UNDERSTANDING AND ENGAGING IN MALARIA CONTROL IN THE ASIA PACIFIC: AN INFORMATION BOOKLET FOR THE PRIVATE SECTOR

MALARIA CONSORTIUM AND MONTROSE INTERNATIONAL, 2015
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1 INTRODUCTION

This information booklet accompanies the website: An interactive web-based resource for technical and practical advice on malaria and malaria control for the private sector working in the Asia-Pacific (www.Malariaconsortium.org/interactive-malaria-guide).

Here we guide you to find solutions relevant to your company, your context and your needs – answering any background questions you may have along the way by directing you to the range of technical information gathered here on malaria and malaria control.

We hope that this resource will raise understanding of the potential impact – both human and financial - that malaria may have on your company as well as the impact – both positive and negative – that your companies’ operations may have on malaria. Armed with this information the website and this accompanying information booklet will help you understand all your options for addressing problems, or for getting more involved in combating malaria in the region.

Whilst company activities can sometimes increase malaria transmission, more and more private companies are making serious contributions to combatting the disease. We showcase a number of the programmes making a difference to malaria control looking at why they got involved, what they have achieved and how they did it. Our hope is that other companies will use this resource to begin to explore options to expand their involvement in malaria control, be it through joining business coalitions, or building on the ground malaria control projects.

1.1 WHO IS THE INFORMATION FOR?

The website and this information booklet is designed for companies working in the private sector in the Asia-Pacific, in particular in the following industries:

- extractive industries (oil & gas, mining)
- infrastructure (roads, dam-building)
- agri-business/plantations

We expect that the personnel who will find this most useful will be site-/asset-level General Managers and corporate Environmental Health and Safety and Social Performance Managers.

Head Quarters staff outside the region may also find it useful to understand the potential for company involvement in malaria, and the potential problems that malaria may cause to assets within malarious areas.

1.2 WHAT DO WE MEAN BY THE ASIA-PACIFIC?

There is no universally accepted delineation for the Asia-Pacific. The term can be interpreted very loosely to include any country in the Asian continent or with a Pacific coastline. Here we take more traditional limits, covering an Asia-Pacific region including the following countries: Afghanistan, Australia, Bangladesh, Bhutan, Brunei, Cambodia, China, East Timor, India, Indonesia, Japan, Laos, Malaysia, Myanmar, Nepal, New Zealand, North Korea, Pakistan, Papua
New Guinea, Philippines, Singapore, Solomon Islands, South Korea, Sri Lanka, Thailand, Vanuatu and Vietnam.

Australia, Japan, New Zealand and Singapore are non-malarious but are included for completeness in maps and tables, particularly for companies who may be looking for information on whether or not malaria is a risk in these settings. Pacific island nations east of Vanuatu are also malaria free.

**Figure 1. Countries of the Asia Pacific region**
(Source: maproom.org)
2 MALARIA INFORMATION

2.1 DISEASE OVERVIEW

Globally malaria is estimated to kill more than half a million people per year. Millions more suffer from the disease. According to the latest estimates from the World Health Organization 198 million cases occurred in 2013.

The disease develops when a person is infected with the microscopic parasite, *Plasmodium*.

The infection is passed from person to person by the bite of a female *Anopheles* mosquito: the ‘vector’ of the disease.

The mosquito picks up the infection when she bites someone carrying the malaria parasite in their blood. The parasite then develops inside the mosquito’s body for some days finally infecting her salivary glands. She can then pass the infection on each time she bites another person.

There are many types (species) of malaria parasite. For example there are malaria parasites that infect different animals ranging from monkeys to crocodiles and even penguins. Five of the malaria species are known to cause disease in humans: *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale, Plasmodium malariae* and *Plasmodium knowlesi*. 
2.2 Types of Malaria and Their Distribution

**Falciparum malaria** is found throughout the tropical and sub-tropical world and is the most lethal form of malaria. The vast majority of deaths from malaria are due to this type of the disease.

**Vivax malaria** is common in Asia and South and Central America and may be the most common form of malaria worldwide. Vivax parasites can develop at lower temperatures than falciparum parasites so its range is wider than the tropical and sub-tropical range of falciparum malaria.
This type of malaria usually results in an unpleasant illness lasting several days. While it can lead to severe illness and sometimes death, typically it is not life-threatening. The economic toll of this form of malaria – to households and employers – is high. Vivax malaria can remain in a patient’s body after treatment if the treatment given fails to clear the parasite forms which lie dormant in the liver. If this happens then people who are infected can fall ill again and again. Treatment that can provide ‘radical’ cure by removing the dormant liver stages is available but the medicine can have serious side effects in a small proportion of people. It must therefore be prescribed with caution and ideally after testing whether the patient is likely to suffer an adverse reaction.

Falciparum and vivax malaria are responsible for the vast majority of malaria cases, but there are also three other forms of the disease that can occur in humans.

**Other malarias**

Ovale malaria has a similar disease profile to vivax malaria. It is found mostly in West Africa and in some islands of the Western Pacific but is also present in South and East Asia.

Malariae malaria is found worldwide though is not common. It is rarely fatal.

*Plasmodium knowlesi*, present in South East Asia, is a species of malaria previously thought to only infect monkeys but is now known to also infect humans. Knowlesi malaria has a disease profile similar to the deadly falciparum malaria and can cause fatalities.

**Figure 3. World map showing distribution of Plasmodium falciparum and Plasmodium vivax**

(Source: WHO Global malaria mapper tool)
2.3 The mosquito vector

There are many types of mosquito however malaria carrying mosquitoes are all part of the Anopheles group. There are almost 500 Anopheles species but only 40 or so species commonly carry malaria.

Non-anopheles mosquitoes also have impacts on human health; for example some Aedes mosquitoes spread dengue and yellow fever and some Culex mosquitoes spread Japanese Encephalitis and filariasis (elephantiasis). Often the distribution of these diseases overlaps with malaria; integrated vector control programmes can therefore sometimes be designed to reduce transmission of a number of mosquito borne diseases at once. See Table 1.

Table 1. Distribution of other mosquito borne diseases in the Asia Pacific

<table>
<thead>
<tr>
<th>Disease</th>
<th>Vector</th>
<th>Distribution within the Asia Pacific</th>
<th>Prevention measures</th>
<th>More details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dengue</td>
<td>Aedes mosquitoes</td>
<td>Widely throughout the Asia Pacific often in urban areas.</td>
<td>• Repellents • Long clothing / treated clothing • Room screening • Removal of breeding sites</td>
<td><a href="http://www.wnc.cdc.gov/travel/diseases/dengue">http://www.wnc.cdc.gov/travel/diseases/dengue</a></td>
</tr>
<tr>
<td>West Nile Virus</td>
<td>Mosquitoes, mostly Culex though local variation in dominant vector</td>
<td>West and central Asia</td>
<td>Depending on local vector • Repellents • Long clothing / treated clothing • Room screening • Insecticide treated nets</td>
<td><a href="http://www.wnc.cdc.gov/travel/diseases/westnilevirus">http://www.wnc.cdc.gov/travel/diseases/westnilevirus</a></td>
</tr>
<tr>
<td>Murray Valley Encephalitis</td>
<td>Culex mosquitoes</td>
<td>Papua New Guinea, remote NW or SE Australia</td>
<td>• Repellents • Long clothing / treated clothing • Room screening Insecticide treated nets</td>
<td><a href="http://www.wnc.cdc.gov/travel/diseases/murray-valleyencephalitis-virus">http://www.wnc.cdc.gov/travel/diseases/murray-valleyencephalitis-virus</a></td>
</tr>
<tr>
<td>Chikungunya</td>
<td>Aedes mosquitoes</td>
<td>Widely throughout the Asia Pacific often in urban areas.</td>
<td>• Repellents • Long clothing / treated clothing • Room screening • Insecticide treated nets</td>
<td><a href="http://www.wnc.cdc.gov/travel/diseases/chikungunya">http://www.wnc.cdc.gov/travel/diseases/chikungunya</a></td>
</tr>
<tr>
<td>Japanese Encephalitis</td>
<td>Culex Mosquitos</td>
<td>Widely throughout Asia Pacific. Often in rural areas associated with rice production or flooding, and near urban areas where these areas are neighbouring.</td>
<td>• Vaccine • Repellents • Long clothing / treated clothing • Room screening • Insecticide treated nets</td>
<td><a href="http://www.wnc.cdc.gov/travel/diseases/japaneseencephalitis">http://www.wnc.cdc.gov/travel/diseases/japaneseencephalitis</a></td>
</tr>
</tbody>
</table>
Anopheline mosquitoes can be distinguished from other types fairly easily by characteristic morphological features in most life stages (Figure 4). Trained entomologists can also identify individual species of Anopheles.

<table>
<thead>
<tr>
<th>ANOPHELES</th>
<th>CULEX</th>
<th>Aedes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Larvae</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rest parallel to water surface</td>
<td>Rest at an angle to the water surface</td>
<td>Rest at an angle to the water surface</td>
</tr>
<tr>
<td>Rudimentary breathing tube</td>
<td>Air tube</td>
<td>Air tube</td>
</tr>
<tr>
<td>Pupae (differ only slightly)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Short, stout breathing tube with one pair of hair tufts</td>
<td>Long, slender breathing tube with several pairs of hair tufts</td>
</tr>
<tr>
<td>Adult</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Proboscis and body in same straight line</td>
<td>Proboscis and body at an angle to one another</td>
<td>Proboscis and body at an angle to one another</td>
</tr>
</tbody>
</table>

**Figure 4. Features of different mosquito genera**
(Source: WHO, 1997, Vector Control Methods for Use by Individuals and Communities)

Anopheles mosquitoes lay their eggs in water. The eggs hatch after 2-3 days and the larvae eat and grow in the water for around a week, before moving into the pupal stage. After a couple of days as a pupa the mosquito adult emerges, waits for its wings to dry and then flies away (Figure 5). The time for this progression through the various life stages (metamorphosis) is very dependent on temperature; at lower temperatures development slows down.

The optimal temperature for mosquito metamorphosis is between 20 and 30°C; this range is also ideal for the malaria parasite to develop quickly within the mosquito.

The lifespan of an adult mosquito varies but on average is around 10-14 days. Some individuals will live longer than this. The life span is very important in the transmission of the disease. The malaria parasite develops inside the mosquito for 1-2 weeks before the mosquito is able to pass it on to anyone else. This means that only a small percentage of mosquitoes (the oldest ones) may actually pass on the disease.
Adult male mosquitoes feed on plant sugars. It is only the adult female mosquitoes that feed on blood, using proteins in the blood to develop their eggs. Female mosquitoes need to consume a blood meal every second to third night on average.

Malaria vectors exhibit a range of behaviours relevant to transmission and control of the disease. Behaviours can vary between species, and, in particular in the Asia-Pacific region, behaviour can also vary within the same species depending on location. Behaviours of interest include:

- Favoured ‘breeding sites’, i.e. where females choose to lay eggs;
- Preference for biting indoors or outdoors
- Preference for resting indoors or outdoors
- Preference for feeding on humans versus other animals
- Preference for time of biting – some prefer dusk and dawn, some late night, some bite throughout the night. Some species show different biting behaviours at different times e.g. bite outdoors at dusk and indoors later in the night.

**Figure 5. Mosquito Life Cycle**
(Source: WHO, 1997, Vector Control Methods for Use by Individuals and Communities)
### 2.4 Malaria Illness, Immunity and Vulnerable Groups

#### 2.4.1 The Illness

The incubation period of malaria in humans varies. It is commonly between 1 week and 1 month which means that after a person is bitten by an infected mosquito they do not fall sick immediately. This is an important consideration when diagnosing a malaria-like illness. Even if the person is in a non-malarious setting, recent travel must be taken into account.

When a person falls ill with malaria the initial signs and symptoms are non-specific and often similar to those of flu. Symptoms can include fatigue, fever, chills, headaches, gastrointestinal disturbances and aching muscles.

![Symptoms of Malaria](https://upload.wikimedia.org/wikipedia/commons/thumb/2/2f/Symptoms_of_Malaria_PDF.jpg/1024px-Symptoms_of_Malaria_PDF.jpg)

**Figure 6. Symptoms of Malaria**
(Source: Mikael Häggström [Public domain], via Wikimedia Commons)
If the infection is not treated promptly it can progress swiftly to become more serious. Falciparum malaria multiplies quickly in the blood and can rapidly develop into severe malaria. Vivax malaria multiplies more slowly; it will progress to more intense symptoms and can occasionally lead to severe malaria, including coma and death but it is very uncommon for vivax malaria to become life-threatening. For a fuller discussion of the potential for vivax malaria to become severe, see Box 8.3 on page 64 of the 2013 WHO World Malaria Report\(^1\).

Severe falciparum malaria can take a number of forms. If cerebral malaria develops then the patient may experience convulsions followed by coma and death. Alternatively the patient may develop severe anaemia, again with possible fatal consequences.

Whether a patient experiences malaria as a mild or severe disease depends on their immune status, how promptly they are treated and whether the treatment is successful. The latter is largely dependent on the quality of case management provided. Where drug resistant parasites are involved the choice of drug may be critical.

### 2.4.2 Immunity

Partial immunity to malaria develops in people who are repeatedly exposed to the infection, generally from childhood.

As immunity develops, older children and adults may experience only mild illness when they are infected. However this immunity will only develop through repeated infection and is therefore only seen in populations living in areas where malaria transmission is intense. Where malaria transmission is moderate, partial immunity may develop later or, as in areas of low transmission, not at all.

Partial immunity can be rapidly lost when people move to areas of lower malaria transmission, they are then equally at risk of severe illness and death as people from non-malarious areas.

### 2.4.3 Vulnerable groups

Some people are more at risk of severe disease than others.

- In areas of high transmission:
  - Young children, who have not yet developed immunity;
  - Immuno-compromised people, such as people infected with HIV;
  - Pregnant women: Women normally with a high level of immunity to malaria may develop severe life-threatening anaemia during pregnancy without displaying the classic symptoms of malaria. The risk is highest in first pregnancies. The chances of miscarriage or giving birth to an underweight baby are high. Malaria in pregnancy can increase infant mortality very significantly in high transmission settings.
  - Visitors from non-endemic areas who have no immunity.

\(^1\)http://www.who.int/malaria/publications/world_malaria_report_2013/wmr2013_no_profiles.pdf?ua=1
Returning former residents who are not aware that they have lost their immunity as a result of spending a long time in non-endemic areas.

- In areas of low / no transmission, immunity will not develop and all ages groups will be at risk of contracting the disease. Those most at risk of serious outcomes include:
  - Immuno-compromised people, such as those infected with HIV;
  - Pregnant women; they are more at risk of severe illness than non-pregnant women. In these cases, spontaneous abortion or miscarriage is a risk across all pregnancies;

There are also groups of people who are more at risk of contracting the disease as a result of their lifestyle. This is particularly the case in Asia where transmission is often focal and largely restricted to specific forest settings due to the behaviour of the mosquito vectors. Forest and forest fringe workers (many of whom may be migrants) and rubber tappers therefore have a much higher-risk of contracting malaria than most.

**Figure 7. Pregnant women are at high risk of suffering serious illness from a malaria infection. Here a pregnant woman is tested for malaria.**

*Source: Malaria Consortium*
3 CONTROLLING MALARIA IN THE ASIA-PACIFIC

Choosing appropriate control approaches requires detailed knowledge of the local epidemiology of the disease. This includes socio-economic conditions, vector species and behaviour, as well as other contextual issues ranging from accessibility of communities to household and individual behaviours linked to day to day life and specific practices by those in specific jobs. The ‘Establishing a Malaria Control Programme’ section below goes into more detail in how to conduct a situation analysis to inform choice of appropriate options.

Table 2 shows the main control approaches recommended in different countries of the Asia Pacific.
# Table 2. Recommended Malaria Control Interventions for the Asia-Pacific Region Countries

(Source: World Malaria Report 2013)

<table>
<thead>
<tr>
<th>Country/Area</th>
<th>Insecticide-treated nets</th>
<th>Indoor residual spraying</th>
<th>Malaria in pregnancy</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ITN/LLNs are distributed for free</td>
<td>ITN/LLNs are distributed to all age groups</td>
<td>DTT is used for IRS</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Bhutan</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Democratic People’s Republic of Korea</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>India</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Myanmar</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Nepal</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Thailand</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Timor-Leste</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>China</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Los People’s Democratic Republic</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Philippines</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Republic of Korea</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
<tr>
<td>Viet Nam</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
</tr>
</tbody>
</table>

ACT, artemisinin-based combination therapy; DTT, diethylether/phenylphthalein; IPT, intermittent preventive treatment for children; IRS, Indoor residual spraying; ITN, insecticide-treated mosquito net; LLN, long-lasting insecticidal net; NA, not applicable; RT, rapid diagnostic test; SMC, seasonal malaria chemoprevention

*Y* = Actually implemented; *N* = Not implemented; *- (NA)* = Not applicable; *- (--) = Question not answered
3.1 Case Management: Diagnosis and Treatment

3.1.1 Diagnosis

Malaria should not be diagnosed based on symptoms alone, because the symptoms are not sufficiently specific and an alternative cause could easily be missed, with potentially severe consequences for the patient (see section 2.4.1). If at all possible malaria should be diagnosed based on the identification of parasites in the patient’s blood either by examination of a blood smear by a skilled microscopist or by testing a drop of blood using an appropriate rapid diagnostic test (RDT).

Microscopy takes longer than an RDT because the blood slide must be stained and dried before it can be examined under a microscope. Malaria microscopy is however the most reliable way of diagnosing a malaria infection as it can detect lower parasite concentrations than RDTs, provided that the slide is well stained and examined by a skilled microscopist. However, if the technician’s skills are not of the highest quality, RDTs may be much more reliable than microscopy for detecting malaria.

An RDT is around the size of a home pregnancy test and works in a similar way, though it tests a drop of blood rather than urine. A drop of blood drawn from a pricked finger is dotted onto the test strip with some diluent and after a few minutes the strip shows whether the blood is positive or negative for malaria. Some tests show whether the malaria is falciparum, or another of the malaria types.

Many types of RDTs are available with varying levels of performance. The tests which are able to differentiate between falciparum and non-falciparum malaria infections are less reliable and more expensive than the falciparum only tests; this is a critical problem in the Asia-Pacific region where falciparum and vivax malaria are both widely distributed. Microscopy is therefore the recommended diagnostic approach throughout the region.

In rare instances test results may be falsely negative (usually when infections are light or patients have already received some antimalarial treatment). Therefore a clinical diagnosis of malaria can be made by a skilled clinician based on a detailed assessment after ruling out alternative causes of disease.

3.1.2 Treatment

Malaria can be treated successfully.

For falciparum malaria, treating the early uncomplicated stages is far easier than treating it once it has progressed to the severe form of the disease. It is therefore extremely important that patients receive treatment as early as possible.

As soon as malaria is suspected medical help should be sought and a diagnostic test carried out. If the test is positive, treatment should begin immediately. The drugs should be taken exactly as indicated, the right quantities at the right time and with food if this is recommended. The full course should be completed even if the patient starts to feel better.

If the test is negative, medical staff will consider other possible infections or illnesses which may require treatment.
While every drug has potential side effects, modern malaria treatments are safe and most are well tolerated.

Drugs used commonly until recently to treat falciparum malaria such as chloroquine, and sulfadoxine-pyrimethamine, face widespread drug resistance problems. Almost all countries worldwide, including all countries in the Asia-Pacific region now recommend artemisinin based combination therapies (ACTs) for treatment of uncomplicated falciparum malaria.

In all but a few areas in the Greater Mekong Sub-region (GMS) artemisinin derivatives are highly effective against all malarias. In ACTs an artemisinin derivative is combined with another drug for better combined effect as well as to try to slow the development and spread of drug resistance, by ensuring parasites not killed by one of the drugs will likely be killed by the other. The drug used in partnership with the artemisinin derivative varies, and is selected based on resistance to the different options in any given area.

ACTs come in tablet form with the two types of drug already combined. Different brands are available and different tablet dosages. Commonly the treatment course will be over several days and it is essential that the course is completed.

Vivax malaria has traditionally been treated with chloroquine partnered with a 14 day course of primaquine. The primaquine is included to clear the dormant liver stages of the vivax parasite (this long course of primaquine is not required for falciparum malaria as it does not develop dormant liver stages). In many places this treatment remains effective for vivax malaria and it is still recommended in some settings. However, in many places vivax malaria is now treated with ACTs, in combination with primaquine. This is the case where vivax has developed resistance to chloroquine, as well as in the many locations worldwide where falciparum and vivax are co-endemic and mixed infections are common.

Primaquine treatment is required to fully clear a vivax infection from the body and avoid relapses of disease. However it is problematic: the 14 day course may well not be adhered to, the drug is not recommended for pregnant women (though can be given after delivery to clear dormant parasites), and the drug is not recommended for individuals with a particular enzyme deficiency - G6PD deficiency – which is common in the Asia-Pacific yet hard to test for.

In order to prevent onward transmission of disease from patients being treated for falciparum malaria with ACT the WHO now recommends a single low-dose primaquine treatment to quickly clear the specialized parasite stages in the blood that are infective to mosquitoes. Without this primaquine treatment patients can remain infective to mosquitoes for some days following their cure.

