

Guideline for the management of community outbreaks and epidemics of malaria in the Torres Strait



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1 Background

1.1 Malaria

Malaria is an infectious disease caused by a parasitic protozoan belonging to the genus *Plasmodium*. There are two species of malaria of importance to the Torres Strait: the potentially life-threatening *P. falciparum* and the more benign *P. vivax*.

Malaria is transmitted to man by the bites of infected female mosquitoes belonging to the genus *Anopheles*. The most important potential malaria-transmitting species of mosquito in the Torres Strait are *An. farauti*, actually a complex of identical-looking mosquito species endemic to Papua New Guinea (PNG) and northern Australia.

These guidelines are primarily written for the Torres Strait context, but could be used as a starting point for any malaria outbreak in northern Australia.

1.1.1 The Malaria Life Cycle

Simplified version

Humans are infected by malaria through the bite of a female *Anopheles* mosquito. Once in the human body the parasites multiply rapidly, first in the liver, then in the blood. Then the parasites are passed back to female *Anopheles* mosquitoes when they suck blood from an infected human.

The parasites multiply again in the stomach wall of the mosquito, then migrate through her body to infect the salivary glands. When the mosquito feeds again she injects saliva containing the parasites into another human and the cycle starts again.

Detailed version

In the malaria life cycle, asexual reproduction occurs in humans and sexual reproduction occurs in the mosquito.

The infective stage - **sporozoites** - are injected from the mosquito salivary glands through the skin into subcutaneous capillaries and circulate to the liver where they invade hepatic cells. Here they multiply rapidly. After 1-2 weeks the cells rupture to release thousands of **merozoites**, which then invade the red blood cells (erythrocytes) in circulation.

In *P. falciparum* malaria, all the liver cells rupture at more or less the same time and no parasites persist in the liver. In *P. vivax*, some cells do not rupture for months (sometimes years) after the initial infection; these latent forms - **hypnozoites** - cause relapses of malaria when they rupture months later.

On entering the erythrocyte, **merozoites** acquire the appearance of signet rings and are called **ring forms**. These ring forms enlarge and distort to become **trophozoites**; these in turn multiply to form a **schizont** which refers to the erythrocyte remnant crammed full of malaria parasites. The schizonts rupture to release more merozoites. The merozoites can then re-invade further erythrocytes; however some develop into **gametocytes**, which are **the only stages capable of reproducing in the mosquito**.

The human cycle (invasion of erythrocyte - development of schizonts - rupture to release of merozoites) takes 36-48 hours in *P. falciparum* and 48 hours in *P. vivax*. Often these waves of release produce periodic fevers. The cycle in the blood cells is repeated until either the patient's immunological responses reduce the severity of the infection, or the patient is successfully treated with antimalarial drugs, or the patient dies.

The mosquito cycle begins when the gametocytes are ingested by a female *Anopheles* mosquito during a blood meal. Within the gut of the mosquito the gametocytes become male and female gametes, which fuse. The resulting fertilised **ookinete** invades the gut wall of the mosquito, and develops further into an **oozyst**, containing thousands of sporozoites. The oocysts rupture, and the sporozoites migrate to the salivary gland. When the mosquito subsequently feeds, the sporozoites

are injected with saliva into the human host and the cycle starts again. Infected mosquitoes probably remain so for life - which may be up to 4 weeks for *An. farauti*.

The time from an infective bite to onset of symptoms in humans is the **intrinsic incubation period (IIP)**. The time from a mosquito biting a human who has circulating gametocytes to becoming infective is the **extrinsic incubation period (EIP)**. These vary by plasmodium species and by temperature.

