquitoes, and commonly suggested ‘repellents’ such as vitamin B₁ and B₁₂, garlic, yeast extract (Marmite) and tea tree oil have never been shown to be effective.

Chemoprophylaxis
Sporozoites introduced into a human when a mosquito bites enter liver cells and develop into merozoites within five to seven days. These are released into the bloodstream and infect erythrocytes. Once inside the red cell, the malaria parasite grows and divides over 24 hours (P. knowlesi), 48 hours (P. falciparum, vivax or ovale) or 72 hours (P. malariae). Infected cells burst, releasing new merozoites to infect other erythrocytes.

Chemoprophylaxis of malaria may be causal (drugs that are active against the primary liver stage of malaria) or suppressive (active only against the blood stages). Causal prophylaxis needs to be continued for seven days after exposure to malaria but suppressive prophylaxis needs to be continued for a month after exposure because it is only active against parasites that have emerged from the liver.

The emergence of drug resistance has complicated the practice of malaria chemoprophylaxis in the past few decades. Chloroquine resistance is now widespread in P. falciparum and this drug can only be recommended in areas where P. vivax (but not P. falciparum) is prevalent (the Middle East and Central America). For areas where resistant P. falciparum is a risk, prophylaxis with atovaquone-proguanil, mefloquine (Lariam) or doxycycline is recommended. The characteristics of these drugs are summarised in Table 1.

Of the three, atovaquone-proguanil is the only causal prophylactic. It is more

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Figure 1. World map of malaria endemicity for children (P. falciparum) in 2010; PfAPI = areas of no risk and unstable risk, PfPR ≥ 10 = P. falciparum parasite rate in 2–10 year olds; after reference 2
than 90 per cent effective against falciparum malaria and side-effects are very uncommon but it is, unfortunately, expensive and not recommended in pregnancy. The protective efficacy of atovaquone-proguanil is at least 90 per cent and currently resistance is only considered a problem in some areas of south-east Asia. Atovaquone-proguanil is only taken weekly and is well tolerated by the great majority of individuals who take it. There is some evidence that atovaquone-proguanil use may increase the risk of psychosis and anxiety reactions and its use is contraindicated in those with a psychiatric history.

The efficacy of doxycycline is similar to atovaquone-proguanil. It is generally well tolerated but can be associated with photosensitivity, gastro-oesophagitis and

### Table 1. Characteristics of the three main antifalciparum chemoprophylactic agents in current use, as well as chloroquine-proguanil

<table>
<thead>
<tr>
<th>Drug</th>
<th>Doxycycline</th>
<th>Atovaquone-proguanil</th>
<th>Mefloquine proguanil</th>
<th>Chloroquine-proguanil</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Frequency</strong></td>
<td>daily</td>
<td>daily</td>
<td>weekly</td>
<td>daily – proguanil</td>
</tr>
<tr>
<td><strong>Efficacy against P. falciparum</strong></td>
<td>&gt;90%</td>
<td>&gt;90%</td>
<td>&gt;90%</td>
<td>unreliable</td>
</tr>
<tr>
<td><strong>Resistance</strong></td>
<td>rare</td>
<td>rare</td>
<td>pockets of SE Asia</td>
<td>widespread resistance in P. falciparum; most nonfalciparum strains remain sensitive</td>
</tr>
<tr>
<td><strong>Children</strong></td>
<td>contraindicated if age &lt;12 years</td>
<td>paediatric suspension</td>
<td>dose adjustment but no paediatric formulation</td>
<td>dose adjustment</td>
</tr>
<tr>
<td><strong>Pregnancy</strong></td>
<td>contraindicated</td>
<td>recommended to avoid unless after first trimester and high risk of malaria</td>
<td>safe</td>
<td>not contraindicated but benefit unlikely to resistance is widespread; proguanil should be taken with folate supplement</td>
</tr>
<tr>
<td><strong>Breast feeding</strong></td>
<td>BNF recommends to avoid, American Academy of Pediatrics states that risk is acceptable</td>
<td>avoid – may be used if no alternative</td>
<td>safe</td>
<td>safe</td>
</tr>
<tr>
<td><strong>Notable adverse reactions</strong></td>
<td>gastro-oesophagitis photosensitivity vaginal candidosis</td>
<td>headache generally very well tolerated</td>
<td>slightly increased risk of psychiatric events</td>
<td>chloroquine may exacerbate myasthenia gravis and psoriasis</td>
</tr>
</tbody>
</table>

### Resources for Guidance for Malaria Prophylaxis

This article is not supposed to provide definitive advice but merely an overview of the rationale and strategies for the prevention of malaria. The following resources provide more detailed and country-specific advice for GPs and travellers.

**Public Health England: Guidelines for malaria prevention in travellers from the United Kingdom 2013**
Available from www.hpa.org.uk

**National Travel Health Network and Centre (NathNaC)**
Telephone advice for health professionals. Tel: 0845 602 6712.
www.nathnac.org/pro/factsheets/malaria.htm

**HPA Malaria Reference Laboratory (MRL) (at London School of Hygiene and Tropical Medicine)**; www.malaria-reference.co.uk
Faxed advice for complicated cases that are not covered by the guidelines: 020 7637 0248
vaginal candidosis.\textsuperscript{14,15} Doxycycline is contraindicated in children under 12 and pregnant and breastfeeding women.

**The role of the GP**

The GP has a vital role in educating travellers about the risk of acquisition of infections (both malarial and non-malarial) while abroad, as well as offering suggestions (and prophylactic medications, if appropriate) as to how these risks can be mitigated. This needs careful evaluation of data from a variety of resources and a good understanding of the travel plans so risk is managed appropriately without unnecessary medication or expense.

GPs also need to have a low threshold for considering acute malaria in a returning traveller with undifferentiated fever, given the consequences that delayed diagnosis may have.

**References**


**Declaration of interests**

None to declare.

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