3.1.3 Managing severe malaria

If the malaria illness has already developed past the early ‘uncomplicated’ stages the patient should be hospitalized. Artesunate suppositories are available for the pre-referral treatment of severely ill patients who present at peripheral health facilities, which do not have in-patient facilities. Until recently quinine was the first-line treatment for severe falciparum malaria, but current WHO guidelines state that intravenous artesunate should now be used in preference to quinine followed by a complete course of ACT. While quinine remains a highly effective drug for the treatment of severe malaria it has unpleasant side effects and so is best avoided, except where artemisinin resistance has been documented.
3.1.4 The challenge of drug resistance

Resistance of *Plasmodium falciparum* to malaria drugs is a major global problem. *Plasmodium vivax* has also developed resistance in some areas.

Drugs such as chloroquine and sulfadoxine-pyrimethamine once used commonly to treat falciparum malaria are now ineffective in most malaria endemic countries around the world. In recent years resistance to artesinin, the most effective antimalarial currently available, has also emerged in the Greater Mekong Sub-region. Here, multi-drug resistant falciparum malaria is now widespread. Even more worryingly, the presence of ACT resistant parasites has recently been confirmed on the Thai Cambodia border.

Resistance to malaria drugs can be found at varying levels and low levels of resistance may not impact on control. Artemisinin and its derivatives, are not used alone for the treatment of uncomplicated malaria, but are combined with a partner drug; this is known as artemisinin-based combination therapy (ACT). Currently the level of artesinin resistance means that ACT treatment can still be effective in these areas provided the partner drug is efficacious. However, there is a real and serious risk that drug resistance will worsen and spread further. ACT resistance has already been identified on the Thai-Cambodia border. Intense efforts by the global malaria control community are underway to attempt to halt the spread of these resistant parasites and to delay emergence of resistance elsewhere.

In some countries (e.g. Indonesia, Papua New Guinea and India) vivax malaria is also resistant to chloroquine. A further concern for vivax malaria is that primaquine (the drug used to effect a ‘radical’ cure of vivax malaria, destroying the dormant stages in the liver to avoid later relapse of the disease) appears to be less effective in Oceania.

3.2 Prevention of Malaria

Selection of an appropriate set of malaria prevention activities must be based on detailed understanding of the disease, and in particular an understanding of both the risk populations and the malaria vectors in the target area. It is important to know which species of mosquitoes are driving transmission and to understand their behaviour. This guides design of appropriate prevention approaches. Comprehensive prevention should include both large-scale interventions to reduce the size and age of the vector population (vector control) as well as measures to provide personal protection for individuals and communities at risk.

3.2.1 Protection for individuals

Personal protection measures for preventing malaria infection fall into two categories:

- Protecting people from being bitten by vector mosquitoes and,
- Using a course of chemoprophylaxis (malaria prevention drugs) so that if a person is bitten by an infected mosquito, the malaria parasites will not multiply in their body.

There are a number of preventative measures that can be taken to protect people from mosquito bites:
Repellents

Repellents are an excellent option for deterring mosquitoes. The most effective repellents contain at least 50% DEET (diethyltoluamide) and these should be used in areas of high transmission. In moderate to low transmission settings slightly lower DEET concentrations may be preferred.

Repellents should be applied to all uncovered skin in the early evening hours. Wearing long trousers and sleeves may be useful. However, since mosquitoes can bite through many fabrics, it is useful to apply repellent underneath the clothes or spray it on them, as well as on exposed areas of skin.

Repellents can provide effective personal protection when used regularly and properly by short to medium term visitors to a malarious area.

Unlike the primary vectors of malaria in Africa, which tend to bite late at night, several key vectors in the Asia-Pacific region tend to start biting earlier in the evening, before people reach the protection of their insecticide treated bed-nets (ITNs). Thus ITNs alone cannot provide full protection. It had been hoped that community-wide use of repellents might provide the solution to this early vector biting but findings from recent research in Lao PDR and elsewhere in the GMS have been disappointing, showing that repellents given to families who also had access to long lasting insecticidal nets, did not provide significant additional protection. It may be that the repellents were not applied well, did not persist long enough to protect from bites, or that mosquitoes that bite indoors later in the night contribute more to malaria transmission in these areas than thought.

Long lasting insecticidal nets

Insecticide treated nets provide about twice as much protection as nets with no insecticide. This is because mosquitoes do not bite through insecticide treated nets, are unlikely to pass through small tears or holes, and if a mosquito gets trapped inside they are likely to be knocked out or killed before they can bite the sleeping person. Long lasting insecticidal nets have insecticide incorporated within the net fibres, or bound around them, meaning the insecticide does not easily wash off. They should withstand 20 washes and remain effectively insecticidal. The effective lifespan of an LLIN usually ranges from 3-5 years depending on the type of material used for the net (polyester/polyethylene) and the process used for incorporating the insecticide.

In sub-Saharan Africa, where mosquitoes bite predominantly late at night and indoors, LLINs provide an ideal means of protecting people from malaria. In the Asia-Pacific region however many important vector species start biting outdoors earlier in the evening. As a result LLINs are somewhat less effective, than in Africa, although studies have demonstrated that they do still have a significant protective effect and therefore an important role to play in malaria prevention in these settings.

While LLINs are primarily a personal protection measure, high coverage rates (in excess of 80%) can also provide a ‘community effect’ reducing overall transmission so that people without nets gain some level of protection.

LLIN hammocks and hammock nets

In a number of areas in the Asia-Pacific, particularly in the Greater Mekong Sub-region, there are high risk groups who temporarily spend time sleeping outdoors in high transmission areas, particularly forested areas visited for personal or employment related work. Given the temporary nature of the exposure and the practice of sleeping outdoors or in crudely constructed shelters; indoor residual spraying and LLINs tend to be inappropriate. Insecticide treated hammock nets, insecticide treated bed-sheets and repellents can all however provide some level of personal protection. In forested areas of central and southern Vietnam, for example, insecticide treated hammocks nets have been shown to provide good protection.

Other methods of bite prevention

Electric vaporizers that emit insecticide from a liquid or tablet and can be easily installed in rooms have been shown to reduce biting. However these are far less effective than an LLIN and should only be used as a complementary measure. Repellent coils can also be effective in deterring mosquitoes indoors provided they burn throughout the night. They are less effective outdoors where any breeze reduces their effect.

Window and door screens provide protection against mosquitoes by preventing them from flying through open doorways and windows. The mesh must be small enough to prevent mosquitoes flying through them, and if they are on windows that can be opened it is important to be disciplined about closing them around dusk.

Chemoprophylaxis

Malaria chemoprophylaxis works by raising the levels of specific malaria drugs in a person’s blood to a level that ensures that if an infective mosquito bite is received, the parasites are destroyed before an infection can take hold.

Chemoprophylaxis must be taken throughout the period of potential exposure but also prior to travel and after returning. This is because prior to travel the drug level needs to be built up in the blood to ensure maximum protection on arrival in the malarious area. Following travel, optimal levels of the drug in the bloodstream need to be maintained as the malaria parasite may still be developing in the liver and yet to emerge. The frequency and the duration of treatment pre- and post-travel varies according to the drug used. There are three recommended prophylactic drugs that are currently prescribed in areas where falciparum malaria is present: atovoquone-proguanil, mefloquine and doxycycline (various brand names exist). The choice of drug depends on the drug resistance profile of malaria parasites in the area in question.

In the Korean peninsula and parts of China, where only vivax malaria is found, chloroquine can provide effective chemoprophylaxis provided parasites are not resistant to it. Where chloroquine resistance is present primaquine may be used provided recipients are not G6PD deficient.

Choice of prophylactic drug should be made by a doctor after discussion with the individual concerned. Each has different pros and cons and will have different effects on different people. For example:

- Mefloquine should be started 2–3 weeks prior to travelling and continued for 4 weeks after leaving the endemic area. It can cause unpleasant psychological side effects in a small minority of
people. These side effects range from mild to more serious. Serious neuropsychiatric disturbances may occur but are very rare (1 in 10,000). The early start of treatment prior to travelling is important both for the effectiveness of the drug but also to enable prescription of an alternative drug if severe side effects are seen.

- **Doxycycline** should be started 2 days prior to travelling and continued for 4 weeks after leaving the endemic area. Side effects include excessive sensitivity to sunlight in some users.

- **Atovoquone-proguanil** needs to be taken 1-2 days prior to travelling and continued for 1 week after leaving the endemic area. It is well tolerated, and side effects are rare. The most common adverse reactions reported are **stomach pain**, **nausea**, **vomiting**, and **headache**. It must be taken at the same time each day and to minimise side effects it should be taken with food or a milky drink.

Recommendations on length of use vary between countries and clinicians. For example atovoquone-proguanil is registered in various European countries with the permitted duration of use varying from 1 month to 1 year; in the US there are no time restrictions on the registration. There is no evidence that potential for adverse side effects to mefloquine increases after 12 months, and experiences on the use of doxycycline for more than 12 months are encouraging. However, what is known is based on limited information as there is scarce data on use of these three regimens for more than 6 months.

Rotation between the different drug options is a way of extending the period of protection without risking side-effects due to long-term use of a single drug.

Recommended chemoprophylaxis drugs are shown in Table 3.

**Table 3 Recommended Chemoprophylaxis Drugs for Countries in the Asia Pacific Region**

<table>
<thead>
<tr>
<th>Country</th>
<th>Recommended Chemoprophylaxis⁵</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Australia</strong></td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Bangladesh</strong></td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine.</td>
</tr>
<tr>
<td><strong>Bhutan</strong></td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td><strong>Brunei</strong></td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Cambodia</strong></td>
<td>In the provinces of Banteay Meanchey, Battambang, Kampot, Koh Kong, Odder Meanchey, Pailin, Preah Vihear, Pursat, and Siem Reap bordering Thailand: Atovaquone-proguanil or doxycycline&lt;br&gt;All other areas with malaria: Atovaquone-proguanil, doxycycline, or mefloquine&lt;br&gt;Phnom Penh: mosquito avoidance only</td>
</tr>
<tr>
<td><strong>China</strong></td>
<td>Along China-Burma (Myanmar) border in the western part of Yunnan province: Atovaquone-proguanil or doxycycline&lt;br&gt; Hainan and other parts of Yunnan province: Atovaquone-proguanil, doxycycline, or mefloquine&lt;br&gt; Anhui, Guizhou, Henan, and Hubei provinces: Atovaquone-proguanil, chloroquine, doxycycline, mefloquine, or primaquine⁷&lt;br&gt; All other areas with malaria including river cruises that pass through malaria-endemic provinces: Mosquito avoidance only.</td>
</tr>
<tr>
<td>Country</td>
<td>Recommended Chemoprophylaxis</td>
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<td>---------------------------------</td>
<td>------------------------------------------------------------------</td>
</tr>
<tr>
<td>Cook Islands</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Fiji</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>India</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Japan</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Kiribati (formerly Gilbert Islands)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Lao People’s Democratic Republic</td>
<td>Along the Laos-Burma (Myanmar) border in the provinces of Bokeo and Louang Namtha and along the Laos-Thailand border in the province of Champasack and Saravan: Atovaquone-proguanil or doxycycline. All other areas with malaria: Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Malaysia</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Maldives</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Micronesia, Federated States of;</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Mongolia</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Myanmar (Burma)</td>
<td>In the provinces of Bago, Kachin, Kayah, Kayin, Shan, and Taninthary: Atovaquone-proguanil or doxycycline. All other areas with malaria: Atovaquone-proguanil, doxycycline, or mefloquine.</td>
</tr>
<tr>
<td>Nauru</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Nepal</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>New Caledonia (France)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>New Zealand</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Niue (New Zealand)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Korea, North</td>
<td>Atovaquone-proguanil, chloroquine, doxycycline, mefloquine, or primaquine</td>
</tr>
<tr>
<td>Pakistan</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Palau</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Papua New Guinea</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Philippines</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Western Samoa</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Singapore</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Solomon Islands</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Sri Lanka</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Korea, South</td>
<td>Atovaquone/proguanil, chloroquine, doxycycline, mefloquine, or primaquine</td>
</tr>
<tr>
<td>Thailand</td>
<td>Atovaquone-proguanil or doxycycline</td>
</tr>
<tr>
<td>Country</td>
<td>Recommended Chemoprophylaxis</td>
</tr>
<tr>
<td>-------------------------</td>
<td>------------------------------</td>
</tr>
<tr>
<td>Timor-Leste (East Timor)</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Togo</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
<tr>
<td>Tokelau (New Zealand)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Tonga</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>Atovaquone-proguanil, doxycycline, or mefloquine</td>
</tr>
</tbody>
</table>
| Vietnam                 | Southern part of the country in the provinces of Dac Lac, Gia Lai, Khanh Hoa, Kon Tum, Lam Dong, Ninh Thuan, Song Be, Tay Ninh: Atovaquone-proguanil or doxycycline  
Other areas with malaria except Mekong Delta: Atovaquone-proguanil, doxycycline or mefloquine  
Mekong Delta: Mosquito avoidance |


Note: Several medications are available for chemoprophylaxis. When deciding which drug to use, consider specific itinerary, length of trip, cost of drug, previous adverse reactions to antimalarials, drug allergies, and current medical history. All travelers should seek medical attention in the event of fever during or after return from travel to areas with malaria. All travellers should seek medical advice on choice of chemoprophylaxis. Other measures to protect individuals

**Intermittent presumptive treatment of malaria in pregnancy (IPTp)**
This approach sees women taking 2-3 doses of an anti-malaria drug at specific points during their pregnancy to clear any parasites and reduce the chances of low birth weight and maternal or new-born anaemia. This approach is only appropriate in high transmission settings where women are semi-immune. The treatment doses are given without a malaria test on the assumption that most women will be carrying low levels of the malaria parasite in the blood long-term, which will need to be cleared to improve pregnancy outcomes. This approach has not been used widely in the Asia-Pacific as in most countries intense transmission is restricted to a few malaria hotspots. It is however used extensively in Papua New Guinea where transmission remains sufficiently high and the approach has been shown to be effective.

**Stand-by Emergency Malaria Treatment**
For travellers to malarious areas who also travel to areas with poor access to high quality health services, stand-by emergency malaria treatment may be provided. Individuals carry this with them, and are given instructions on when, why and how to use it. If they become ill with suspected malaria and are unable to promptly present themselves to a good quality health provider, they can take the emergency treatment.

**Malaria vaccine**
There is currently no commercially available malaria vaccine.
A number of vaccine candidates for falciparum malaria are being developed or trialed and the most advanced of these – RTS,S – could be used operationally in the medium term (WHO predicts making a policy recommendation in 2015). RTS,S has however been designed for the vaccination of children living in highly endemic areas. It will not be appropriate as a vaccine for international travellers and there are currently no vaccines in the later stages of development that would be appropriate for this target group.

There is currently no vaccine candidate being tested for use in the Asian setting.

There are currently no vaccine candidates for any other species of malaria.

### 3.2.2 Protection for communities

There are several methods of controlling mosquitoes at a camp or community level. These work by reducing the number of mosquitoes, and/or the average age of mosquitoes in an area. The average age is important: if most mosquitoes don’t live longer than 10-14 days they will not live long enough to pass on the malaria parasite.

**Indoor residual spraying or IRS**

The application of this protective measure involves spraying a long lasting insecticide indoors onto the walls and ceilings of all rooms. The insecticide typically lasts for 3-6 months when it then needs to be reapplied. Indoor residual spraying (IRS) results in fewer mosquitoes coming indoors and, more importantly, it kills any mosquitoes that rest on the sprayed areas. Through IRS the incidence of malaria can be drastically reduced.

IRS works best when the target mosquito species prefers to bite indoors and to rest indoors either before or after biting. IRS can also have a significant impact on mosquitoes that prefer biting outdoors, but tend to rest indoors after feeding. These mosquitoes often choose to rest in animal sheds and outhouses so spraying the ceilings and walls of these is often as important as spraying the dwellings themselves. In several areas in the Asia-Pacific the outdoor resting and feeding habits of the main vectors means that IRS may not be sufficient to control transmission. Where transmission is exclusively forest-based, providing IRS in villages will have no impact on transmission at all.

Whilst IRS may appear simple in theory, it is in fact difficult to do properly. To be fully effective spraying needs to be carried out in every room (and where appropriate in every outbuilding), in every household in the target community. This requires a high level of community acceptance. It must be carried out by trained spray personnel using specialized spray equipment and appropriate safety gear. Poor spraying results in patchy coverage allowing mosquitoes to find unsprayed patches of wall to rest on thus reducing the effectiveness of the approach. Where transmission of malaria fluctuates seasonally the timing of IRS is critical. Campaigns should be timed to take place at the very early stages of any expected seasonal increase. Large scale IRS requires detailed and rigorous planning, management and supervision. In 2013 WHO produced an updated operational manual on IRS for malaria control and elimination, which provides an in-depth resource.

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2. [http://apps.who.int/iris/bitstream/10665/80126/1/9789241505123_eng.pdf](http://apps.who.int/iris/bitstream/10665/80126/1/9789241505123_eng.pdf)
Insecticide treated wall linings

Insecticide treated wall linings have a similar effect to IRS. The wall linings, which are similar to wall paper, are available in rolls about a meter wide. They are cut to size and pasted onto the inside walls of a house. Wall linings ensure even coverage of insecticide without the need for specialized training and equipment. Insecticide is gradually released to provide effective vector control over a period of several years thus avoiding the problems of low user compliance that are associated with the regular reapplication required in the case of IRS.

Larval control / environmental management

Reducing the number of places where mosquitoes can lay eggs, or treating these places with chemical or biological products to kill mosquito larvae reduces the number of adult mosquitoes in an area. This is termed source reduction.

Environmental management can be applied to reduce the number of existing breeding sites and to minimize the creation of new breeding sites, for example during construction work. It can take the form of permanent environmental modification (e.g. draining swamps, preventing seepage from canals, installing effective drainage systems) and ongoing environmental manipulation to ensure unfavourable conditions for vector breeding (e.g. water level management in rice paddies and shrimp farms).

In some Asian-Pacific settings environmental management has been shown to work well, for example in Indonesia and the Solomon Islands successes have been achieved through development of specific draining regimes for rice paddies and managing salinity levels in aquaculture.

A number of reports relevant to environmental management for vector control are available from WHO.

Larval control requires the regular application of chemical and biological insecticides to breeding sites. In general, larviciding should only be considered for malaria control in areas where the breeding sites are few, fixed and findable.

Measures that reduce vector longevity, such as ITNs and IRS, have greater potential impact than measures that reduce only vector density, such as environmental management and larviciding. Generally measures that reduce adult densities should only be used as a supplement to ITNs or IRS; only in a very few specific circumstances with low transmission will it be appropriate to deploy source reduction methods alone.

Long Lasting Insecticidal Nets (LLINs) as a community-wide control measure

Given the cost effectiveness of LLINs, they are commonly used as a community-wide control measure. This involves large scale distribution to all households through community-wide campaigns. This approach is used in most countries in the Asia-Pacific. LLINs reduce malaria parasite transmission mainly by killing or blocking mosquitoes that attempt to feed on humans sleeping under nets.

http://www.who.int/water_sanitation_health/resources/pubresources/en/
http://www.who.int/malaria/publications/atoz/interim_position_statement_larviciding_sub_saharan_africa.pdf
While the impact of wide scale LLINs usage on incidence of malaria in settings where outdoor early biting mosquitoes are more common will be lower than in areas with predominantly late night indoor biting vectors, this intervention is still shown to provide useful protection against mosquitoes.

Other community-wide control methods

Fogging and space spraying
Fogging or space spraying is the release of insecticide into the air as smoke or fine droplets. It is primarily reserved for emergency situations such as epidemics of dengue fever. Fogging has not been shown to be effective in any malaria-endemic areas. Fogging and area sprays must be properly timed to coincide with the time of peak adult mosquito activity, because resting mosquitoes are often found in areas that are difficult for the insecticide to reach (e.g., under leaves, in small crevices). In addition, fogging and area spraying will have to be repeatedly applied to have an impact, and it can easily become too costly to maintain or result in the overuse of insecticides.

3.2.3 The challenge of insecticide resistance

Insecticides are an essential tool in the battle against malaria. There are four classes of insecticide that are used in malaria vector control. Pyrethroids are the most commonly used since these are the only insecticides recommended by WHO for use on insecticide treated bed-nets. Organophosphates, carbamates and the organochlorine DDT are also used in other vector control interventions, most commonly indoor residual spraying. Mosquito populations can become resistant to these insecticides through a number of mechanisms:

- Changes in how well or how quickly the mosquito detoxifies the insecticide – ‘metabolic resistance’.
- Changes to the insecticide’s intended target site within the mosquito, which mean the insecticide can’t bind as effectively – ‘target site resistance’.
- Changes to the insect’s cuticle or digestive tract, which mean the insecticide can’t penetrate as easily – ‘penetrative resistance’.
- Changes in the behaviour of the mosquito population leading to insecticide avoidance, For example an early biting strain of a vector species might assume dominance over a late biting strain because it’s behaviour allows it to avoid contact with lethal insecticide treated bed-nets.– ‘behavioural resistance’.

Resistance to one insecticide in a class generally confers some level of resistance to the rest of that class of insecticides. Cross-resistance across classes also exists. Depending on the type of resistance, mosquitoes resistant to pyrethroids may also be resistant to DDT, and vice versa; or to organophosphates, and vice versa.