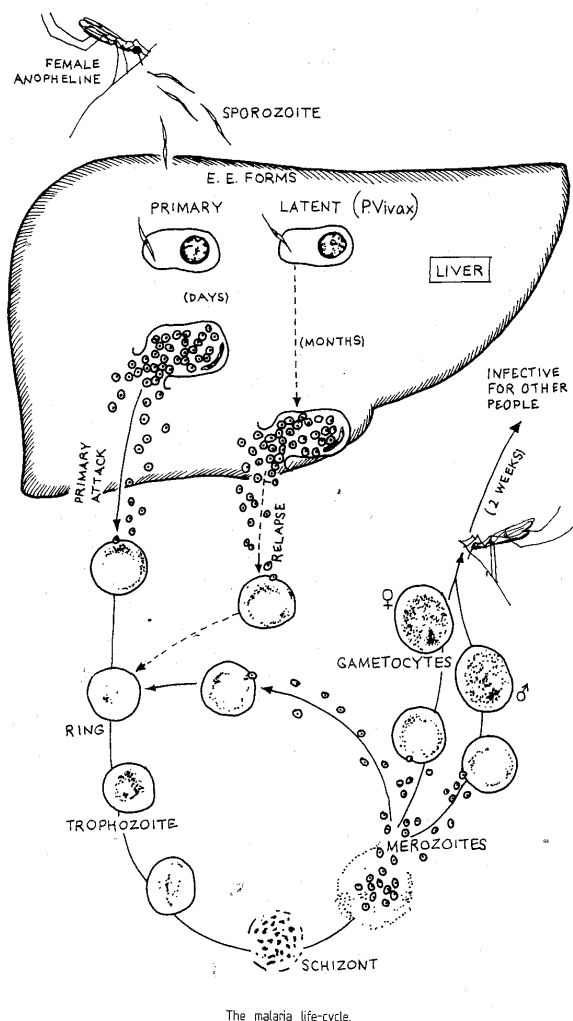
Table 1. Approximate time periods for malaria transmission in Torres Strait conditions

Malaria type	Intrinsic I P: from bite until onset of symptoms	Human: from bite until infectious	Extrinsic I P: from bite until mosquito is infective	Serial interval: human – vector - human
<i>P. falciparum</i>	9 – 14 days	19 – 20 days	~12 days	~ 40 days
<i>P. vivax</i>	12 – 18 days+	15 – 20 days+	8 - 10	23 – 30 days

Notes

- *P. vivax* malaria can have a very prolonged incubation period, plus relapses
- The minimum *serial interval* means it can take over a month from an undetected malaria import to trigger a locally acquired outbreak.
- If imported symptomatic *P. falciparum* cases are detected and treated within a week with gametocytocidal drugs (artemether / lumefantrine), a local outbreak can be avoided.

Figure 1. The Malaria Life Cycle



1.2 Clinical presentations of malaria

1.2.1 The acute attack

The incubation period (the interval between being infected and the development of symptoms) is approximately 12 days for *P. falciparum* and 14 days for *P. vivax*. However several factors, such as immunity to malaria and recent antimalarial drugs, can prolong the incubation period.

It is the rupture of the schizont, and the release of the merozoites into the blood, that is responsible for the malarial paroxysm that is the hallmark of acute malaria. Each 'attack' of malaria is usually abrupt and often severe; they are similarly intense for both *P. falciparum* and *P. vivax*. The patient feels very ill with headache, backache and other nonspecific symptoms. A feeling of unbearable cold comes on rapidly and causes violent, uncontrollable shivering. Within an hour or so a high fever (40-41°C) develops; a feeling of unbearable heat follows and lasts for another one to two hours. Profuse sweating then ends the attack, as the temperature returns to normal some five to eight hours after it began to rise. Each attack exhausts the patient, but between attacks there are few other symptoms.

Although fever patterns may occur with some regularity, such as every 48 hours in *P. vivax* infections, fever patterns are often irregular. This is particularly true for *P. falciparum* infections. Other common features of malaria include vomiting, diarrhoea, muscle pains, abdominal pain, and febrile convulsions in young children.

Anaemia is a common consequence of malaria resulting from the rupture of infected red blood cells during the release of merozoites. Enlargement of the spleen -splenomegaly- results from the spleen's role in removing damaged red blood cells from circulation. A mild jaundice due to haemolysis can occur in both *P. falciparum* and *P. vivax* malaria. Severe jaundice only occurs in *P. falciparum* infection, and is due to specific liver involvement.

1.2.2 Severe malaria: a medical emergency

Severe and complicated malaria is mostly caused by *P. falciparum* infection.

Children and non-immune adults are most at risk of severe malaria. The cycle of asexual multiplication in the red blood cells is more rapid than in *P. vivax* and a very high percentage of red blood cells can be parasitised; the sudden destruction of a large proportion of red blood cells has serious consequences and can cause a rapid deterioration in the condition of the non-immune patient (e.g. Torres Strait residents).