Resistance comes about when mosquito populations are exposed to considerable levels of insecticide, giving a strong competitive advantage to any mosquitoes which are not killed off. Following this, resistance can rapidly spread. Use of insecticides is often widespread in agriculture and in the past it has often been agricultural use of insecticides that has led to insecticide resistance in mosquito vectors.
Limiting agricultural use of insecticides in the interest of insecticide use for public health can be useful; however large scale public health use of insecticides can also lead to resistance.

Various strategies have been developed to limit the development of insecticide resistance. They include: rotations of insecticides, use of interventions in combination and mosaic spraying. The use of insecticide mixtures is also being investigated.

3.3 COMMUNICATIONS: PROMOTING ACCEPTANCE AND UPTAKE OF MALARIA SERVICES

Making good quality prevention and treatment services available is only one step in reducing the incidence of the disease. The target population must also play a role.

For the workforce there may be company policies which employees are expected to adhere to. This might include use of repellents or chemoprophylaxis for example. Companies may want to try to enforce compliance to a certain extent but with most interventions this will be hard to do. Achieving compliance with policy will be most successful if the workforce understands:

- The risks of malaria,
- The rationale for the different components of the malaria policy,
- Why other commonly known techniques may not be being used,
- The effectiveness of the approaches they are being asked to comply with,
- That they have an opportunity to ask questions or raise concerns e.g. about side effects of repellents or chemoprophylaxis.

Workforce training and sensitization programmes can be rolled out in a number of ways using print materials, online short courses, recorded video presentations etc. An important component though is that employees are given the opportunity to interact and raise questions and concerns with someone qualified to give a full response.

Community-wide malaria control programmes also require substantial communications components in order to maximize effectiveness. Indoor residual spraying campaigns require the agreement of target communities to maximize the compliance of community members. Home owners must not only allow the spray teams access but also put considerable effort in to preparing their homes so that spray teams can access all walls and ceilings. In the case of insecticide treated bed-nets regular action may be required to encourage all family members to use their nets each night. High quality diagnostic and treatment services will only be useful in reducing the impact of disease if people with suspected malaria seek diagnosis promptly and accept the recommended treatment. Effective communication is key in every case.

For community-wide programmes therefore it is necessary to work closely with the community at the planning stages, to foster their support for the programme and ensure they have an opportunity to get involved in the design. Community engagement increases the likelihood that the approaches proposed will be not only appropriate to the epidemiological context, but also to the lifestyle and needs of the target communities.

http://www.who.int/malaria/vector_control/gpirm_executive_summary_en.pdf?ua=1
Prior to roll out of any intervention thorough sensitization of communities should happen; giving detailed information on what is planned and why. Opportunities for community members to ask questions and get answers are important.

On-going communication activities are also important to ensure communities remain aware of the services available, the risk of malaria and the actions they can take to access services and reduce risk to themselves and their families. In areas where malaria is seasonal an increased communication drive just prior to the malaria season can be useful.
3.4 Surveillance and Outbreak Response

Malaria surveillance is important in every epidemiological setting but it is important to note that it takes different forms.

In areas of very low malaria incidence, where elimination is a realistic goal, programmes will need to identify and respond to every potential malaria case. This entails ensuring that every possible malaria case is accurately diagnosed, and that confirmed malaria cases are treated effectively. Where funds allow, active case detection may also be used. This means taking the tests to the community rather than waiting for symptomatic people to present themselves to a healthcare provider. Active case detection may involve screening whole communities in areas where malaria cases are expected.

In areas of moderate and unpredictable malaria transmission surveillance is particularly important to maintain accurate information on the geographical distribution of the disease. Surveillance of this kind is used to target control efforts and to detect early signs of malaria outbreaks, so that a timely response can be initiated to prevent or limit the size of epidemics. Often such surveillance is conducted through routine reporting of malaria cases identified at health facilities and by peripheral healthcare providers such as village health workers. Efforts need to be made to ensure that this reporting system is accurate and timely. The resulting data needs to be analysed correctly and acted upon swiftly and appropriately.

Upon detection of an outbreak programme managers should conduct an outbreak investigation. This should involve:

- A visit to the sites reporting an upsurge in cases,
- Investigation of the quality of data and the validity of the reported upsurge in cases,
- Mapping the cases and investigating their likely origins,
- Focal screening and treatment of any additional cases.

If an outbreak is confirmed the officer responsible should immediately initiate an outbreak response. This should involve:

- Entomological assessment and design of vector control response if appropriate. Most commonly any response would involve indoor residual spraying and/or ensuring everyone at risk has access to an insecticide treated bed-net.
- Active case detection throughout the target area with expansion of the target area as appropriate if additional cases are identified. This should continue until caseload falls to normal levels.
- Communication campaigns to remind communities how to protect themselves and seek treatment,
- Continued close monitoring of case reports from the target area and surrounding epidemic prone areas after the outbreak is brought under control.

Malaria surveillance data from all areas is also key to assessing programme impact over time. Where scientific methodology is applied, malaria surveillance data can be used to assess the impact of specific interventions in specific settings, an essential step in the design of locally appropriate malaria control strategies in areas of residual transmission for example.
Routine surveillance is also required at the national level to monitor drug and insecticide resistance. This surveillance enables programmes to ensure that only effective drugs and insecticides are used. In the event of early signs of resistance being detected, prompt action can be taken to avoid treatment or intervention failure and thereby prevent malaria resurgence.
4 MALARIA IN THE ASIA-PACIFIC

Here we give an overview of malaria in the Asia-Pacific, discussing characteristics of its transmission and control in the region.

4.1 MALARIA DISTRIBUTION AND BURDEN IN THE ASIA-PACIFIC

Malaria is present in 20 countries in the southern, eastern and south-eastern regions of Asia as well as in the Asia Pacific. Countries with malaria transmission in this region include:

- **South Asia**: Bangladesh, Bhutan, India, Nepal and Sri Lanka
- **Eastern Asia**: China, DPR Korea and Republic of Korea
- **South-east Asia**: Cambodia, Timor-Leste, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Thailand and Vietnam
- **Pacific**: Papua New Guinea, Solomon Islands and Vanuatu

[Source: [Roll Back Malaria Regional Strategy for the Asia-Pacific](http://www.rollbackmalaria.org/microsites/gmap/3-4.html)]

Notable countries / territories that are malaria free include Australia, Hong Kong, Japan, New Zealand and Singapore.

Approximately 2.1 billion people are considered to be at risk of acquiring malaria in the Asia-Pacific region. The 2014 World Malaria Report estimates that in 2013, there were 25 million cases of malaria and 44,300 deaths in the region.

Table 4 gives an overview of the malaria epidemiological context for countries in the Asia Pacific Region.

---

<table>
<thead>
<tr>
<th>Country</th>
<th>Areas with Malaria</th>
<th>Malaria Species</th>
<th>Drug Resistance</th>
<th>Main vectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Australia</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>All areas, except in the city of Dhaka.</td>
<td><em>P. falciparum</em> 91% <em>P. vivax</em> 9%</td>
<td>Chloroquine</td>
<td><em>An. dirus, minimus, philippinensis, sondaicus, albimanus, annularis.</em></td>
</tr>
<tr>
<td>Bhutan</td>
<td>Rural areas below 1,700 m (5,577 ft) especially the southern belt districts along the border with India: Chirang, Geylegphug, Samchi, Samdrup, Jongkhar, and Shemgang.</td>
<td><em>P. falciparum</em> 43% <em>P. vivax</em> 57%</td>
<td>Chloroquine</td>
<td><em>An. maculatus, culicifacies, philippiensis and annularis.</em></td>
</tr>
<tr>
<td>Brunei</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Cambodia</td>
<td>Present throughout the country including Siem Reap city.</td>
<td><em>P. falciparum</em> 56% <em>P. vivax</em> 44% Occasional <em>P. malariae</em></td>
<td>Chloroquine Mefloquine</td>
<td><em>An. dirus, minimus, maculatus, sondaicus.</em></td>
</tr>
<tr>
<td>China</td>
<td>Present year round in rural parts of Anhui, Guizhou, Hainan, Henan, Hubei, and Yunnan Provinces. Rare cases occur in other rural parts of the county below 1,500 m (4,921 ft) May–December. None in urban areas. Some major river cruises may go through malaria endemic areas in Anhui and</td>
<td><em>P. falciparum</em> (58%) <em>P. vivax</em> (42%)</td>
<td>Chloroquine Mefloquine</td>
<td><em>An. sinensis, anthropophagus, dirus, minimus.</em></td>
</tr>
<tr>
<td>Country</td>
<td>Areas with Malaria</td>
<td>Malaria Species</td>
<td>Drug Resistance</td>
<td>Main vectors</td>
</tr>
<tr>
<td>---------------------------------</td>
<td>-------------------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>Cook Islands (New Zealand)</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Fiji</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>French Polynesia</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>India</td>
<td>All areas throughout country including cities of Bombay (Mumbai) and Delhi, except none in areas above 2,000 m (6,562 ft) in Himachal Pradesh, Jammu and Kashmir, and Sikkim.</td>
<td>P. vivax 50%</td>
<td>Chloroquine</td>
<td>An. culicifacies, fluviatilis, stephensi, minimus, dirus, annularis.</td>
</tr>
<tr>
<td>Indonesia</td>
<td>Rural areas of Kalimantan (Borneo), Nusa Tenggara Barat (includes the island of Lombok), Sulawesi, and Sumatra. All areas of eastern Indonesia (provinces of Maluku, Maluku Utara, Nusa Tenggara Timur, Papua, and Papua Barat). None in the cities of Jakarta, Ubud, or resort areas of Bali and Java. Low transmission in rural areas of Java including Ujung Kulong, Sukalumi, and Pangadaran.</td>
<td>P. falciparum 55%</td>
<td>Chloroquine (P. falciparum and P. vivax)</td>
<td>An. sundaicus, balabacensis, maculatus, farauti, subpictus</td>
</tr>
<tr>
<td>Japan</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Kiribati (formerly Gilbert Islands).</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Lao People’s Democratic Republic</td>
<td>All, except none in the city of Vientiane.</td>
<td>P. falciparum 87%</td>
<td>Chloroquine</td>
<td>An. dirus, minimus, maculatus, jeyporiensis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>P. vivax 13%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Areas with Malaria</td>
<td>Malaria Species</td>
<td>Drug Resistance</td>
<td>Main vectors</td>
</tr>
<tr>
<td>-------------------------------</td>
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</tr>
<tr>
<td>Malaysia</td>
<td>Present in rural areas of Malaysian Borneo (Sabah and Sarawak Provinces), and to a lesser extent in rural areas of Peninsular Malaysia</td>
<td>Occasional P. malariae and P. ovale 1%</td>
<td>Mefloquine</td>
<td>An. balabacensis, donaldi, maculatus, sundaicus, flavirostris</td>
</tr>
<tr>
<td>Maldives</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Marshall Islands</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Micronesia, Federated States of;</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Mongolia</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Myanmar (Burma)</td>
<td>Present at altitudes below 1,000 m (3,281 ft). None in the cities of Mandalay and Rangoon (Yangoon).</td>
<td>P. falciparum 65%, P. vivax: 35% Occasional P. malariae and P. ovale</td>
<td>Chloroquine, Mefloquine</td>
<td>An. minimus, dirus</td>
</tr>
<tr>
<td>Nauru</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Nepal</td>
<td>Present throughout country at altitudes below 2,000 m (6,562 ft). None in Kathmandu and on typical Himalayan treks.</td>
<td>P. vivax 70% P. falciparum 30%</td>
<td>Chloroquine</td>
<td>An. fluviatilis, annularis, maculatus</td>
</tr>
<tr>
<td>New Caledonia (France)</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>New Zealand</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Niue (New Zealand)</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Pakistan</td>
<td>All areas (including all cities) at altitudes below 2,500 m</td>
<td>Chloroquine</td>
<td>An. culicifacies, stephensi</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td>Areas with Malaria</td>
<td>Malaria Species</td>
<td>Drug Resistance</td>
<td>Main vectors</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>--------------------</td>
<td>----------------</td>
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<td>------------------------------------</td>
</tr>
<tr>
<td>Palau</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Papua New Guinea</strong></td>
<td>Present throughout country at altitudes below 2,000 m (6,562 ft)</td>
<td><em>P. falciparum</em> 89% <em>P. vivax</em> 11%. Occasional <em>P. malariae</em> and <em>P. ovale</em></td>
<td>Chloroquine (both <em>P. falciparum</em> and <em>P. vivax</em>)</td>
<td><em>An. punctulatus, farauti, kaliensis</em></td>
</tr>
<tr>
<td><strong>Philippines</strong></td>
<td>Present in rural areas below 600 m (1,969 ft) on islands of Basilan, Luzon, Mindanao, Mindoro, Palawan, Sulu (Jolo), and Tawi-Tawi. None in urban areas.</td>
<td><em>P. falciparum</em> 69% <em>P. vivax</em> 31%</td>
<td>Chloroquine</td>
<td><em>An. flavirostris, maculatus, balabacensis, litoralis</em></td>
</tr>
<tr>
<td><strong>Western Samoa</strong></td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Singapore</strong></td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td><strong>Solomon Islands</strong></td>
<td>All</td>
<td><em>P. falciparum</em> 64% <em>P. vivax</em> 36% <em>P. ovale</em> &lt;1%</td>
<td>Chloroquine</td>
<td><em>An. farauti, punctulatus, koliensis</em></td>
</tr>
<tr>
<td><strong>Sri Lanka</strong></td>
<td>All areas, except none in the districts of Colombo, Galle, Gampaha, Kalutara, Matara, and Nuwara Eliya.</td>
<td><em>P. vivax</em> 83% <em>P. falciparum</em> 17%</td>
<td>Chloroquine</td>
<td><em>An. culicifacies, subpictus, annularis, varuna</em></td>
</tr>
<tr>
<td><strong>Thailand</strong></td>
<td>Rural, forested areas that border Burma (Myanmar), Cambodia, and Laos. Rural, forested areas in districts of Phang Nga and Phuket. None in the cities of Bangkok, Chang Mai, Chang Rai, Koh Phangan, Koh Samui, Pattaya, Phang Nga, and Phuket.</td>
<td><em>P. falciparum</em> 40% (up to 75% some areas) <em>P. vivax</em> 60% (down to 25% in some areas) Remainder <em>P. ovale</em></td>
<td>Chloroquine and Mefloquine</td>
<td><em>An. dirus, minimus, maculatus, sondaicus</em></td>
</tr>
<tr>
<td><strong>Timor-Leste (East Timor)</strong></td>
<td>All</td>
<td><em>P. falciparum</em> 56%</td>
<td>Chloroquine</td>
<td><em>An. subpictus, barbirostris</em></td>
</tr>
<tr>
<td>Country</td>
<td>Areas with Malaria</td>
<td>Malaria Species(^4)</td>
<td>Drug Resistance</td>
<td>Main vectors</td>
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<tr>
<td>-------------------------</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(P. \text{ vivax} ) 44%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occasional (P. \text{ ovale} ) and (P. \text{ malariae})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tokelau (New Zealand)</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Tonga</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Tuvalu</td>
<td>None</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>Vanuatu</td>
<td>All</td>
<td>(P. \text{ falciparum} ) 32%</td>
<td>Chloroquine</td>
<td>(\text{An. farauti})</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(P. \text{ vivax} ) 68%</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Occasional (P. \text{ ovale})</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vietnam</td>
<td>Rural areas only,</td>
<td>(P. \text{ falciparum} ) 63%</td>
<td>Chloroquine</td>
<td>(\text{An. minimus, dirus, sundaicus, maculatus, sinensis})</td>
</tr>
<tr>
<td></td>
<td>except none in the</td>
<td>(P. \text{ vivax} ) 37%</td>
<td>Mefloquine</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Red River Delta.</td>
<td>Rare cases in the Mekong Delta. None in Da Nang,</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Haiphong, Hanoi, Ho Chi Minh City (Saigon), Nha Trang, and Qui Nhon.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In all these countries in the region, both falciparum and vivax malaria are present, with some of the less common types of malaria seen on occasions. Vivax malaria has a wider range than falciparum malaria due to its greater tolerance of lower temperatures during the mosquito-borne stages of its life-cycle. For this reason it is more common in China and the northern/higher altitude parts of Afghanistan, Nepal and Pakistan and Vietnam. Vivax is the only form of malaria found in North and South Korea.

These maps, created using the University of Oxford’s Malaria Atlas Project\(^9\) map creator, show the limits of falciparum and vivax malaria transmission in the Asia-Pacific.

\(^9\) http://www.map.ox.ac.uk
FIGURE 8 A/B. SPATIAL DISTRIBUTION (2010) OF (A) Plasmodium falciparum AND (B) Plasmodium vivax IN THE ASIA PACIFIC

Source: University of Oxford’s Malaria Atlas Project
4.2 Transmission Patterns in the Asia-Pacific

Malaria intensity varies throughout the region. In some countries the majority of the population (over 90%) live in areas of high falciparum malaria transmission, these countries include Papua New Guinea, Myanmar, parts of Indonesia, Bangladesh, Solomon Islands, Timor-Leste, and some states of India. Elsewhere in the region countries are categorized as having low to moderate transmission except Australia, Japan, New Zealand, Singapore and the Pacific island nations east of Vanuatu, which are all malaria free.

![Figure 9: Control Status of Countries in the Asia-Pacific Region](http://www.cdc.gov/malaria/map/)

**Figure 9. Control status of countries in the Asia-Pacific Region.** *(Source: World Malaria Report 2014)*

It is important to note that there are local variations within countries. Countries considered to have low levels of malaria may have localized foci with intense transmission and ‘malarious’ countries may have large areas that are malaria free. The CDC Malaria Map Application[^10] allows users to zoom into countries to find information on areas of greatest risk within the country as well as specific information by province.

Transmission patterns are determined by a broad range of factors. Behaviour may vary very considerably from one vector species to another. Host preferences (animal or human), preferred biting time, resting behaviour are a few of the factors that determine the capacity of a mosquito species to transmit malaria and their vulnerability to control measures. Meteorological factors such as differences in rainfall, humidity and temperature (also linked to altitude) determine the geographical range of different mosquito species and so influence transmission patterns. Land use, types of housing as well as insecticide and drug resistance levels also affect disease patterns. The epidemiology of malaria in the Asia-Pacific region is particularly complex, reflecting the diversity of habitats, vector species and human behaviours. Where transmission occurs determines who is at risk of contracting malaria. For example urban malaria transmission may put most of a community at risk (e.g. Honiara in the Solomon Islands),

[^10]: [http://www.cdc.gov/malaria/map/](http://www.cdc.gov/malaria/map/)
whereas malaria transmission restricted to forests may result in the majority of cases being seen in forest workers (e.g. areas along the Thai-Cambodia border).

In areas with moderate to high transmission rates, malaria may be stable i.e. year round with seasonal peaks. In areas of low to moderate transmission malaria transmission is often unstable and it is common to have malaria outbreaks, potentially leading to epidemics if the outbreak response is absent, late or otherwise ineffective.

Mixed malaria infections, particularly of falciparum and vivax, are common; this has implications for diagnostic and treatment approaches.

This map shows the burden of malaria by country, along with other information on malaria types, drug and insecticide resistance status and control approaches.

4.3 Drug Resistance in the Asia-Pacific

Resistance of *Plasmodium falciparum* to various malaria drugs is a major problem in the Asia-Pacific region. In some countries *Plasmodium vivax* has also developed resistance but only to chloroquine.

Some drugs used commonly until recently to treat falciparum malaria (chloroquine and sulfadoxine-pyrimethamine) are now reported to be ineffective in all malarious countries in the region. In recent years resistance to artemisinin (the most effective malaria treatment compound that we currently have) has emerged in the Greater Mekong Sub-region. Here multi-drug resistant falciparum malaria has now emerged, with parasites that are tolerant to chloroquine, sulfadoxine-pyrimethamine, artemisinin-based drugs and others.
Resistance to malaria drugs can be found at varying levels and low levels of resistance may not impact on control. Artemisinin and its derivatives, are not used alone for the treatment of uncomplicated malaria. They are typically combined with a partner drug, creating what is known as artemisinin-based combination therapy (ACT) (see section 3.1.2). Currently the level of artemisinin resistance means that ACT treatment can still be effective in these areas provided the partner drug is efficacious. However there is a real and serious risk that drug resistance will worsen and spread further within the region, as well as beyond. Intense efforts by the global malaria control community are underway to attempt to halt the spread of these resistant parasites and to delay emergence of resistance elsewhere. A small focus of ACT resistance has already emerged on the Thai-Cambodia border and extreme efforts are now underway to eliminate the disease in this area. Region-wide elimination efforts are also gathering pace.

In some countries in the region (Indonesia, Papua New Guinea and India) vivax malaria has been found to be resistant to chloroquine. A further concern for the vivax strain of malaria is that primaquine (the drug used to effect a ‘radical’ cure of vivax malaria, destroying the dormant stages in the liver to avoid later recurrence of the disease) appears to be less effective in Oceania.

4.4 VECTOR SPECIES AND INSECTICIDE RESISTANCE IN THE ASIA-PACIFIC

This map, from the University of Oxford’s Malaria Atlas Project⁹ shows the distribution of the different potential malaria vectors in the Asia-Pacific region.

![Malaria vectors of the Asia-Pacific region](image_url)

**Figure 10. Malaria vectors of the Asia-Pacific region**
(Source: University of Oxford’s Malaria Atlas Project⁹)
There are many potential vectors, 16 of which are known to play a role in transmission, with 6 considered to be the most important\(^\text{11}\).

The Asia-Pacific region can be considered to have three distinct ecological areas. The different vectors driving transmission can be characterised by these ecological areas:

- In the Greater Mekong sub-region transmission is mainly driven by the *Anopheles dirus* and *Anopheles minimus species complexes*. Transmission is greater in rural forested areas with agricultural and forest workers at particularly high risk of infection. Early outdoor biting by primary vector species makes malaria somewhat less amenable to control by insecticide treated bednets and indoor residual spraying. The preferred breeding sites for these vectors are small, widely dispersed and often temporary bodies of water which means that larval control is not feasible in most settings.

- In the South Asia sub-region transmission is mainly driven by *Anopheles culicifacies* in rural areas and *Anopheles stephensi* in urban areas. However, the former also plays a large role in transmission in peri-urban and urban areas. These vectors bite indoors and outdoors but they often rest indoors making IRS effective in some settings. In urban settings larval control can also sometimes be useful.

- In the Pacific sub-region transmission is mainly driven by *Anopheles farauti* and *Anopheles punctulatis* complexes. Differences within the complexes and the distribution of the species, in particular in the farauti complex, mean that mosquito behaviour can vary in different places. Although biting and resting can be indoors and outdoors, LLINs and IRS have proven to be somewhat effective in these settings. Larval control is difficult given the range of breeding sites, including brackish water around coastal areas for some species.

Table 5 gives more information on these different vector species, and their behaviours and what measures may be appropriate for malaria control.

There are important variations within sub-regions, even at local levels. The diversity of vector species that transmit malaria in the Asia-Pacific (contrast this to the 2-3 main species in sub-Saharan Africa) can cause considerable problems for control. The difference in vectors’ behaviours by location contributes to differences in epidemiology and has impacts on control. For example, in the Mekong and Pacific regions most important mosquito vector species tend to rest outdoors and bite outdoors in the early evening\(^\text{12}\). These behaviours mean that insecticide treated bed-nets and indoor residual spraying are not as effective as they might otherwise be (although both have been shown to have a significant and valuable impact even where vectors are predominantly outdoor early biters).

Innovative approaches are needed in the Asia-Pacific more than anywhere else in order to maximise the impact of vector control efforts. In developing interventions in this region, it is particularly important to identify the primary vectors and determine local breeding, feeding and resting behaviours before planning a control programme.


Table 5 gives an overview of the most important characteristics of vector behaviour for the six main vectors in the region. However, it is important to note that local variations can occur and basic entomological assessments should be carried out to ensure control strategies are appropriate.

Most of the Asia-Pacific countries report some level of resistance to insecticides in at least one of their major vectors, although sometimes this is quite focal. The case of India is particularly concerning since resistance is widespread and there is a high incidence of malaria. Insecticide resistance in the Greater Mekong Sub-region is also of serious concern as if it were to become more pronounced and then spread it could hamper the elimination of multidrug resistant (including ACT resistant) falciparum malaria parasites.

The operational significance of insecticide resistance on the success of malaria control interventions is still not clear. It is likely that even with low to moderate levels of resistance many control measures will still work reasonably well. It is also likely that varying levels of resistance for different insecticides will have different impacts depending on the control approach used.
**Table 5. Characteristics of the main vectors of the ecological sub-regions of the Asia Pacific.**

Information in this table is drawn from the Malaria Control in complex emergencies inter-agency handbook<sup>13</sup> (WHO, 2005, Table 6.6) and from Sinka et al., [2011]<sup>14</sup>. This latter paper has extensive details on the range of important vector species in the Asia Pacific.

*A note on terminology for vector species and complexes*
Mosquito species are often grouped together in groups called complexes. The ‘sibling’ species within these groups are morphologically identical and can only be differentiated by molecular techniques. In some complexes all sibling species have similar behaviours or characteristics; in other complexes there are important differences which can impact on control, meaning identifying which species are present and driving transmission can be important.

Species complexes are named after one of the main species in the complex; e.g. *An. dirus* is part of the *An. dirus* complex. To clarify whether the writer is referring to the specific species or the complex as a whole, the terms *sensu stricto* (the specific species) and *sensu lato* (the complex) are often used, and are often abbreviated to s.s. or s.l. *An. dirus* s.l. therefore refers to the complex and *An. dirus* s.s. to the specific *An. dirus* species within the *An. dirus* complex.

<table>
<thead>
<tr>
<th>Species complex</th>
<th>Important sibling species</th>
<th>Range and primary habitats</th>
<th>Biting time</th>
<th>Feeding behaviour</th>
<th>Resting behaviour</th>
<th>Breeding sites</th>
<th>Appropriate vector control approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>An. dirus</em></td>
<td>The <em>An. dirus</em> complex includes a number of different species, some of which are poor vectors or not vectors at all. Two species in the complex (<em>An. dirus</em> s.s. and <em>An. baimaii</em>) have long life spans and strong preference for feeding on</td>
<td>Thoroughly south-east Asia. Forested mountains and foothills, culivated forests (e.g. rubber) and forest fringes</td>
<td>Between 20:00 and 02:00 though variable by species. <em>An. dirus</em> s.s. between 20:00 – 23:00. <em>An. baimaii</em> peak biting varies between 22:00 – 02:00 by setting. Another of the vector species in this complex, <em>An. scanloni</em>, bites</td>
<td>Highly anthropophilic</td>
<td>Mainly outdoors.</td>
<td>Small, temporary, somewhat shaded water which is standing or very slowly flowing. Including small pools, puddles, animal footprints, wheel ruts etc.</td>
<td>Repellents.</td>
</tr>
<tr>
<td>An. dirus</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Insecticide treated nets or hammock nets for protection when sleeping outside. Biting times will affect how effective this is.</td>
</tr>
<tr>
<td>An. dirus</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Larval control not feasible in most settings.</td>
</tr>
</tbody>
</table>

<sup>13</sup> http://whqlibdoc.who.int/publications/2005/924159389X_eng.pdf
<sup>14</sup> http://www.parasitesandvectors.com/content/4/1/89
<table>
<thead>
<tr>
<th>Species complex</th>
<th>Important sibling species</th>
<th>Range and primary habitats</th>
<th>Biting time</th>
<th>Feeding behaviour</th>
<th>Resting behaviour</th>
<th>Breeding sites</th>
<th>Appropriate vector control approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>An. minimus</td>
<td>An. minimus is a complex of three species, two of which (An. minimus s.s. and An. harrisoni) are important throughout the Asia Pacific.</td>
<td>Throughout south-east Asia. Hilly forest regions as well as open agricultural fields, particularly rice agro-ecosystems, particularly on forest fringes.</td>
<td>very early (18:00 – 19:00h) and plays a role in transmission in Thailand.</td>
<td>An. harrisoni appears to bite in peaks throughout the night early evening (18:00 – 21:00) and later (either 00:00 – 02:00 or 03:00 – 06:00); An. minimus s.s. bites later (with peaks ranging from 22:00 to 01:00 – 04:00).</td>
<td>Resting indoors or outdoors varies by location.</td>
<td>Larvae develop in clear, cool, partly shaded slow running water; primarily streams in forest foothills. In some settings (Hanoi, Vietnman) larvae have also been found in man-made containers, i.e. water tanks though this is considered unusual.</td>
<td>Effectiveness of ITNs, IRS and wall linings depends on local behaviour. Larval control in forest streams is unlikely to be feasible in most settings.</td>
</tr>
<tr>
<td>An. culicifacies</td>
<td>Five sibling species, with varying important for malaria</td>
<td>Widely distributed across South Asia, including southern China, India, Pakistan and Afghanistan. An important rural vector of</td>
<td>Late evening and night. Varies by location and may also vary by season with changes between warmer and cooler months.</td>
<td>Often prefer to feed on cattle and other domestic animals rather than humans, though some sibling species appear to have greater preference for humans in some settings.</td>
<td>Mainly indoors (especially cattle sheds) though also outdoors.</td>
<td>Clean water either slowly flowing (on the edge of rivers, streams) or standing (e.g. rice fields, irrigation canals, man-made pits and pools. Can breed in small</td>
<td>ITNs and IRS can be effective in some areas. ITN use for those sleeping outdoors can be effective. Preference for non-human feeding mean that control</td>
</tr>
<tr>
<td>Species complex</td>
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<td></td>
<td>plains or hilly mountainous areas, though also found in peri-urban and urban habitats. Rural habitats include forested areas with perennial streams, irrigation sites.</td>
<td>Late evening and night.</td>
<td>Indoors and outdoors.</td>
<td>temporary pools such as hoof prints and can breed in man-made containers such as tanks and gutters.</td>
<td>Urban type: river margins, rice fields, borrow pits.</td>
<td>approaches including applying insecticide to cattle have been effective in some areas.</td>
</tr>
<tr>
<td>An. stephensi</td>
<td>Single species of two main 'types' with a possible third 'intermediate' type.</td>
<td>Extensively found across South Asia including Afghanistan, Pakistan and India where it is an important vector; but also found eastwards into Bangladesh, southern China, Myanmar and Thailand. Urban and rural (different 'types' of the vector found in urban and rural locations; the rural type is not</td>
<td>Peak times may vary by season.</td>
<td>The urban type feeds primarily on humans. Perhaps primarily indoors though outdoors biting is also common, particularly in warmer months.</td>
<td>Mainly indoors in poorly constructed structures rather than brick dwellings.</td>
<td>Water tanks, man-made containers, construction sides.</td>
<td>ITNs and IRS can be effective in some areas. ITN use for those sleeping outdoors can be effective. Preference for non-human feeding mean that control approaches including applying insecticide to cattle have been effective in some areas. Well designed larval control may be effective in urban settings.</td>
</tr>
<tr>
<td>Species complex</td>
<td>Important sibling species</td>
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<tr>
<td></td>
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<td>considered particularly important as a vector.</td>
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</tr>
<tr>
<td>An. farauti</td>
<td>Eight species. Specific species appear to be important in specific settings - e.g. An. farauti s.s. is found normally within 1km of coastal areas; An. irenicus is restricted to the Solomon Islands.</td>
<td>Ranges from the Maluku island group in Indonesia to Vanuatu in the western Pacific. Highland river values, intramontane plains, coastal areas.</td>
<td>Varies by locality and likely by specific species. Commonly throughout the evening and daytime biting is also known.</td>
<td>Varies by locality and likely by specific species. General preference for humans though other animal biting is also common.</td>
<td>Indoor and outdoor.</td>
<td>Varies by locality and likely by specific species. Commonly found in natural rain-fed temporary pools to large semi-permanent or permanent water bodies. Can also breed in containers such as coconut shells, canoes, drums etc. In places, an important coastal vector breeding in brackish water; however only some of the species in the complex tolerate salinity.</td>
<td>Different behaviour between species makes control approaches different in different settings. Potential for larval control is highly site specific.</td>
</tr>
<tr>
<td>Species complex</td>
<td>Important sibling species</td>
<td>Range and primary habitats</td>
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<tr>
<td>An. punctulatus</td>
<td>Two closely related species both often referred to as An. punctulatus.</td>
<td>Lowland river valleys and plains throughout the Pacific.</td>
<td>Varies by location and seasons, peak biting can be before midnight in some areas / seasons and well after midnight in other locations.</td>
<td>Primarily humans.</td>
<td>Primarily outdoors but also indoors.</td>
<td>Small, scattered, sunlit, temporary fresh water pools and even moist soil. Sites can include hoof prints, gardens, cleared areas for road or other construction, pools in stream or river beds. High adult densities often found near breeding sites as dispersal can be more limited for this species than others.</td>
<td>IRS and ITNs can be effective in some areas. Larval control is not feasible in most settings but environmental management to avoid creating new sites during construction can be important as the vectors can exploit such sites quickly and rapidly increase in numbers.</td>
</tr>
</tbody>
</table>
4.5 Building Country Specific Profiles of the Malaria Context

This website gives an overview of the malaria context in the Asia-Pacific with some detail of the generalizable context by sub-regions. However in this region malaria epidemiology can vary considerably within sub-region and within countries.

It would be helpful then to build up a profile of information for your country of interest, including information such as main parasites, vectors, possible control approaches, national strategy and progress.

Good sources for country specific information include:

- **WHO country profiles**\(^{15}\)
- **APMEN country briefings**\(^{16}\)
- **APMEN atlas**\(^{17}\)
- WHO country office websites which often have a malaria specific section,
- The National Malaria Control Website (if available) will have links to useful national documentation. These may be easy to locate using a search engine or may be accessible through the main Ministry of Health website. In cases where such sites may not exist, searching for the country’s National Malaria Control Plan/Strategy/Policy may help locate the main national guidance document.
- Current Global Fund\(^{18}\) malaria grants. Successful proposals are available on the Global Fund website and these can be a useful source of detailed country information. [This webpage]\(^{19}\) allows you to carry out a search by country, download previous proposals and select the most recent malaria proposal.

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\(^{16}\) [http://apmen.org/country-briefings/](http://apmen.org/country-briefings/)

\(^{17}\) [http://apmen.org/apmen-atlas/](http://apmen.org/apmen-atlas/)

\(^{18}\) The Global Fund (The Global Fund to fight AIDS, Tuberculosis and Malaria).

5 ESTABLISHING A MALARIA MANAGEMENT PROGRAMME AND/OR A MALARIA CONTROL PROGRAMME

A malaria control programme will encompass the activities that address prevention, diagnosis, treatment and surveillance of malaria in a particular area or group of people.

A malaria management programme would be designed by a company to define how malaria will be addressed by the company more broadly. This may include malaria control programmes in certain areas as well as approaches to inform and manage risks of malaria in all staff including frequent travellers.

This section gives guidance on the specific steps that could be taken to design a sound malaria programme and also includes a range of additional information which will be useful to managers or planners establishing a programme.

5.1 STEPS IN THE DESIGN OF A MALARIA PROGRAMME

The steps described here are adapted from a range of materials available to support companies in the design of malaria management programmes, with additions. Key resource documents companies should access and on which the summary below is based include:

- ICMM’s good practice guidance for malaria
- IPIECA and OGP’s guide to vector-borne disease management programmes
- WHO’s training materials on an epidemiological approach to malaria control

5.1.1 Step 1: Screening and Scoping

The purpose of this phase is to assess how important it is that a malaria management programme is put in place, and to collate the data to support this.

These initial steps will collate available data or expert opinion on:

- Disease burden by location. Sources may include high level estimates of burden by location such as those available through the following mapping applications, as well as national and sub-national data from health services (if the quality is considered sufficient) or national surveys such as demographic health surveys or malaria indicator surveys.

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20 http://www.icmm.com/hiv
Data on workforce malaria cases should also feed into development of a complete picture of the known and potential scale of the malaria problem relevant to the company.

Travel practices of the local and international work force that may bring them in and out of malarious zones even if some sites are non-malarious.

The likelihood of the company worsening malaria transmission. Assessment of these findings will allow the company to consider whether it has a responsibility to address malaria as a problem and/or whether there are significant benefits to the company in designing a malaria management programme. Benefits may arise from meeting health and safety responsibilities. For example, there may be financial benefits in implementing a malaria management program through a decrease in the number of employee sick days or increased social capital through supporting malaria control in wider communities, potentially through capacity building within local institutions.

If the scoping finds that malaria is not currently a major concern for the company, then the company may still consider getting involved in advocacy work or malaria business coalitions given its presence in the region.

The subsequent steps refer to progressive activities companies may undertake once they have determined that malaria is likely to have an impact on their business activities, or vice versa, and a substantive programme may be needed to address this.

### 5.1.2 Step 2: Establishing Commitment and Support

A vital component of a successful control programme is robust commitment from senior managers to the programme. This commitment is important for:

- Ensuring sufficient funds are made available or robust support is given to advocating for external funds.
- Ensuring senior managers support field managers in progressing with required changes to working sites or operations.
- Ensuring senior managers support field managers in requiring certain practices to be followed by staff, e.g. use of personal protection measures.
- Ensuring senior managers support processes for expanding beyond site control programmes to engage with national and sub national programmes and stakeholders.

Data from Step 1 will support the process of establishing commitment at senior levels.

### 5.1.3 Step 3: Situation Analysis of Epidemiology and Context

A company malaria management programme will include aspects on protecting and informing travelling staff as well as location specific control programmes.

Location specific control programmes must first and foremost be grounded on a detailed and accurate understanding of the epidemiological context. Required activities include:

- **Vector surveys:** These will address the following questions:
  - What are the dominant malaria vector species?
What are their behaviours?
What is the insecticide resistance profile?

Answering these questions will require specialist entomological surveys.

- **Epidemiological profiling:** This will address the following questions:
  - What is the transmission profile? Is malaria stable or unstable?
  - Who are the most affected groups (where caseloads or infection rates are highest)?
  - What phase of control effort is the country in? Control or moving towards elimination?
  - What malaria species are present?
  - What is the range of transmission relevant to the site of interest? i.e. is transmission localized in specific company assets of interest, or are nearby communities involved in the transmission?

Epidemiological profiling requires access to very high quality and localised data and it is likely that this type of data will only be available if dedicated malaria prevalence surveys are carried out. Such surveys involve a representative sample of the population group of interest providing blood samples for testing. These surveys must be designed by a malaria surveillance specialist with appropriate skills to ensure the results are robust and that ethical requirements are attended to.

- **Malaria related knowledge, attitudes, practices and behaviours surveys** should be conducted and targeted at the relevant group (either the workforce or the local communities) who may be included in a control programme. A researcher with expertise on malaria and qualitative research should be responsible for this survey.

- **Health system surveys** should include health facility surveys as well as a broader assessment of the capacity (resources, infrastructure, equipment, personnel and systems) of the health system in the area of interest. These will inform planners about opportunities for linking and supporting the local health system, with potential for more sustainable programme impacts. The health system survey should be conducted by an expert in health systems, and malaria.

- **Geo-spatial mapping:** overlaying malaria prevalence information with meteorological and land cover information can give a useful visual understanding of the areas targeted in the control programmes and the variation within them. Specialist software and skills are required.

- **Workforce reviews to determine high risk groups:** combining information from the epidemiology in specific locations and the practices of different employees, the company should identify who are the highest risk groups in the work force. This may include those who travel locally or internationally between malarious and non-malarious areas and security guards or other night shift workers who work in malarious sites.

- **Stakeholder analyses** should define which groups are relevant to potential malaria control activities, their level of interest, level of support and the potential roles they could play as supporters, funders or implementing partners.
5.1.4 Step 4: Policy and Goal Development

As part of ensuring senior commitment, companies should plan on developing a malaria policy for the company. Guidance on company malaria policy development is available as part of the World Economic Forum’s malaria guidance document23.

The goal will likely specify the desire to reduce the malaria burden within employee or local populations, reduce the financial impact of malaria on the business, or support sustainable effective community-wide malaria control as part of a social responsibility component.

For country specific community-wide programmes, goals should align with national malaria goals where possible.

5.1.5 Step 5: Option Appraisal

Here different technical and operational options need to be assessed for appropriateness and cost-effectiveness. Options to be considered include:

- Scope: Whether to implement company and location specific control programmes or to expand into community-wide, ‘outside the fence’ control programmes.
- Partnership approach: Whether to plan a programme that will be delivered using the companies own health, safety and environmental personnel, to partner with the local health system, or to partner with other implementing organisations.
- You will need to access detailed information on the appropriate approaches for your setting and it may involve getting expert epidemiological or entomological advice.

5.1.5.1 Protecting employees without community-wide programmes

It may be that the decision is made to focus malaria control measures on the workforce alone, without expansion to local communities.

If a strategy of focusing only on the workforce is chosen then vector control efforts may be in place within but not outside the fence; yet local employees may be on rotation and returning regularly to home communities outside the fence. Measures to limit the malaria risk in employees at all times could include:

- Providing employees with malaria prevention measures that they can take with them to use when returning to home communities. This could include any of the personnel protection measures considered appropriate to the context, such as insecticide treated nets, insecticide treated traditional clothing and repellents. If this approach is taken it is highly recommended that the employees are given sufficient commodities to provide protection for their whole family. Aside from the clear ethical impetus for this approach, it also improves the likelihood that the employee will receive the protection from malaria which the company intends; rather

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23 http://www.weforum.org/search/google/malaria?query=malaria&cx=005374784487575532108%3Azwr8u4lxoba&cof =FORID%3A11&sitesearch=
than, for example, ensuring his/her children or other family members are protected by the one ITN provided.

- Ensuring high quality case management services are available, for prompt diagnosis and treatment should the employee fall sick with malaria. Employees should be able to access on site clinics regardless of whether they are currently on rotation on site; and the company may also consider reviewing and, where appropriate, supporting clinical services available in some of the major communities from which the workforce is drawn.

5.1.5.2 Building a community-wide malaria programme: advantages, disadvantages and options

Disadvantages of establishing a community-wide malaria control programme:

- Costs: malaria commodity costs can be considerable (WHO, 2012\textsuperscript{24} and Wafula et al., 2010\textsuperscript{25})
  - LLINs cost around $2.7 - $4 per net if bought in bulk, often more if bought in smaller quantities.
  - ACTs cost around $1.3 - $1.4 for an adult treatment course (for the most commonly procured brand which is an artemether-lumefantrine combination).
  - RDTs cost around $0.7 for a multi-species test.
  - IRS costs vary considerable in relation to economies of scale. Where more than 1 million people are protected, as in large national programmes, costs per person protected will be lower; but in smaller programmes, such as those likely to be supported by private companies, costs can be around $5.5 per person protected.

Expanding services beyond employees to employees’ families or to whole communities can therefore have important cost implications.

- Designing and implementing an effective community-wide malaria control strategy requires specialised skills in entomology, malaria vector control, case management, community health promotion and communication.

Advantages of establishing a community-wide malaria control programme:

- A high impact option for a corporate social responsibility programme.

- An ethical responsibility if companies are working in a local area where malaria is a high priority problem and where their activities risk increasing transmission.

- Lowering malaria transmission at the community scale will reduce the risk of malaria in the company’s workforce and the importance of a buffer zone thereby having economic benefits for the company through reduced work time lost, improved productivity, lower healthcare costs etc.

Options for establishing a community-wide malaria control programme:

Some general options planners could consider are described here.

Options that are considered potential choices for your setting should be appraised against the following considerations:

\textsuperscript{24} http://www.who.int/malaria/world_malaria_report_2011/WMR2011_chapter3.pdf

\textsuperscript{25} http://www.malariajournal.com/content/12/1/466
➢ Technical appropriateness - linked to:
  o Disease epidemiology
  o Potential for impact on disease
  o Alignment with international and national priorities

➢ Operational appropriateness – linked to:
  o Capacity of local health systems
  o In-house capacity in relevant areas
  o Capacity available through out-sourcing
  o Size and life of operation and potential for sustainability
  o Cost-effectiveness and efficiency
  o Equity

➢ Feasibility (political, financial), including consideration of options using lobby and advocacy activities to increase political will and secure additional financing

➢ Potential for impact on:
  o Disease burden
  o Company finances
  o Company reputation

This appraisal will inform detailed planning undertaken in the next step.

**Option 1: One off focus on community-wide LLIN coverage**

**Rationale:** Companies could fund and support mass insecticide treated net distribution if appropriate to the setting and if ownership of LLINs is low. Depending on the epidemiological context, this could provide good community protection as long as the nets remain in use.

**Approach:** A one-off distribution campaign with sufficient LLINs to provide total coverage in all households in the target community (usually one LLIN per two people) – either door-to-door or through community distribution points. This would need to be accompanied by a health communication component to promote use.

**Pros:** Few specialized skills are required aside from advice on whether LLINs are an effective control measure in the setting.
Can have a high and instant impact in areas where LLINs are appropriate and if coverage was previously low.

**Cons:** Ideally a mass distribution of nets should be accompanied by an approach for communities to access replacement nets as needed, otherwise coverage levels will gradually drop. Companies are therefore encouraged to think longer term than a single distribution campaign.
Option 2: On-going community-wide prevention

**Rationale:** Ensuring effective vector control measures are in place community-wide in all local communities would have a high impact and help to reduce the risk of infection in those people residing within the company compound, given the community-wide impact on transmission levels.

**Approach:** This would need to be tailored to the local setting but could include indoor residual spraying cycles or larval site mapping and removal / treatment programmes. Community involvement would be critical and long-term engagement required. Health promotion would be a necessary component to ensure support.

**Pros:** Can be high impact if a well-designed programme is put in place; based on the local epidemiological context and with quality assurance measures in place for its implementation.

**Cons:** Requires staff with specialized skills to be engaged in the activities on a long-term basis. Requires strong community involvement and support for success. Requires long-term commitment and a clear exit-strategy.

Option 3: Establishing new clinics

**Rationale:** Where there are no malaria case management services, establishing and maintaining high quality facilities would be an effective way to reduce the rates of serious illness and death from malaria.

**Approach:** This could involve making clinics inside compounds accessible to communities; or building, equipping, staffing and maintaining new clinics outside the compound to serve local communities. A range of levels of involvement are possible depending on the capacity of the local health authorities or other local organisations, for example the company could establish the clinics and hand over their management to others (see below). Health promotion would be a necessary component to ensure facilities are used.

**Pros:** Potential for extremely high impact. Appropriate to fulfil the responsibility of care to employees and their families. Good quality clinical services may be the highest priority need if these do not exist.

**Cons:** Requires staff with specialized skills to be engaged in the activities on a long-term basis. Requires long-term commitment and a clear exit strategy. There can be high initial costs if infrastructure and equipment is needed.

Option 4: Support existing clinics

**Rationale:** Where existing clinics are accessible, the company could consider supporting these. This may be a more cost-effective and sustainable approach.

**Approach:** Health facility assessments would be needed to examine existing infrastructure, equipment, supplies, personnel and services. These should include
gathering community perspectives on their needs and the current services. As discussed above, partnership with the organizations responsible for the health facilities would be essential from early planning stages throughout assessment and design of the support package. The support package could be purely financial, or could see the company contracting groups to provide infrastructure, equipment improvements or training. If this approach is taken a quality assurance component would be needed to ensure that company support is resulting in better quality of care.

**Pros:** May be more cost-effective than establishing new clinics. May be more sustainable, though an exit strategy and measures to ensure sustainability would need to be included in the support package.

**Cons:** Working with partners may be problematic in some settings. Change in service provision and care approaches may be difficult to achieve in some settings. The company may have less control over quality than they had hoped. May be less opportunity than some other approaches for clear ‘branding’ of company support.

- **Option 5: Support other existing activities**

**Rationale:** In some locations the local health authorities and other organisations may be very active in malaria control, or in public health with the possibility of expansion into malaria control. They may have clear plans and clear knowledge of resource gaps which the company could fill.

**Approach:** Discuss with all organizations working in health locally to determine if there are other activities that the company could support. The company will need to assess potential partners for capacity and appropriateness for support.

**Pros:** Fills an already identified need; leverages existing local skills and partnerships.

**Cons:** There may be few or no organisations active in the company’s location. Organisations that are active may not have the capacity to absorb additional funds or to manage expanded programmes. May be fewer opportunities than in some other approaches for clear ‘branding’ of company support.

- **Option 6: Contribute financially to the national malaria control programme**

**Rationale:** All countries within this region have national malaria control programmes with clear malaria control strategies and often up to date gap analyses showing where they need additional support in order to fulfil their strategic aims. Companies with funds available to support malaria control could effectively leverage these existing national plans.

**Approach:** Discussion with national malaria control programmes should include: review of existing gaps; options for use of contributed funds; company interest in supporting specific geographical areas and likelihood of this being achieved. There could also be an additional component for more locally focused malaria control support.
**Pros:** Leverages existing national capacity and skills. Demonstrates company’s commitment to the country and its authorities. Fills an already identified need. Has potential for long-term and sustainable impact.

**Cons:** There may be extremely limited opportunities for clear ‘branding’ of company support. Assurances that funds will be used as planned may be difficult to attain or verify. May not lead to improvements in malaria control in the specific geographical areas in which the company works (which may or may not be the aim).

- **Option 7: Contribute financially to other initiatives in country, such as the private malaria control sector**

  **Rationale:** In the Asia-Pacific region there are many private companies working in the malaria industry, from Artemisia growers to drug manufacturers and distribution companies for malaria commodities. There may be opportunities to partner with such an organization to expand its role in the malaria industry, playing a useful role in the area of malaria commodities supply.

  **Approach:** Review local private companies working in the field. Through meetings and discussions explore opportunities for support. This process should be led by or include expert advice from specialists in the field of malaria and malaria commodities.

  **Pros:** The role of the private sector in the malaria industry is important at a number of levels but such companies often have few opportunities to access financial support to expand their role.

  **Cons:** Requires specialist advice on needs and appropriate areas of support. May not lead to improvements in malaria control in the specific geographical areas in which the company works (which may or may not be the aim).

- **Option 8: Contribute financially to regional or global bodies**

  **Rationale:** Regional organizations such as WHO regional offices, the Asia Pacific Leaders Alliance and the Asia-Pacific Malaria Elimination Network are all credible organisations working to reduce malaria in the region with clear strategies and likely existing resource gap analyses. Companies that have funds available to support malaria control could effectively leverage these existing national plans.

  **Approach:** Discussion with national malaria control programmes should include: a review of existing gaps; options for use of contributed funds; company interest in supporting specific geographical areas and the likelihood of this being achieved. There could be an additional component for more locally focused malaria control support.

  **Pros:** Leverages existing national capacity and skills. Demonstrates company’s commitment to the country and its authorities. Fills an already identified need. Has potential for long-term and sustainable impact.
Cons: There may be extremely limited opportunities for clear ‘branding’ of company support. Assurances that funds will be used as planned may be difficult to attain or verify. May not lead to improvements in malaria control in the specific geographical areas in which the company works (which may or may not be the aim).

5.1.5.3 Information on main control options by region

Note that the information on this website may not be sufficient to guide appropriate approaches since these can be highly specific to the local context so professional advice should be sought.

- A) Greater Mekong Sub-region (GMS)

In the GMS malaria is transmitted mostly by *An. dirus* and *An. minimus* which are extremely efficient malaria vectors primarily found in forested and forest fringe areas. Although habits vary both geographically and seasonally, they primarily bite outdoors in the first two quarters of the night. The rate of outdoor early evening biting has increased following the widespread use of LLINs. Despite the reduced level of protection of LLINs, they are still highly recommended although they should be complemented with other measures to combat outdoor transmission. Understanding local vector behaviour is important in the design of an appropriate approach.

Transmission can be intense but is usually highly focal and often sporadic; the high-risk groups include all those spending nights in forest or forest fringe areas. These include forest-based communities (often ethnic minority groups), forest workers (such as soldiers, forest/wildlife protection workers, timber extraction teams, gem miners, wood cutters and hunters), forest fringe agricultural workers (especially seasonal migrants) and rubber tappers.

Recommended options for the GMS setting are:

1. Conduct detailed entomological surveys to determine main malaria vectors and their behaviour in the local setting. Although a complete survey is advised, behaviours of particular interest are peak biting times and whether vectors primarily bite and rest indoors or outdoors.
2. If entomological surveys show any level of indoor biting or resting then indoor residual spraying may be appropriate for shelters in which people sleep, eat, work or spend their recreational time.
3. Use indoor residual spraying on the walls and roofs of any semi-outdoor areas such as verandas, covered recreational areas etc.
4. Fit all doors and windows with mosquito screens.
5. Ensure all staff sleep under insecticide treated mosquito nets whether they are sleeping indoors or outdoors. Alternative designs of insecticide treated nets such as treated hammock nets are available and could be used for workers who tend to sleep outdoors.

Consider site location: the further away that sites can be located from forest fringe, the lower the transmission risk is likely to be. On large sites it would be beneficial to locate
sleeping areas, evening recreational areas or areas where night time work is carried out as far away from forest cover as possible.

6. Personal protection measures should include:
   a. Use of an appropriate chemoprophylaxis.
   b. Application of repellents in the early evening hours, especially by workers who are typically outside throughout the night (e.g. security guards, night shift workers and those working in or near forested areas).
   c. Consider these other personal protection measures for personnel who spend most of their working hours outdoors during and between dusk and dawn:
      o Insecticide treated clothing/ uniforms
      o Insecticide treated scarfs or other traditional clothing for those used to wearing these

7. Effective case management is an essential element in malaria control. Differential diagnosis is important to identify malaria species and thereby support the selection of an appropriate treatment. It is also essential in order to identify other possible causes of disease. Microscopy is recommended over RDTs if possible provided that robust quality assurance is in place.

8. Health promotion and communications activities are key to promoting safe prevention and treatment seeking behaviours.

APMEN has developed country profiles and other summary resources on malaria control with more detailed information specific to countries within the region.

- B) Pacific

The epidemiology of malaria in the Pacific sub-region is highly complex due in part to the diversity of behaviours exhibited by the different sibling species that make up the An. farauti and An. punctulatus species complexes. Breeding site selection, which is often determined by tolerance to salinity, and adult feeding behaviour varies throughout the region. These behaviours have a major effect on transmission patterns; in some settings for example, transmission takes place mostly in coastal areas. However, some generalizations can be drawn. In most areas a significant proportion of transmission occurs indoors late at night, which means that the use of insecticide treated nets should have a strong protective effect. Some indoor resting occurs in most areas and so IRS is also generally useful.

Larval control may be feasible in defined areas where all breeding sites can be mapped and accessed. However, generally this approach is not feasible as most vectors breed in a range of small, scattered temporary pools. Measures should be taken to avoid the creation of new breeding sites (during construction work for example) since An. punctulatus can rapidly increase in numbers in response to a proliferation of breeding sites.

In some countries, such as the Solomon Islands, wide-spread use of insecticide based control measures has reduced the importance of An. punctulatus as a vector, but has
also resulted in a shift in the biting behaviour of *An. farauti*, which now bites earlier and outdoors. This means that ITNs and IRS alone are insufficient to provide full protection against malaria.

Recommended options for the Pacific setting include:

1. Conduct detailed entomological surveys to determine main malaria vectors and their behaviour in the local setting. Although a complete survey is advised, behaviours of particular interest are the distribution and type of larval breeding sites as well as biting behaviour (time and location).

2. Indoor residual spraying on the walls and ceilings of houses and any semi-outdoor areas such as verandas, covered recreational areas etc. in which people spend time at night sleeping, eating, working or relaxing.

3. Fit all doors and windows with mosquito screens.

4. Ensure all staff sleep under insecticide treated mosquito nets whether they are sleeping indoors or outdoors. Alternative designs of insecticide treated nets such as treated hammock nets are available and could be used for workers who tend to sleep outdoors.

5. Personal protection measures should include:
   a. Use of an appropriate chemoprophylaxis. Where malaria transmission is highly seasonal, seasonal chemoprophylaxis could be considered.
   b. Application of repellents in the early evening hours and later at night for those who are exposed to vector biting, especially by workers who are typically outside throughout the night (e.g. security guards and night shift workers).

6. Effective case management is an essential element in malaria control. Differential diagnosis is important to identify malaria species and thereby support the selection of an appropriate treatment. It is also essential in order to identify other possible causes of disease. Microscopy is recommended over RDTs if possible provided that robust quality assurance is in place.

7. Health promotion and communications activities are key to promoting prevention and safe treatment seeking behaviours.

**Special case: Indonesia**

Indonesia has a particularly complex malaria profile and here generalizations are more difficult to make than elsewhere.

Indonesia spans the Asia and Pacific sub-regions and has a large number of malaria transmission profiles. Bali, Java and Batam have low transmission. Sumatra, Kalimantan and Sulawesi have moderate transmission. All other provinces have moderate to high transmission.

There is high diversity of vector species on the major islands. For example, in Sumatra, *An. sinensis* is found inland along with the *An. barbirostris* complex, *An. leucosphyrus/An. latens* and the *An. minimus* complex. A number of other vector species also exist on Sumatra but none are considered dominant on the island; hence
they are over-laid by the other, more dominant species. Alongside the An. sundaicus complex distributed along the coast, An. flavirostris does increase in relative ‘dominance’, by virtue of a reduced presence of other species, extending southward through Java until it is the only dominant vector species found in the Lesser Sunda islands. In Sumatra, there is very little overlap amongst the dominant species found, suggesting that each occupies a separate niche. Anopheles balabacensis dominates across most of Borneo, with some impact by the An. barbirostris complex and An. leucosphyrus/latens inland and the An. sundaicus complex on the coast.

This APMEN profile\textsuperscript{26} gives more detail about the complex Indonesian setting.

\textbf{o} \textbf{C) South Asia}

Here transmission is dominated by \textit{An. culicifacies}, \textit{An. stephensi} and to a lesser extent \textit{An. fluviatilis}. \textit{An. stephensi} is the only urban vector. These vectors are common across a range of habitats and transmission is often fairly wide-spread rather than focal. The urban vectors are especially adapted to these contexts and can breed in numerous man-made containers and structures.

In cooler parts of South Asia such as Afghanistan and northern Pakistan, malaria is at the fringe of its range and transmission is fairly unstable and very seasonal, with little to no transmission in the cooler winter months.

These vectors can bite both indoors and outdoors and biting is usually during the late evening and night. They often rest indoors; in rural areas most frequently in livestock sheds. The indoor resting means that indoor residual spraying can be highly effective in these areas. Insecticide treated nets are also useful and where people sleep outside during the hotter months outdoor use of nets has been successfully promoted. Depending on the result of entomological surveys and on the context, larval control through environmental management or larviciding can sometimes be useful.

Recommended options for the South Asia setting are:

1. Conduct detailed entomological surveys to determine main malaria vectors and their behaviour in the local setting. Although a complete survey is advised, behaviours of particular interest are: the distribution and type of larval breeding sites, level of preference for human hosts and night biting behaviour (time and location).
2. Indoor residual spraying of walls and ceilings in dwellings, livestock sheds and shelters.
3. Fit all doors and windows with mosquito screens.
4. Ensure all staff sleep under insecticide treated mosquito nets whether they are sleeping indoors or outdoors. Alternative designs of insecticide treated nets such as treated hammock nets are available and could be used for workers who tend to sleep outdoors.

\textsuperscript{26} \texttt{http://apmen.org/indonesia/}
5. Based on the result of the entomological surveys, larval control measures may be appropriate in some settings, particularly urban settings or areas which are predominantly dry with few breeding sites.

6. Personal protection measures should include:
   a. Use of an appropriate chemoprophylaxis.
   b. Where malaria transmission is highly seasonal, seasonal chemoprophylaxis could be considered.
   c. Application of repellents in the early evening hours and later at night for those who are exposed to vector biting, especially by workers who are typically outside throughout the night (e.g. security guards and night shift workers).

7. Effective case management is an essential element in malaria control. Differential diagnosis is important to identify malaria species and thereby support the selection of an appropriate treatment. It is also essential in order to identify other possible causes of disease. Microscopy is recommended over RDTs if possible provided that robust quality assurance is in place.

8. Health promotion and communications activities are key to promoting prevention and safe treatment seeking behaviours.

### 5.1.6 Step 6: Programme Design

The programme design will need to address all components of a robust malaria control programme. At a minimum:

- Prevention: measures to prevent malaria will ideally combine vector control and personal protection measures, but at the least, the latter.
- Diagnosis: measures to ensure accurate diagnostic facilities are available.
- Treatment: measures to ensure prompt and effective treatment of diagnosed cases.
- Communication approaches: efforts to increase awareness of and adoption of prevention and case management components in the workforce and communities.
- Surveillance, monitoring and evaluation: sound strategies must be in place to ensure appropriate on-going refinement of programmes and demonstration of impact.

Ideally a programme will also include:

- Capacity building: building the skills, infrastructure and resources of local partners, in particular the local health system to improve the likelihood of sustainable impact.

Aside from these components a responsible malaria control programme will also:

- Have a robust exit strategy.
- Work in close partnership with communities at all stages to ensure their full engagement in the plans. This will improve development of appropriate plans and foster community support while moving towards community empowerment.
- Manage community expectations.
- Work in partnership with local health authorities and other well placed stakeholders to access available skills and experience (see below).

  ICMM's good practice guidance for malaria\textsuperscript{20} includes a more detailed checklist of key activities to be carried out at each stage of the development of a malaria programme.

### 5.2 Other Aspects of Programme Planning and Management

Aside from following the basic steps to designing a malaria management or control programme, managers and planners may well need guidance in these other aspects of programme planning and management:

#### 5.2.1 Sourcing and Buying Malaria Commodities

A range of commodities is required for comprehensive malaria control programmes. These may include insecticides; application equipment; insecticide treated nets as well as diagnostic and treatment commodities.

It is essential that high quality commodities are procured, and that reliable suppliers are identified to avoid the potential for delays in delivery and potential stock-outs of essential items.

There is a range of advice available for those looking to source reliable and quality malaria commodities, which can be accessed here. The most comprehensive source of advice for most products is Roll Back Malaria’s Commodities Access page. This includes details of recommended commodities along with details of approved suppliers around the world and their contact details. Links to these pages, as well as other potentially useful links are also included below.

##### 5.2.1.1 Vector control

- RBM Commodities access: Procurement of Long Lasting Insecticidal Nets\textsuperscript{27}
- RBM Commodities access: Procurement of insecticides and equipment for Indoor Residual Spraying List of WHO recommended Long Lasting Insecticidal mosquito nets\textsuperscript{28}
- List of WHO recommended insecticides for indoor residual spraying\textsuperscript{29}
- List of WHO recommended larvicides
- Guidelines for procuring public health pesticides
- Equipment for vector control: specification guidelines\textsuperscript{30}

##### 5.2.1.2 Diagnostics

- Purchasing and using RDTs\textsuperscript{31}: Clear step-by-step guidance from leading international agencies

\textsuperscript{27} http://www.rollbackmalaria.org/microsites/wmd2014/nets-and-insecticides.html
\textsuperscript{28} http://www.rollbackmalaria.org/commodity-access/llins-and-irs/procurement-of-irs
\textsuperscript{29} http://www.who.int/whopes/Insecticides_IRS_Malaria_25_Oct_2013.pdf
\textsuperscript{30} http://whqlibdoc.who.int/publications/2010/9789241500791_eng.pdf?ua=1
\textsuperscript{31} http://www.wpro.who.int/malaria/sites/rdt/using_rdt/list.html
5.2.1.3 Drugs

- **RBM Commodities access: Procurement of ACTs**
- **List of pre-qualified malaria drugs** (suppliers whose ACT drugs have been found to be, in principal, of acceptable quality for approved procurement).

5.2.2 Understanding and adhering to national policy and international guidelines

International guidelines for malaria control are developed by the World Health Organization (WHO). Links to their guidelines for prevention, diagnosis, treatment, communications, surveillance and monitoring and evaluation aspects of malaria control programmes are included in the additional resources section.

National malaria control programmes use these international guidelines to develop their own national malaria policies and strategies for malaria control within their country. These typically include detailed guidelines for prevention approaches that should be supported, diagnosis approaches to be used, and treatment guidelines for uncomplicated and severe malaria of different types and in different patient categories. These detailed national guidelines often include specific instructions for variation within the country depending on epidemiology and context.

All malaria control activities should adhere to international guidelines. In addition, it is good practice to adhere to national guidelines. These should almost certainly be adhered to where community-wide activities are undertaken, and should generally also be adhered to for interventions targeting employees, unless there are compelling reasons otherwise.

Reasons for adhering to national guidelines include:

- Improving the likelihood that activities will be sustainable by building capacity relating to national approaches in the local health system or local organizations.
- Improving the likelihood that company activities can be used to leverage additional or continuing funding from the government or other regional donors.
- Responsibility to support the goals and plans of the host government.

Compelling reasons to veer from national guidelines when considering employee health may include:

- If national policies are not in-line with international best practice.

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33 http://www.rollbackmalaria.org/commodity-access/acts-1/procurement-of-acts
34 http://apps.who.int/prequal/query/ProductRegistry.aspx?list=ma
If national policies are based on a context of insufficient funding, and the company is able to commit to supporting higher cost but more effective interventions.

### 5.2.3 Partnering with and supporting local health systems

Companies with funds to support malaria control have the opportunity to see that those funds have far more sustainable impacts if efforts are made to work with and through the local health systems. Activities to provide clinical services to asset bound employees may commonly require the establishment of dedicated and independent on-site clinics. However, any work to address malaria control outside the fence or to simply make clinical services available to the community, could very effectively and very usefully be conducted by strengthening existing local health facilities or expanding the local health facility network by creating new facilities.

Existing facilities could be supported with renovations; new equipment; ongoing funding for consumables and drugs; and training and supervision for staff. New facilities could also be built and equipped in partnership with the local health authorities to be owned by them. Funding would need to be available for staffing and consideration given to their need for support for future on-going costs such as maintenance, refresher training, drugs and consumables.

In the areas of prevention, communications, surveillance, monitoring and evaluation there is also value in working with and through local health systems. You may want to review this overview of options for the different ways to get involved with and through partners.

### 5.2.4 Building wider partnerships

In some locations local or international non-governmental organizations (NGOs) may have an entrenched presence including the provision of health services to communities in their scope of work. Working in partnership with such organizations can:

- Alleviate implementation responsibility from the company.
- Support organisations which may work in the area in the long-term thereby increasing sustainability.
- Allow the company to benefit from strong local knowledge and experience, benefiting the malaria control programme.

More broadly it may be useful to consider partnering with a wider range of stakeholders including:

- National, sub-national and local media companies to support communications activities.
- Organisations involved in other vector borne disease control to consider developing a combined, integrated programme.
- Other companies working in the area, to form a local business coalition to increase leveraging opportunities and funding capacity.

You may want to review this overview of options for the different ways to get involved with and through partners.
5.2.5 Engaging in national fora

All malarious countries in this region have forums focusing on malaria in which a wide range of stakeholder groups take part. Where malaria specific forums are not established, malaria stakeholders meet as part of health or child health forums.

These forums are a way of ensuring that all potential and current partners involved in the national malaria control effort remain up to date both on national policy and on the activities being undertaken by others. Joint strategizing and planning is often a feature.

These meetings are a good opportunity to find out who is working on malaria in your area and to start the process of looking for partners. Taking part in these meetings can also be an excellent way to show that your company is taking the issue of malaria seriously, as well as showcasing your activities and achievements.

Common national forums include:

- Health partners meetings,
- Malaria stakeholders meetings,
- Working group meetings for specific malaria control areas such as vector control and case management.

Sources of information on appropriate stakeholder forums in which your company could take part are:

- The Ministry of Health or National Malaria Control Programme website,
- The local health authority office,
- The WHO country office / website.
- The Country Coordinating Mechanism (for grantees of funds from the Global Fund to fight AIDS, TB and Malaria). These groups typically work across AIDS, TB and Malaria. From the list of contacts you can find the most relevant groups to approach. To access contact information, choose a country location from the drop down box on this webpage and, on the right, click ‘Country Coordinating Mechanism’ to access the list for malaria specific contacts).

5.2.6 Engaging in Advocacy and Business Coalitions

Recognizing that the private sector can have an important influence on malaria control there are a number of coalitions that have formed to bring together the voice of the private sector. These groups lobby for and provide guidance on good practice and work to leverage the voice and influence of this sector in the support of progress on malaria globally or within specific regions.

Engaging in this way can also raise the profile of a company’s support for an engagement in malaria.

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35 http://portfolio.theglobalfund.org/en/Downloads/Index
Examples of advocacy groups and coalitions which companies could consider getting involved with include:

- **Roll Back Malaria (RBM) Partnership** The RBM Partnership mobilises for action and resources on malaria and forges consensus among partners. A founding member of the Partnership, Malaria Consortium, is a key contributor to the global framework to implement coordinated action against malaria. The Partnership comprises more than 500 members, including those from malaria endemic countries, international donors and foundations, the private sector, non-governmental and community-based organisations, and research and academic institutions.

- **World Malaria Day Website** In 2009 Malaria Consortium launched the World Malaria Day website bringing together malaria activists, practitioners and stakeholders from all over the world to encourage collaboration, resource and information sharing.

- **GBCHealth** (Global Business Coalition on Health) serves as a hub for private sector engagement on the world’s most pressing global health issues. Since 2001, GBCHealth has worked with hundreds of members -- individually and in partnership with one another to tackle the challenges of HIV/AIDS, Tuberculosis, Malaria, Diabetes and other health issues facing the workplace and communities where business is conducted.

- **APMEN** (The Asia Pacific Malaria Elimination Network) is composed of 15 Asia-Pacific Country Partners as well as regional partners from academia, development, NGOs, the private sector and global agencies, including WHO. APMEN’s mission is to collaboratively address the unique challenges of malaria elimination in the region through leadership, advocacy, capacity building, knowledge exchange and by building the evidence base.

### 5.3 Personal Protection for Short Term Visitors to Malarious Areas

Short term visitors to a malarious area should all take the following measures to protect themselves from infection and disease:

- **Know your setting:**
  - Know when and where the malaria vectors bite.
  - Know which drugs are effective for chemoprophylaxis and treatment.
  - Know where your nearest good quality clinical facility is.
  - Know what you will be doing whilst in the malarious area; will you be working outside at night, if so you can prepare by bringing long sleeved clothes and sufficient repellent.

- **Take appropriate chemoprophylaxis,** ensuring it is taken the recommended number of days before arrival and after departure, and that the regimen is followed carefully when in country
  - Medical advice should be sought to select a drug appropriate to each individual health status.

- **Use a good quality repellent** when outside between dusk and dawn, reapplying it as indicated, more frequently if sweating or after washing or swimming.

- **Sleep under an insecticide treated net** whether sleeping indoors or outdoors.
• Have stand-by emergency malaria treatment to hand if more than two hours from a good quality healthcare facility. This drug should be different from the one being taken for chemoprophylaxis.

• Be vigilant about fevers or other symptoms that could be malaria. Seek urgent medical advice and a firm diagnosis in the event of developing symptoms.

• Remain vigilant about the possibility of malaria after returning to your non-malarious base. Inform medical staff about your visit to a malarious area if you do seek care for symptoms.

5.4 PERSONAL PROTECTION FOR LONG-TERM VISITORS TO MALARIOUS AREAS

Whilst most of the measure for personal protection advised for short term visitors to malarious areas also apply for long-term visitors, the one exception is that long-term visitors will need to weigh up the pros and cons of taking malaria chemoprophylaxis for an extended period of time.

Different malaria chemoprophylaxis drugs are recommended for different maximum periods. Different countries also have different guidelines as to how long these different drugs should be taken for. Individual health status will also affect how long medical practitioners advise that a chemoprophylaxis course be continued for. It may be possible to change between chemoprophylaxis drugs to extend the period of time during which chemoprophylaxis can be taken. Advice on chemoprophylaxis must be based on the local recommendations for options (see Table 3) but also, vitally, on each individual’s health status. For this reason the decision about which drug to take and how long to take it for must be made in consultation with a medical practitioner.

When staying longer term in a malarious area, local malaria epidemiology and risk should be taken into account when considering the benefit of using malaria chemoprophylaxis long-term. In some locations it may be advisable to take an initial course of malaria chemoprophylaxis in order to give time for the visitor to get used to the location and get used to being vigilant with bite protection measures; and then after this course rely on bite protection measures alone. This could be appropriate where transmission is lower and where the risks to the visitor in their primary location are fairly low. Even in countries with some areas of high transmission malaria can be very focal, and understanding the local risk is important in order to make informed decisions about the risks and benefits of long-term chemoprophylaxis use.

If long-term visitors stay in an area of lower transmission but move within the region or country to higher transmission areas for shorter visits, chemoprophylaxis could be considered for these shorter trips even if it has been discontinued in the primary location.

5.5 ENSURING YOUR WORKFORCE UNDERSTAND THE PREVENTION MEASURES ON SITE

Most malaria prevention measures require the active support and involvement of the targeted community in order to be effective. Clearly employees must take daily action if repellents, chemoprophylaxis and insecticide treated nets are to be used as key prevention measures; but even other, site-wide approaches, such as window and door screening, environmental management,
insecticide spraying of rooms, shelters, verandas etc., are easier to put in place and maintain with employee support.

Employees who do not understand the risks of malaria, have concerns about the insecticide or don’t believe the approaches are effective enough to be important can often cause problems to the smooth implementation and maintenance of a site-wide malaria prevention approach. Most people are aware of malaria and may have come across it around the world throughout their careers; others may have lived with it in the local area. Whatever the experience with and background to employees understanding of malaria, misconceptions that can hamper employees understanding of the approaches being taken are common.

Suggested actions to ensure a well informed and supportive workforce include:
- Designing a briefing programme for all staff that will ensure they have the facts about:
  - Malaria as a disease: focusing on risks and transmission
  - Malaria in the local area: focusing on understanding the transmission dynamics and local vectors
  - Prevention approaches: what is likely to work and what is not – in particular addressing why some commonly known approaches may not have been selected for this site.
  - This will of course need to be part of a wider briefing and communication strategy that addresses diagnosis, treatment etc.
- If the briefing is paper or online there must also be an opportunity for employees to ask questions and receive full answers from an expert in the field.
- Seeking regular feedback on the approaches being used.
- Discussing and explaining any changes being planned.
- Showing results of malaria surveillance data to demonstrate impact.

### 5.6 Community-wide transmission of malaria and considering a buffer zone

Although most mosquito vectors of malaria have a flight range of around 2km, this can vary considerably (for instance, one of the major Pacific vectors has an average flight range of about half this) and flight ranges greater than about 5km are not usual. Mosquitoes can spread malaria within their flight ranges so a new works site for example located within a few kilometres of an endemic community can quickly become a focus of transmission.

In areas of high transmission older children and adults develop a high degree of immunity to the disease and harbour parasites without developing symptoms. These individuals act as a permanent reservoir of parasites for the local mosquito vectors to pick up and pass on.

When considering site-wide vector control approaches, it is often wise to consider expanding control efforts into the surrounding communities to create a buffer zone of lowered transmission around the site. Where IRS is used this is particularly important since this control approach relies on achieving a community-wide impact on the mosquito vector population, shortening the average mosquito life span.
so that individual mosquitoes don’t live long enough for the parasite to have sufficient time to develop in the mosquito and be passed on.

5.7 UNDERSTANDING THE RISKS OF MALARIA IN FREQUENT TRAVELLERS

The incubation period for malaria – the period from infection to the first signs and symptoms – is commonly around 9 – 14 days for falciparum malaria, 12 - 14 days for vivax malaria and 18 – 40 days for malariae malaria. This means that frequent travellers may become infected with malaria in one location but not show symptoms of illness until they reach another location.

With a work-force that may move around regionally or globally it is important to understand this fact, and its implications:

- A malaria infection in a frequent traveller should not be assumed to have arisen in the current location. Assumptions about drug resistance and parasite species should not be based purely on the local context. The possibility that the infection was picked up elsewhere, with a different parasite species ratio and different drug resistance profiles, should be considered.
- Clinic services that serve a community that includes employees who travel frequently, must be able to provide diagnosis and treatment for all malaria species, regardless of the local parasite context.
- Employees on a trip including several malarious areas will need to choose a chemoprophylaxis appropriate to all sites to be visited.
- Employees who travel between malarious and non-malarious sites should remain conscious of the threat of malaria even when in a non-malarious location. It is easy to forget about malaria as a risk when back at a non-malarious home / work location, yet any fever or cold / flu like symptoms in the few weeks and months following a trip to a malarious location should prompt the traveller to seek diagnosis and treatment.
- Travellers should be prepared to brief their practitioners in non-malarious locations about the malaria risk and the need for diagnosis. Emergency standby treatment may be useful to have access to even in locations where you may consider the health services to be of high quality as in non-malarious settings there is often a risk of lengthy delay in suspecting malaria, and diagnosing and treating the disease.

5.8 ESTABLISHING MALARIA DIAGNOSTIC AND TREATMENT SERVICES

Reducing the likelihood of serious illness and death from a case of malaria depends on:

- High quality and appropriate diagnostic services being available
- People with suspected malaria accessing these services
- Case management guidelines being followed by clinical staff
- Treatment being adhered to by patients if not directly administered or observed.
Establishing sound guidelines and high quality facilities are one step in this process, but maintaining quality of services and ensuring communities access facilities are also critical and should also be addressed.

**Steps in establishing good quality malaria case management services include:**

1. Determining the type of malaria parasites found in this site
2. Deciding which approach to diagnosis will be taken.
   
   [Malaria diagnosis requires specialized equipment – either rapid diagnostic tests (RDTs) which require appropriate transport and storage, or microscopy for which both specialized equipment and skills are required. In the Asia-Pacific context where both vivax and falciparum malaria are present and co-infection is common, microscopy may be the best choice where it is considered feasible. RDTs that can differentiate between falciparum and vivax malaria are available but perform less well than good microscopy.]

Diagnosis guidelines should include:

1. Patient characteristics (signs, symptoms, history) that indicate the need for a malaria diagnostic test.
2. Procedures for diagnosis including time targets.
3. Recording procedures.
4. Procedures following a negative result including:
   a. Time-frame and indicators for repeat testing
   b. Considerations for alternate diagnosis

3. Developing guidelines for transport, storage and handling of RDTs if these are to be used. A good resource for this is available [here](http://www.finddiagnostics.org/programs/malaria-afs/malaria/improving_rdt_use/storage_transport_guides.html).

4. Deciding which treatment guidelines will be recommended. This should always follow international best practice and almost always be in-line with national treatment guidelines.

Treatment guidelines should include:

a. Recommended treatment for each malaria species
b. Recommended treatment and clinical management depending on severity of illness: uncomplicated malaria versus severe malaria
c. Recommended treatment and clinical management for special groups including those with HIV, pregnant women, young children, those on malaria chemoprophylaxis.
d. Detailed referral guidelines.

5. Developing a clear, succinct written malaria case management guidelines document for local use.
6. Developing brief job-aides which can be displayed or referred to at the clinic or lab.
7. Identifying reliable suppliers of high quality diagnosis and treatment commodities.
8. Establishing a quality control strategy.

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9. Developing a communications strategy to ensure all those permitted to access the services are aware of their availability and the basics of the services provided.

5.9 **Quality control for diagnostic and treatment facilities**

5.9.1 **Diagnosis**
Deciding whether to use RDTs or microscopy or a combination of the two for confirmation of a malaria infection is important but an informed decision relies on the assumption that either of the tools will go on to be used in such a way as to ensure the best performance possible.

5.9.1.1 **Quality control of handling**
For RDTs, appropriate transport, storage and handling, in-line with the manufacturer’s recommendations, are important to ensure the RDTs remain stable and achieve their reported levels of sensitivity and specificity (rates of false negatives and false positives).
Guidelines for handling and storage of RDTs should be in place and should include recording of the conditions of storage daily. A supervisory structure should be put in place that allows checking of storage facilities at regular intervals.

The FIND manual on storage, handling and transport of RDTs can be accessed here[^37].

5.9.1.2 **Quality control of RDT use and results**
- Regular supervisory checks of clinical services should include observation of RDT use to verify that user instructions are being carefully followed. It is advisable to increase supervision if the RDT product is changed as instructions for use vary from product to product.
- Regular quality assurance of results should be conducted. Blood slides should be prepared at the same time as the RDT test for a random sub-set of people tested for malaria. These should be read by a skilled microscopist (either on-site or by a referral laboratory) to confirm alignment with RDT results.

5.9.1.3 **Quality control of microscopy**
A random sub-set of blood smears should be sent for cross-checking by an external microscopist, likely to be available in a referral laboratory within the country. The cross-check results should be compared with the on-site results.

Quality control findings should be carefully reviewed each time to identify needs for remedial training of on-site microscopy staff.

The WHO manual on quality control of malaria microscopy can be accessed here[^38]. Whilst it is written for an audience of national managers it includes an overview of all the key steps in a quality control process.

5.9.1.4 **Quality control of use of diagnostic results**

[^37]: http://www.finddiagnostics.org/resource-centre/reports_brochures/rdt_transport_storage.html
[^38]: http://www.who.int/malaria/publications/atoz/mmicroscopy_qam/en/
Whilst a main focus of diagnostic quality control will be to ensure tests are accurate, it is also important to provide quality control for the second step in the diagnostic process which is ensuring the results are used appropriately. Health clinic record books should require health staff to record details for every person tested for malaria, the means of testing, the result, the actions taken and the staff member responsible. These records should be regularly checked as part of the quality control process and remedial training undertaken if appropriate.

5.10 Considering who to make clinical services available to

There are four main options:

• Employees only
• Employees and their families
• All local communities within a specified area
• Anyone who comes to the clinic. (In many areas will add few additional patients to the above, it may therefore be easier to avoid making statements or guidelines about the communities who are permitted to access. This will also avoid the need to verify place of residence).

Reasons to limit access to services could include:

• To reduce the costs associated with use of commodities and other resources
• To reduce the burden on the services in-line with the staff time available
• To reduce the consumption of commodities if these are scarce or there is or is expected to be a supply problem.

However, good reasons for expanding the availability of services as far as possible include:

• The epidemiology of malaria transmission means that control of the disease is most effective if both prevention and treatment services are in place at scale and community-wide. Reducing the parasite reservoir in the local communities by prompt and effective treatment of cases is an important contributing factor to successful malaria control. Extending the availability of services is therefore not purely altruistic but will also likely reduce the impact of malaria within the workforce itself, and thus on the company.

• Availability of high quality malaria case management services is often poor in the rural and remote areas in which many companies work. Making these services available to the local communities is an undeniably useful and potentially high impact option for part of a corporate social responsibility programme.

Options to make some services available more widely and some to a more defined group are also possible. For example, a company might offer diagnostic and out-patient services to local non-employee families but refer them elsewhere for in-patient care if required, while providing full in-patient services as necessary for employees and their family members.
5.11 HEALTH FACILITY BASED DATA COLLECTION AND ANALYSIS FOR MALARIA

A range of data should be collected as part of an overall surveillance strategy. Clinical data on people tested and diagnosed as well as the treatments undertaken and if possible the outcomes, are an important part of this surveillance strategy. These data can be used to track burden of disease – in general and in sub-groups – as well as to monitor performance of drugs.

Specific data that should be collected include:

- Details of all people tested for malaria: name, age, sex, occupation, residence, places visited in past month, malaria history. This should be linked to:
- Results of all malaria tests: type(s) of test, person(s) responsible, result(s) and action taken. This should be linked to:
- Results of all malaria treatments given including results of follow-up testing after treatment if recommended.
- Data summaries that will be useful:
  - People tested by month and sub-group
  - Test positivity rate by month and sub-group
  - Number of malaria cases by month and sub-group

Specific uses that these data can be put to include:

- Tracking the disease burden over time.
  Looking at annual trends to ascertain when any peaks of malaria transmission occur by malaria type. This information can guide control approaches as well as inform commodity supply planning.
- Looking at the malaria incidence rates (number of cases per 1,000 population during a given period) in different sub groups, such as:
  - Occupational groups: this could help identify high risk occupations which could benefit from targeted control measures.
  - Residence (on-site, off-site or workers who move between locations; different off site locations) this could help identify where transmission is occurring and inform planning of vector control interventions or targeted personal protection for those in or visiting certain sites.
  - Those using / not using chemoprophylaxis: this can help determine the effectiveness of the chemoprophylaxis as well as inform analysis of the cost benefits.
- Looking at the total burden of malaria to inform:
  - estimates of economic impact of malaria on the company and local communities
  - commodity planning
  - impact evaluations
6 MALARIA AND INDUSTRY

6.1 IMPACT OF BUSINESSES ON MALARIA

Business activities can have both positive and negative impacts on malaria. Some company activities can lead to increased malaria transmission by for example:

- Bringing people into unpopulated areas with high malaria transmission potential.
- Moving non-immune employees into malaria endemic areas.
- Requiring employees to work outside during peak transmission times (e.g. night-time shift work).
- Increasing the size/number of mosquito breeding sites as a result of construction work, leading to increased transmission (e.g. by the creation of trenches alongside new roads which may collect rain water).
- Causing long-term changes in land-use leading to a long-term increase in transmission potential (e.g. through irrigation projects).

Other company activities can result in reduced malaria transmission by for example:

- Reducing the size/number of mosquito breeding sites through construction work (e.g. improving drainage through the strategic use of culverts, drains and soakaways).
- Making high quality malaria treatment facilities available to employees and the wider community. This can have a particularly profound impact where companies are working in remote populated areas beyond the reach of national health services.

Private companies, perhaps more in the Asia-Pacific than in any other region, have the potential to effect major transformational impact on malaria control. The extensive presence of large scale private companies working in malarious areas, often in remote locations, provides an opportunity to bring high quality malaria control to areas that Government may be unable to reach.

6.2 IMPACT OF MALARIA ON BUSINESS

As the World Economic forum states:‘Malaria is bad for business’! It impacts on company profits through employee absenteeism, reduced productivity and escalating benefit costs. It can also have negative reputational impacts.

In 2006 the World Economic Forum conducted a review of business attitudes and approaches to malaria, detailing businesses’ estimates of the impact of malaria on their operations, including financial impact. This document can be accessed here and its key messages are summarized below.

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39 http://www.k4health.org/sites/default/files/What%20is%20the%20Economic%20Impact%20of%20Malaria.pdf
40 http://www.weforum.org/search/google/malaria?query=malaria&cx=00537478448757532108%3Azwr8u4lxoba&cof=FORID%3A11&sitesearch=
Attempts have been made to estimate the financial returns on investing in malaria control. Marathon Oil estimates 4:1 returns on its investments in malaria control\(^\text{41}\), though this is the in the African setting. Firm estimates of the financial impact of malaria on companies in the Asia-Pacific are not available. However it is known that malaria can impact on business in a number of ways:

Directly: through impact on workforces, increased spend on healthcare and corporate reputational effects. Specifically through:

- Absenteeism of employees who fall ill with malaria or take time off to care for family members who fall ill. Around 1 – 5 days can be expected to be lost for each malaria case.
- High healthcare costs for companies that provide health services to their employees.
- Costs of pay-out packages in the case of a death, as well as related recruitment and retraining costs for replacements.
- Poor company morale when cases and/or deaths are high.
- Corporate reputational risks where companies are seen to either make malaria worse or to engage insufficiently in what is seen to be a priority local problem.

Indirectly: through impacting on the economic climate in which the business is operating, for example:

- By damaging children’s educational prospects.
- Weakening labour productivity.
- Influencing decisions on savings and investments.
- Impacting on household solvency and ability to be economically active.
- Altering a country’s demographic structure.

### 6.2.1 Impact of Malaria on the Extractive Industry

The extractive industry often sees assets located in remote areas where malaria transmission may be high and health services may be particularly weak or absent. This combination of characteristics means that employees, and local communities may be particularly at risk from malaria. Working practices in the extractive industry can also exacerbate the potential for impact from malaria for example:

- Night-shift workers are commonly used at drilling sites. These workers will be at greater risk of being bitten by evening and night biting malaria vectors.
- Employees often work on rotation meaning both local and international employees may go back and forth between home communities and company assets. The differences in malaria context at these locations can complicate the malaria control needs. For example in Papua New Guinea assets may be located in non-malarious areas but the workforce may travel to malarious home communities on rotation. International staff may work at malarious sites but travel to non-malarious ‘home’ locations where the health service may not be expert at dealing with malaria infections.
- Extractive industry activities could make malaria transmission potential worse by creating mosquito breeding sites.

\(^{41}\) [http://www.gbchealth.org/our-work/health_focus_areas/malaria/]
The economic impact of malaria on companies in the extractive industry may therefore be particularly high. There is also a duty of care towards workers for whom the job raises the risk of malaria infection and there may be a strong social responsibility case for intervening to support malaria control in the local communities. The often long-term engagement in an area strengthens the case for getting involved.

### 6.2.2 Impact of Malaria on the Agri-Business Industry

Agro-business activities may often bring employees into closer contact with forest, forest-fringe, or rural malaria vectors than they would normally be.

Exacerbating factors can include:

- Some workers may be active in rural locations at dusk or dawn, increasing their chances of contracting malaria.
- Irrigation associated with some agri-businesses may increase the number/size of breeding sites.

This will have economic implications on the company but will also bring about a duty of care towards employees brought into greater risk of malaria transmission than would otherwise be the case, and towards local communities if malaria transmission potential is raised by company activities.

There may also be a social responsibility to tackle malaria if it is a major health issue in surrounding communities, particularly given the likelihood that the company will be engaged in an area long-term.

### 6.2.3 Impact of Malaria on Infrastructure Industry

The infrastructure industry can encompass a wide range of companies and projects.

Infrastructure development activities have the potential to increase or decrease malaria transmission in various settings. Land may, for example, be drained to support construction work reducing the number/size of breeding sites and lowering malaria transmission potential. Certain vectors however favour temporary pools as breeding sites, and for these species the drainage of permanent water bodies could result in increased vector densities and an upsurge in malaria transmission. In other sites construction may see a proliferation of ‘borrow pits’, which can collect rain water and act as breeding sites for particular mosquito species, potentially increasing malaria transmission. Projects that inadvertently prevent drainage can result in long-term increases in the salinity of surface water, which can favour the breeding of certain malaria vectors and result in increased malaria transmission.

Certainly most companies active in this industry will want to put mitigating measures in place to avoid making the malaria situation worse.
7 MALARIA FREQUENTLY ASKED QUESTIONS

Are there different kinds of malaria?
Yes, there are five types of human malaria namely falciparum, vivax, ovale, malarialae and knowlesi.

All malarias are found in the Asia-Pacific region though ovale, malarialae and knowlesi are relatively rare.

Falciparum malaria is the most dangerous form of the disease. It is the most common form in sub-Saharan Africa but it is also found in considerable numbers in the Asia-Pacific. Vivax malaria is however the most common strain of the disease in the Asia-Pacific.

Knowlesi malaria (usually a disease of monkeys) is rarely seen in humans, to date only in specific parts of South East Asia.

Are all types of malaria serious?
Falciparum malaria is the most serious common form of the disease and is often life threatening in non-immune people. Knowlesi malaria is also very serious and should be treated as falciparum, though it is rare and only seen in specific areas of South East Asia.

Vivax malaria is not usually life-threatening though it can cause severe illness and death.

Ovale and malarialae are not life threatening but they do cause unpleasant illness, making people feel unwell enough to have to stay in bed for a number of days.

Other than being bitten by a mosquito, how else can I get malaria?
Almost all malaria cases are a result of being bitten by an infective mosquito. In a small number of cases each year, malaria is also transmitted through infected blood transfusions. In rare cases it can be passed from mother to foetus during pregnancy or childbirth.

How long after being bitten can it take for malaria to appear?
Most people will fall ill within 7 to 30 days of receiving an infected bite. The shorter periods are usually associated with falciparum malaria and the longer ones with malarialae malaria. However, antimalarial prophylaxis can delay the appearance of malaria symptoms by weeks or months so symptoms can appear long after a person has left the malaria-endemic area (particularly in the cases of vivax and ovale malaria due to their ability to lie dormant in the liver). Returned travellers should therefore always remind their health-care providers of any travel to malaria endemic areas.

Can malaria recur later?
Once a malaria patient has been treated and recovered there are possible reasons why the disease may recur later:
The initial infection may not have been fully treated and may have just been suppressed. It could then resurge later causing another episode of illness. This will normally happen within a week or two.

*Vivax* and *ovale* malaria have a form of the parasite which can lie dormant in the liver. With these types of malaria there is an initial period of illness that may be treated and cured, but the dormant stage may still be present. The dormant stage can then emerge into the blood stream several months, or occasionally, several years later. These malarias can be completely cured and removed from the liver by treatment with ‘radical cure’ drugs. The most commonly used drug for this is primaquine.

Some types of chemoprophylaxis are not fully effective against vivax or ovale malaria. People taking this type of prophylaxis who become infected may never experience an initial illness but may still harbour the dormant liver stages of the disease. The active blood stages of the infection can then relapse months or possibly even years after prophylaxis is stopped.

**How far do mosquitoes travel?**

Most mosquito species generally only have a maximum flight range of around 2km and usually fly much shorter distances if food and breeding sites are available locally. Some species have longer flight ranges and all species can travel considerably further if taken by the wind, or inadvertently carried by a vehicle.

**Will there be a malaria vaccine soon?**

There are currently no commercially available malaria vaccines.

A number of vaccine candidates for falciparum malaria are currently being developed or trialled. The most advanced – RTS,S, could be used operationally in the medium term (WHO predicts making a policy recommendation in 2015)\(^4\). However, RTS,S has been designed to vaccinate children living in highly endemic areas. It will not be appropriate as a vaccine for international travellers and there are at present no vaccines in the later stages of development that would be appropriate for this target group.

There is currently no vaccine candidate being trialled for use in the Asian setting.

There are currently no vaccine candidates for any other species of malaria.

**Aren’t untreated nets just as good as treated nets? What is the added advantage of insecticide?**

While untreated nets certainly provide some protection, treated nets are proven to offer twice as much protection from malaria as untreated nets. Nets treated with insecticide stop mosquitoes from biting through the net and mosquitoes are less likely to find their way under the net or through small holes.

**How safe is the insecticide on the nets?**

Only one class of insecticides, the ‘pyrethroids’, is registered by the World Health Organisation as safe to put on mosquito nets. This is because extensive safety testing has been done on this class of insecticide to ensure they are safe for people to sleep under. The safety testing showed that the amount of insecticide needed to cause harm was far above the amount used to treat one net. This

\(^4\) [http://www.who.int/malaria/areas/vaccine/en/]
means that everyone can safely sleep under an insecticide treated net. Some people experience short-term minor irritations from new or freshly treated nets. This can include experiences such as itching, tingling skin or sneezing. This is relatively common in people handling new nets out of the bag or freshly treated nets. However these side effects are not bad for your health.

**Do air conditioners and fans stop mosquitoes from biting?**

Air conditioners do prevent some mosquito biting as mosquitoes are less active in cooler temperatures. However the main protection comes from the fact that air conditioners are normally in place in well-sealed rooms, meaning there may be fewer mosquitoes in the room. Fans also reduce mosquito biting to some extent if you are sleeping directly under the air movement. However, neither of these is effective enough to rely on as a protective measure in areas where malaria is a problem.

**How effective is chemoprophylaxis?**

No malaria chemoprophylaxis gives complete protection and this is important to note as ensuring you protect yourself from mosquito bites remains important. However, the medication is extremely effective and, as a rule provides about 95% protection from fatal disease. The amount of protection you will get depends on how regularly you are taking the medication, whether you miss doses, and how well your body absorbs the drug. The World Health Organisation which monitors malaria cases each year notes that: “*most falciparum malaria cases in non-immune travellers each year occur because of poor adherence to or complete failure to use, chemoprophylactic drugs*”

**How do the drugs work?**

The different drugs, be they for chemoprophylaxis or treatment, work at different points in the parasites life-cycle. Some attack the blood stages of the malaria parasite, others attack the liver stages of the malaria parasite, and some attack both. They attack the parasite in different ways, for example some block the malaria’s self-detoxifying process, and some block its cell respiration process.

All of the drugs work to destroy the parasites in the infected person by preventing them from multiplying. The drugs stop parasites from multiplying and existing ones die. For treatment this means that over the course of around 7 days or less the treatment will have eradicated the parasites from the body.

With chemoprophylaxis the parasites are never able to get well established in the body because the high levels of the drug in the blood stream prevent the initial multiplication within the blood. *Some drugs used for prophylaxis are not able to destroy the dormant liver stages of the parasite found in vivax and ovale infections.*

Some of the drugs that are used for treatment of severe malaria, rather than chemoprophylaxis, work in a slightly different way. They prevent parasites from maturing into the more dangerous stages that can cause coma and organ failure while at the same time removing parasites from the body.

**Doesn’t chemoprophylaxis just reduce the number of parasites in the blood meaning you are only able to notice symptoms later leading to delayed treatment and more problems?**

When the chemoprophylaxis is working, it does not just reduce the number of parasites in the blood, but removes them entirely. If you are unfortunate and get a break-through infection,
perhaps because the malaria is developing some resistance to that drug, then it may fail to prevent the malaria parasites from spreading and multiplying in the body. In this case the development of the illness will be slowed down but will continue to progress as the malaria continues to multiply in your body slowly. Symptoms will appear later than with an infection in someone not taking chemoprophylaxis but this is a good thing; this is because the whole disease itself is developing more slowly in your body. This means you have longer to react and seek treatment.

How long can you take chemoprophylaxis for?
Recommendations on how long to take chemoprophylaxis for vary from country to country and should be tailored to suit a patient’s individual circumstances by a doctor. For instance, UK product licensees indicate that mefloquine (Larium) can be taken continuously for a period of up to 12 months, doxycycline can be used for up to 6 months, and atovoquone-proguanil (Malarone/Malanil) can be used for from 9 to 34 weeks without experiencing adverse effects. Nevertheless, long-term use of any drug should be prescribed with careful consideration. Prescriptions and experiences should be reviewed with a medical practitioner intermittently.

What side effects does chemoprophylaxis have?
All drugs have some possible side effects. Serious side effects are rare; minor side effects are far more common but are often so mild that they do not affect the activities of the traveller. Each malaria drug is contraindicated (not recommended) for some groups of people and this guidance should be carefully followed to avoid serious side effects in these groups. The most common side effects include:

- Atovoquone-proguanil: abdominal pain, nausea, vomiting and headache.
- Doxycycline: photosensitivity, nausea, vomiting and vaginal yeast infections.
- Mefloquine: psychoses, seizures (these are very rare), gastrointestinal disturbance, headache, insomnia, abnormal dreams, visual disturbances, depression, anxiety disorder, dizziness, tingling, numb skin, tremor, agitation or restlessness, mood changes, panic attacks, forgetfulness, confusion, hallucinations, aggression and paranoia

Anyone who develops serious side effects, particularly serious neurological or psychological disturbances after taking mefloquine (Larium), should stop taking the drug and seek medical advice. This is one of the reasons why it is important to take Larium for 2-3 weeks before travelling. This allows doctors to determine if a different option is going to be needed. Mild nausea, occasional vomiting or loose stools should not prompt discontinuation of prophylaxis, but medical advice should be sought if symptoms persist.

It is important to note that these side effects are on the whole rare. The potential side effects (barring people with specific medical issues) do not warrant avoiding chemoprophylaxis in preference to waiting until you get malaria and then treating it. It is not safe to assume that any malaria infection will be successfully treated.

If you travel last minute is it ok to start taking the medication 1 day before you travel or even once you arrive?
The best protection is given when you take the drugs for the recommended time before travelling (this timing depends on the type of drug). For atovoquone-proguanil you only need to take it 2-3 days before travelling to have the best protection. However, yes, it is always worth starting the medication whenever you can, even if you are already in the malarial areas. You will still get some protection from it though you must be aware that the initial protection will not be nearly as good as
if you had started at the recommended time. If you have started it late then protecting yourself from mosquito bites is even more of a priority than normal.

**How quickly does malaria infection progress?**

Once you are bitten by an infective mosquito there will be a period of delay before you fall ill. During this time the malaria parasite is developing in the liver. Once it emerges from the liver and starts circulating in your blood stream you will start to feel unwell. This is normally within a couple of weeks after being bitten, but can be up to a few months or even years in certain circumstances. Initial symptoms may be very vague and flu-like including lethargy, aching muscles, headache and then fever and chills. Often these relatively mild symptoms persist for a couple of days before becoming more serious, however the progression can be much faster with severe malaria and possibly cerebral complications developing within 24 hours of initial symptoms. This is why it is very important to act quickly.

**Do tests tell you which malaria you have?**

You can test for malaria by having a drop of blood from a finger prick examined by a skilled microscopist or tested with a rapid diagnostic test (RDT).

Microscopy can tell you what kind of malaria you are infected with and how many parasites there are in your blood. Rapid tests come in different types. Some only tell you if you have *falciparum* malaria. Others tell you if you have falciparum malaria or one of the other types. The sensitivity and specificity of most RDTs is high (and steadily improving) but for the time being at least, microscopy in the hands of a skilled technician is still more reliable if the number of parasites in the blood is low.

**Can I just treat myself for malaria?**

Recommendations for emergency self-treatment from the World Health Organization are given below:

- Take medical advice on the appropriate drug to take along with you as stand-by emergency treatment.
- Consult a physician immediately if fever occurs 1 week or more after entering an area with malaria risk.
- If it is impossible to consult a physician and/or establish a diagnosis within 24 hours of the onset of fever, start the stand-by emergency treatment and seek medical care as soon as possible for complete evaluation and to exclude other serious causes of fever. This is important as the drug you are taking may fail and you may need a second line treatment.
- Do not treat suspected malaria with the same drugs used for prophylaxis; if the infection has broken through the chemoprophyaxis it may be because of tolerance to that drug and a different drug should be used for treatment.
- Vomiting of antimalarial drugs is less likely if fever is first lowered with antipyretics (e.g. paracetamol). A second full dose should be taken if vomiting occurs within 30 minutes of taking the drug. If vomiting occurs 30–60 minutes after a dose, an additional half-dose should be taken. Vomiting with diarrhoea may lead to treatment failure because of poor drug absorption.
Complete the stand-by treatment course and resume antimalarial prophylaxis 1 week after the first treatment dose. To reduce the risk of drug interactions, at least 12 hours should elapse between the last treatment dose of quinine and resumption of mefloquine prophylaxis.

Medical advice should be sought in all cases of suspected malaria illness.

**Can you use chemoprophylaxis medicines for treatment?**

Yes, all the preventative medicines can theoretically be used for treatment but there are a few important points:

- The doses used for chemoprophylaxis and for treatment are very different. It is vital to get medical advice on the appropriate treatment dose.
- If a breakthrough case of malaria occurs when someone is on chemoprophylaxis, it may be because the parasite is tolerant to the drug being used. It is therefore important that a different drug is used to treat the case.
- The drug provided for standby emergency treatment should be different from the drug being used for chemoprophylaxis.

Medical advice should be sought in all cases of a suspected malaria illness.

**Can you ever get better from malaria without treatment?**

People who have grown up in areas with a lot of malaria and stay in these areas develop some immunity to the disease. This partial immunity means that they may get ill with malaria a couple of times a year but not seriously so. Sometimes these malaria episodes will need treatment while others may resolve themselves without treatment.

Non-immune people are those people who did not grow up in a malaria-endemic area or people who did grow up in these areas but moved away for around 6 months to a year or more. In this group every *falciparum* malaria infection will cause serious illness and need urgent treatment.

**What other diseases do mosquitoes spread?**

Different groups of mosquito species spread different diseases:

- Anopheles mosquitoes: malaria, lymphatic filariasis (also known as elephantiasis is a public health problem for people who have been living for many years in endemic areas but is not of concern for travellers).
- Culex mosquitoes: Lymphatic filariasis, Japanese encephalitis, other viral diseases.
- Aedes mosquitoes: Yellow Fever, dengue, dengue haemorrhagic fever, other viral diseases, lymphatic filariasis.
8 CASE STUDIES OF SUCCESSFUL INDUSTRY INVOLVEMENT IN MALARIA CONTROL PROGRAMMES

Private companies have increasingly been playing an important role in malaria control in the region through a number of engagement modalities such as:

- Engaging in advocacy and lobbying.
- Multi-company coalitions to support national programmes with a private sector focus.
- Financial support to malaria programmes.
- Implementation of high quality malaria treatment and control services, both within and outside the fence. The latter can have a particularly profound impact where companies are working in remote populated areas beyond the reach of national health services.

Donors, governments and regional bodies are increasingly recognizing the important role that the private sector has been playing and could increasingly play in making good quality malaria interventions more accessible.

In 2012 the Australia Department for International Development convened a conference to consider the role of the private sector in malaria control in the Asia-Pacific region. A number of useful issue papers were prepared for this meeting (see section 9).

Case studies of successful private involvement in malaria control collated by Montrose International are summarised here:

8.1 ELIMINATION OF TAXES AND TARIFFS, PAPUA NEW GUINEA

In 2011, the Malaria Taxes and Tariffs Advocacy Project (M-TAP) reported that only six countries worldwide had completely removed tariffs on products used to fight the disease despite agreement to do so ten years ago. Dropping taxes and tariffs can play a key role in cutting costs because the vast majority of medicines and other products used to fight malaria are imported. These are: LLINs, ACTs, RDTs, insecticides for indoor spraying, and insecticide spray pumps.

M-TAP, which has been gathering evidence from nearly 80 malarious countries over the two year project, found that taxes and tariffs on anti-malarial products provide only minimal revenues, and these gains are often offset by health costs and lost productivity from preventable malaria illnesses. In Cambodia, M-TAP found that non-tariff barriers present more obstacles for importation than existing taxes and tariffs, for example, in issues of procurement and supply management. Private sector providers continue to play a critical role in supplying access to malaria treatment and prevention despite the huge increase in donor commitments over the past five years, so removal of taxes and tariffs are another way to ensure that cost does not pose a significant barrier to access.
8.2 Affordable Medicines Facility for Malaria (AMFM), Cambodia

Despite efforts to assure quality of care in the provision of ACTs, an alarming resistance to artesunate (an active derivative of artemisinin) was documented in western Cambodia. The poorly regulated private sector, where approximately 70 per cent of fever sufferers seek treatment, is believed to have contributed to this resistance development by dispensing artemisinin based monotherapies (AMTs) and sub-therapeutic doses of artemisinin.

The government reconsidered its use of the private sector in its battle against malaria. International support programs offered new opportunities to test market-based incentives that compel the private sector to provide optimal malaria care. The AMFm, hosted and managed by the Global Fund, invited Cambodia (and six other countries) to participate in its plan to flood their markets with highly subsidised formulations of ACTs that are so inexpensive that private sector providers can sell them as profitably as AMTs and other ineffective treatments. The AMFm program required participating countries to partner with the private sector for the distribution of ACTs.

The AMFm enables private importers to pay up to 80 per cent less than they did in 2008-2009. It pays most of this reduced price (a ‘buyer co-payment’) directly to the manufacturers to further lower the cost to eligible first-line buyers of ACTs. Unfortunately, low cost ACTs procured through AMFm arrived late in country and so it was not possible to show impact in the ACTwatch evaluations in Cambodia.

8.3 Net Bundling Strategy, Cambodia

A bundling strategy was devised as an interim measure to address the issue of high demand for untreated nets. The strategy aimed to make use of the huge cost efficiencies of using the existing private sector net retail channels to supply long-lasting insecticide treatment kits bundled with untreated nets. This was possible because Cambodia has relatively few net importers and a highly centralised retail distribution system, with one major wholesale market as the hub through which most products flow out to provincial markets.

Population Services International (PSI) was identified as the partner to work with to implement the strategy due to their significant experience of working in the private sector. PSI approached and gained buy-in from the existing net traders (importers and wholesalers) operating in Phnom Penh. Conventional nets were bundled at the top of the supply chain where possible. A mass communications strategy encouraged buying a bundled net and dipping the net in the insecticide. The evaluation found 72 per cent of outlets were selling bundled nets (according to PSI MAP Survey data).

It was learnt that it is not efficient to segment the retail market and limit it to cater only to the high transmission areas of the country without incurring huge cost inefficiencies; therefore the program was designed to bundle all nets, reaching all areas of the country. It was considered that as there is migration around the country, nets would be assured to reach migrant populations via this method before they moved to the at-risk areas.

8.4 Social Franchising – Sun Quality Health (PSI) Myanmar

Launched in Myanmar in 2001, the social franchise network consists of a first tier of private licensed General Practitioners (GPs) called Sun Quality Health (SQH). SQH clinics offer services in malaria and also
reproductive health, TB, pneumonia, diarrhoea, and HIV including STIs. In 2008 a Sun Primary Health (SPH) channel was launched to reach poor and vulnerable rural communities within a 3 hour radius of the SQH clinic. SPH are a second tier of the network and are trained in a range of health areas for which they sell subsidised products. Currently SPH is being scaled up. Payment sources are 99 per cent out-of-pocket expenditure and 1 per cent free. Malaria disability adjusted life years (DALYs) averted in 2010 were 18,523 rising to 46,567 in 2011. This significant increase was attributable to the SPH community health workers.

### 8.5 Private Provider Alliances, the Myanmar Medical Association

The Myanmar Medical Association (MMA) is the only professional body of medically qualified doctors in Myanmar, with over 8,000 members and a total of 74 branches throughout the country. In 2009 MMA was funded to implement the Quality Diagnosis and Standard Treatment of Malaria by Private General Medical Practitioners (QDSTM) Project.

MMA’s QDSTM project aims to provide quality assured diagnosis and treatment of malaria by the private medical GPs in selected townships. It is a continuation of a Three Diseases Fund project that empowered 173 GPs in 46 townships and provided quality assured diagnosis and treatment of malaria. Two fixed clinics extend the services to the village level through setting up mobile teams and trained volunteers. The mobile teams and volunteers provide health education and case management of malaria. The volunteers are provided with essential medicines and RDTs to manage malaria in between the visits of mobile teams. The mobile team visits one/two villages per week and also supervises the activities of trained volunteers. The implementation is regularly supervised and provides feedback to MMA technical staff, central supervisors and the WHO malaria unit.

In year 3 and 4, the project will further expand to 14 new project townships and train 50 more GPs to deliver malaria case management in accordance with the National Malaria Treatment Guidelines. In addition, the project management, in consultation with WHO, will open fixed and mobile clinics in two remote townships (Kachin and Rakhine) where malaria is highly endemic and access to health services is very limited. The project will focus on strengthening in-house capacities; ensuring participating GPs follow the QDSTM Project Standard Operating Procedures; and improving monitoring and evaluation.

### 8.6 ExxonMobil, Papua New Guinea

ExxonMobil is implementing ‘inside’ and ‘outside’ the fence initiatives at its operations in PNG. Inside the fence, the Malaria Control Programme covers both employees and contractors working in malaria-prone areas. It includes awareness campaigns, mosquito bite prevention tools, and anti-malarial medication, and promotes early diagnosis and treatment to fight malaria. Outside the fence, ExxonMobil, through its Malaria Initiative, has collaborated with the Rotarians Against Malaria Program on logistics, planning and bed net distribution. Plans are under development for enhanced malaria diagnostics at relevant community clinics. More than 1,000 community members have been tested for malaria and were treated if positive. ExxonMobil is also working with the Medicines for Malaria Venture to fund clinical trials of new antimalarial medicines in PNG.

### 8.7 Newcrest Mining Ltd., Gosowong, Indonesia
Newcrest Mining Ltd is implementing an ‘inside the fence’ employee protection malaria control program at the Gosowong gold mine in Indonesia. Education, counselling, prevention, risk-control and treatment programs are available to all workers and treatment is also provided to workers’ families. Employees are given safety inductions to learn about the dangers of malaria and can obtain further information from or report cases of malaria to the safety officer, malaria control officer or site doctor. Prevention and risk-control methods include reporting of potential malaria hazards, fogging, IRS, and sanitation. Malaria cases are treated at the site clinic or the local hospital where employees are covered by health insurance.

8.8 Newmont, Batu Hijau, Indonesia

Since 1996, Newmont has been contracting International SOS to operate an integrated broad-based health service at its Batu Hijau mine. The program involves prevention and treatment activities both inside and outside the fence including larviciding, screening of military personnel for malaria before entering the control zone, distribution of mosquito nets, space spraying, training of community members on diagnosis of malaria, capacity building of government health workers, screening and treatment of children in surrounding villages, case management in the site clinic and first aid posts and medical evacuation if necessary. Malaria prevalence reduced in community school children from 47.3 per cent in 1999 to 1.5 per cent in 2007. In addition, the malaria incidence rate in the mine workforce dropped from 53 per 1,000 employees in 1998 to 5 per 1,000 in 2007.

8.9 Shell, Palawan, Philippines

In 1999, the Pilipinas Shell Foundation launched the Movement Against Malaria social investment program. The foundation worked with the provincial government and the Department of Health to set up 344 malaria village laboratories in the Palawan province, with trained local staff to detect the malaria parasite in blood smears. The program provides leaflets and holds village meetings to raise awareness of malaria prevention. It encourages people to sleep under mosquito nets, clear breeding areas and keep themselves covered in the evening. In 2006, the program received a US$14 million five-year grant from Global Fund to expand to four more provinces. Another grant in 2010 provided US$31.4 million and increased the total number of provinces covered to 40. The program has reduced malaria deaths by nearly 97 per cent from 99 deaths a year in 1999 to three in 2011.

8.10 Oil Search, Southern Highlands Province, Papua New Guinea

Since 1998, Oil Search has been implementing the Marasin Stoa program, a village malaria treatment initiative at its Hides gas field project area in the Southern Highlands Province. The program entails training a community member, usually a woman, in basic malaria diagnosis using a Rapid Diagnostic Kit and supplying pre-packaged (dosage for weight category) malaria medication. The village treatment providers also collect malaria blood slides from each case for laboratory analysis in the Oil Search laboratory in order. The treatment providers charge a nominal fee and can sell additional ‘over the counter’ health products to supplement their income. This ensures sustainability of the program and addresses other social development issues such as poverty and gender equity. The program has seen a steady decline in the incidence and prevalence of malaria in all affected communities. Direct
management has been taken over by a local church health service provider, with technical support provided by the Oil Search Health Foundation. The National Department of Health (NDOH) has endorsed the program and the model is being trialled in other parts of the country. Additionally, Oil Search has been appointed the new principal recipient (PR) of funding from the Global Fund replacing the NDOH as PR.

8.11 mHealth Management Information Systems, Philippines, Indonesia

EpiSurveyor is a free mobile phone- and web-based data collection system. It is used for the collection of information regarding clinic supervision, vaccination coverage or outbreak response, and it helps to identify and manage important public health issues including HIV/AIDS, malaria, and measles. As of April 2012, EpiSurveyor, based in Kenya, has nearly 8,000 users in more than 170 countries worldwide including the Philippines and Indonesia, making it the most widely used mHealth software. Partners include: Datadyne, United Nations Foundation, Vodafone Foundation, and Knight Foundation.
9 ADDITIONAL RESOURCES

This section gathers together a range of information on malaria, from general to specific, with resources that provide both written information as well as more interactive resources which can be used for self-teaching. There are detailed reference manuals, as well as short fact sheets. Also included are links to audio and video podcasts and relevant malaria apps.

These resources are listed here by type and by subject area, though links to these are also found throughout the website at relevant points.

Accessing this section of the website will allow you to click links directly to these appropriate websites.

9.1 WEBSITES AND DOCUMENT DOWNLOADS

9.1.1 Information booklet which accompanies the website.

This document.

9.1.2 Basic malaria information

- **WHO malaria topics pages**
- **CDC ‘About malaria’ pages**

9.1.3 Malaria distribution

- CDC [Malaria Map Application](https://www.cdc.gov/malaria/) showing the worldwide distribution of malaria with information by country.
- **WHO World Malaria Report 2013.**
- **Asia-Pacific specific information** by country from the APMEN group.

9.1.4 Information for travellers

- **WHO Information for travellers to malarious areas.**
- **CDC’s travel fact sheets for malaria**
9.1.5 International guidelines for malaria control interventions

9.1.5.1 Prevention
- CDC Mosquito repellent fact sheet
- Malaria Vector Control and Personal Protection, WHO.
- A toolkit for mass distribution campaigns to increase coverage and use of long-lasting insecticide-treated nets, AMP.
- Indoor Residual Spraying (IRS) Toolkit, MACEPA/PATH.

9.1.5.2 Insecticide resistance

9.1.5.3 Case Management

9.1.5.4 Diagnosis
- Diagnosis Guidance from the Centers for Disease Control and Prevention, CDC.
- Good practices for selecting and procuring rapid diagnostic tests for malaria, WHO.
- Use of Malaria Rapid Diagnostic Tests (RDT), WHO.
- Interactive guide for malaria RDT selection, FIND.
- Guidelines for the transport, storage and handling of RDTs, FIND. Appropriate for use in health clinics.

9.1.5.5 Treatment
- Treatment guidelines for clinicians. CDC.

9.1.5.6 Drug resistance
- Global plan for artemisinin resistance containment (GPARC)

9.1.5.7 Anti-malarial drug policies
- Country anti-malarial drug policies in South East Asia, WHO.
- Country anti-malaria drug policies in Western Pacific, WHO.
9.1.5.8 Communications
- The US President’s Malaria Initiative Communication and social mobilization guidelines and primer.

9.1.5.9 Community Implementation
- Malaria Community Competency Package, MACEPA.

9.1.5.10 Surveillance, Monitoring and Evaluation
- Disease surveillance for malaria control: operational manual. April 2012, WHO.
- LiST: The Lives Saved Tool.
- T3: Test. Treat. Track. Scaling up diagnostic testing, treatment and surveillance for malaria. April 2012, WHO.

9.1.6 Asia-Pacific specific information
- Defeating Malaria in Asia, the Pacific, Americas, Middle East, and Europe, November 2012. Publication from the AusAID funded Malaria 2012 regional political congress.
- Consensus on Malaria Control and Elimination in the Asia-Pacific. Publication from the AusAID funded Malaria 2012 regional political congress.
- ACTMalaria: the Asian Collaborative Training Network for Malaria. This website has a lot of useful regional and country specific information on malaria and its control.
- Review of malaria prevention in the Greater Mekong Region. Malaria Consortium for Networks, 2012. This includes a useful overview of malaria stratifications within country in Myanmar, Cambodia and Thailand as well as a discussion on alternative malaria prevention methods.
- Atlas of malaria in the Asia Pacific (APMEN)
- Country profiles of malaria in the Asia Pacific (APMEN)
- Country profiles including for countries in the Asia Pacific (WHO)

Issue papers from the Malaria 2012 political congress.
- Malaria 2012 Issues Paper No.1: Burden, success and challenges
- Malaria 2012 Issues Paper No.2: Challenges and opportunities for sustainable financing
- Malaria 2012 Issues Paper No.3: Challenges and opportunities for access to quality malaria medicines and other technologies
- Malaria 2012 Issues Paper No.4: Modelling the current potential impact of artemisinin resistance and its containment
9.1.7 Industry involvement and guidance: Health and malaria control

- **Analysing relationship between the state and non-state healthcare providers, with special reference to Asia and the Pacific**, The Nossal Institute for Global Health, University of Sydney.
- **Community Health Programmes in the Mining and Metals Industry**, ICMM.
- **ICMM Good practice guidance for HIV, TB and malaria**.
- **The Role of Agribusiness in malaria transmission, control and prevention**, GBCHealth.
- **A guide to malaria management programmes in the oil and gas industry**, IPIECA, 2006. An overview of the 'science and value' of malaria management programmes. Also available as a 'pocket guide'.

9.1.8 Co-ordination and/or advocacy groups

- **Asia-Pacific Malaria Elimination Network**
- **Asia-Pacific Malaria Leaders Alliance** formed in October 2013
- **GBC Health** coalition for private sector engagement in global health issues.
- **International Council on Mining and Metals**
- **OPG-IPIECA Health Committee**. The health committee of OPG, the Association of Oil and Gas Producers (OPG) and IPIECA, the Global Oil and Gas Industry Association for Environmental and Social issues.
- **HANSHEP: Harnessing non-state actors for better health for the poor**

9.1.9 Case studies

- **Mining Health Programs in Papua New Guinea: Lessons Learned to inform good practice**, Montrose and Health Partners International.
- **Malaria 2012 Issues Paper No.5: The role of the private sector in ensuring equity and access to services**. This publication includes a number of succinct case studies as an annex.
9.2 MALARIA PODCASTS AND VIDEOS

- A number of malaria related podcasts from CDC focusing on clinical issues as well as advice to travellers. Particularly useful ones from this set include:
  - Malaria Matters – an overview of malaria
  - Recognizing and Treating Malaria in returning travellers
  - Malaria and Tropical Travel
  - Insecticide resistance reducing effectiveness of malaria control
- University of Oxford collection of audio podcasts on various malaria related subjects. Also available as video podcasts.
- Bill Gates Ted Talk on malaria.
- DFID Podcast Malaria: A winnable war.
- London School of Hygiene and Tropical Medicine Audio News podcasts on malaria. Particularly useful ones from this list include:
  - Latest results of a malaria vaccine trial
  - Reporting on the problem of fake malaria medicines
  - Rapid diagnostic tests for malaria
  - Malaria resistance genes
  - How mosquitoes resist repellents
  - Bed-nets to prevent malaria
  - Diagnostic tests for malaria
  - Malaria drug resistance
  - Malaria elimination prospects
- Wellcome Collection Packed Lunch Podcast. Focus on researching drug resistance in Cambodia. Some useful background though focuses on the research experience.
- Malaria Life-Cycle explained. You tube video giving an overview of transmission with animation.
- RBM: Saving lives in the Asia-Pacific. You tube video giving a summary of the problem and options for control in the Asia-Pacific.
- Global Fund Malaria Day Story: Malaria in Papua New Guinea. You tube video case study of a child with malaria in PNG.

9.3 MALARIA APPS

- CDC’s ‘Yellow Book’ of health information for travellers, which contains a chapter on malaria, is available as an app.
Note that there are a number of apps described as sonic mosquito repellents, or similar. There is no evidence that these apps have any repellent properties at all and should not be used in place of proven bite protection measures.

9.4 Staying Up To Date

- The Tropical Health and Malaria hub. The Guardian newspaper and Malaria Consortium worked in collaboration on this as a part of the wider Guardian Development Professionals Network. This professional network is supported by the Bill and Melinda Gates Foundation. Its purpose is to stimulate debate, discussion and learning among global development professionals. It aims to link to the best content on the web and to promote the sharing of research and ideas.
- APMEN. Regularly updated site listing recent studies and news on malaria in the Asia-Pacific.
- GBCHealth news
- Subscribe to the World Health Organization’s newsletter
- Get WHO news via RSS
- Subscribe to the regularly updated WHO podcast
- Follow WHO on twitter
- Follow WHO-EMRO on twitter
- Follow WHO-SEARO on twitter
- Follow WHO-WPRO on twitter
- Follow Malaria Consortium on twitter
- Follow Roll Back Malaria on twitter
- Follow Malaria No More on twitter
- Follow The Global Fund against AIDS, Tuberculosis and Malaria on twitter
- Follow APMEN on twitter
- Follow ICMM on twitter
- Follow GBC on twitter
- Follow IPIECA on twitter

9.5 Training Courses

- CDC free online training course: Malaria 101 for the Healthcare Provider. Although this course is aimed and healthcare providers it also includes useful information on the disease and its control.
- USAID Measure: a 4-6hr free online course on monitoring and evaluating malaria control programmes.
Global Health Learning centre: a 2hr free online course on the basics of malaria and its control. The course was updated in 2012.

WHO training modules on malaria control
  o These training modules include manuals for trainers and trainees. The training goes into considerable detail but may be useful for those looking to investigate these issues further, in particular the case management course may be helpful for company health officers. Subjects include:
    o Case management
    o Entomology and vector control
    o Epidemiological approach for malaria control.

9.6 Accessing further support

9.6.1 What Malaria Consortium can offer

Established in 2003, Malaria Consortium is one of the world’s leading non-profit organizations specializing in the prevention, control and treatment of malaria and other communicable diseases among vulnerable populations. We have increasingly found our work on malaria can be effectively integrated with similar public health interventions for greater impact and have therefore expanded our remit to include child health and neglected tropical disease interventions. Our areas of expertise include:

  ➢ Disease prevention, diagnosis and treatment
  ➢ Disease control and elimination
  ➢ Health systems strengthening
  ➢ Research, monitoring and evaluation leading to best practice
  ➢ Behaviour change communication
  ➢ National and international advocacy, and policy development

To support the growth of private sector involvement in malaria control in the Asia-Pacific Malaria Consortium will support companies interested in knowing more about the disease and its control in the region, either generally or for more specific advice.

Malaria Consortium can be contacted on info@malariaconsortium.org or using the contact form on the website.
9.6.2 What Montrose can offer

Montrose is an international development services company providing support to developing world-oriented clients in the areas of technical assistance, social investment programming, project planning and management.

We are specialized in the sectors of health, water and sanitation, education and livelihoods and offer a full project management service for development projects, from design and implementation to monitoring and evaluation.

Montrose is a performance-based results-oriented company combining the efficiencies of the private sector with an understanding of current development actors and challenges. Our clients include bilateral and multilateral organizations, major corporations, non-governmental organizations and other development stakeholders.

We work with a network of trusted partners to provide a comprehensive range of solutions.

Montrose is available to provide technical assistance in scoping, situation analysis and design of malaria management programmes, including assisting with development of company malaria policies and of companywide trainings.

Montrose can be contacted on info@montroseint.com, +256 (0) 772 765 680 or using the contact form on the website.
### Species complex | Important sibling species | Range and primary habitats | Biting time | Feeding behaviour | Resting behaviour | Breeding sites | Appropriate vector control approaches |
---|---|---|---|---|---|---|---|
An. f. | Eight species. Specific species appear to be important in specific settings - e.g. An. f. s.s. is found normally within 1km of coastal areas; An. irenicus is restricted to the Solomon Islands. | Ranges from the Maluku island group in Indonesia to Vanuatu in the western Pacific. Highland river values, intramontane plains, coastal areas. | Varies by locality and likely by specific species. Commonly throughout the evening and daytime biting is also known. | Varies by locality and likely by specific species. General preference for humans though other animal biting is also common. | Indoor and outdoor. | Varies by locality and likely by specific species. | Different behaviour between species makes control approaches different in different settings. IRS and ITNs can be effective in some areas. Potential for larval control is highly site specific. |
<table>
<thead>
<tr>
<th>Species complex</th>
<th>Important sibling species</th>
<th>Range and primary habitats</th>
<th>Biting time</th>
<th>Feeding behaviour</th>
<th>Resting behaviour</th>
<th>Breeding sites</th>
<th>Appropriate vector control approaches</th>
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<tr>
<td><em>An. punctulatus</em></td>
<td>Two closely related species both often referred to as <em>An. punctulatus</em>.</td>
<td>Lowland river valleys and plains throughout the Pacific.</td>
<td>Varies by location and seasons, peak biting can be before midnight in some areas / seasons and well after midnight in other locations.</td>
<td>Primarily humans. Outdoors and indoors.</td>
<td>Primarily outdoors but also indoors.</td>
<td>Small, scattered, sunlit, temporary fresh water pools and even moist soil. Sites can include hoof prints, gardens, cleared areas for road or other construction, pools in stream or river beds. High adult densities often found near breeding sites as dispersal can be more limited for this species than others.</td>
<td>IRS and ITNs can be effective in some areas. Larval control is not feasible in most settings but environmental management to avoid creating new sites during construction can be important as the vectors can exploit such sites quickly and rapidly increase in numbers.</td>
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