The presentation of uncomplicated *P. falciparum* malaria is very variable and mimics many other diseases. It may be misdiagnosed as influenza. The fever is usually irregular and variable.

Unless diagnosed and treated promptly the clinical picture deteriorates at an alarming speed and often with catastrophic consequences. Severe malaria occurs almost invariably as a result of delay in treating an uncomplicated attack.

A patient with severe malaria may present with impaired consciousness, prostration and extreme weakness. The following complications may occur:

- cerebral malaria (this accounts for most acute malaria deaths. It is defined as an unrousable coma with evidence of *P. falciparum* infection and with no other obvious cause of the coma)
- severe anaemia (may be fatal unless a transfusion is given)
- renal failure (peritoneal dialysis may be required)
- profound metabolic disturbances (including hypoglycaemia)
- pulmonary oedema
- circulatory collapse and shock
- bleeding and clotting disorders (disseminated intravascular coagulation)

These complications may occur in combination in the same patient; they are all potentially life-threatening.

The only malaria deaths in the Torres Strait in the past 35 years occurred in patients with a substantial delay in commencing therapy. Treatment for presumed malaria can be lifesaving; it can easily be stopped if some other diagnosis becomes apparent.

1.3 Malaria in Australia

Malaria was endemic in northern Australia until control measures effectively eradicated the disease. Australia was declared malaria-free by the World Health Organization in 1981. Malaria is imported into Australia by travellers entering from endemic regions, or as a result of traditional movement between Papua New Guinea (PNG) and the Torres Strait Islands.

The mean number of cases of malaria in Australia reported over the past ten years to 2010 was 664. The only locally acquired cases notified in Australia in the past 25 years have occurred in north Queensland (see table 2).

1.3.1 Malaria in the Torres Strait

The unique Torres Strait Treaty (1978, modified 1985) allows some Torres Strait Islanders to visit PNG, and vice versa, for traditional and family purposes. This means that malaria poses a substantial, and continuous, health threat to the Torres Strait; more so than to any other part of Australia. Health access is excluded as a justification for travel in the treaty, however Queensland Health policy permits provision of acute services to PNG residents requiring urgent medical attention. Treatment of PNG residents who present with malaria is justifiable on humanitarian and public health grounds.

1.3.2 What is the current malaria situation in PNG?

It is difficult to obtain reliable information about malaria prevalence in PNG or about the numbers of people travelling between PNG and the Torres Strait Islands. Only about 15% of suspected malaria presentations are confirmed parasitologically, and there is limited systematic data collection. World Health Organisation (WHO) estimates suggest that there are 500,000 malaria cases annually in PNG. Over 70% of these are *falciparum* malaria.

In Australia, local cases can occur by importation (i.e. the infection was acquired out of the area in which it is diagnosed) or by introduction (secondary case(s) contracted locally, derived from an imported case). Importation can occur in a returning traveller, or in a visiting PNG resident.

PNG visitors to Australia can have malaria, with gametocytes in their peripheral blood, while apparently healthy. If the visitor is bitten by *Anopheles* mosquitoes on a visit to Australia, the mosquitoes can become infected and, in turn, transmit the infection to locals who have not travelled outside Australia.

Disease in Australian residents can be more severe than in residents of PNG because residents of PNG, apart from young children, are likely to have a degree of immunity.

Malaria is not only an important, potentially life-threatening clinical problem for people who travel to PNG, and for PNG visitors, but may lead to local outbreaks.

1.3.3 Potential for malaria to become re-established in the Torres Strait

Because *Anopheles* mosquitoes are endemic to the region, the potential for the re-establishment of malaria in northern Australia remains. It is usually accepted that the receptive region for the reintroduction of malaria is that part of Australia north of the 19° parallel, i.e. north of a line from south of Broome to, but not including, Townsville (see figure 2). Clearly, malaria could be reintroduced into the Torres Strait.

The best conditions for the development of malaria in the mosquito and the transmission of malaria are when the mean temperature is between 20-30°C, while the mean relative humidity is at least 60%. A high relative humidity lengthens the life of the mosquito, and enables it to live long enough to transmit the infection to several people.

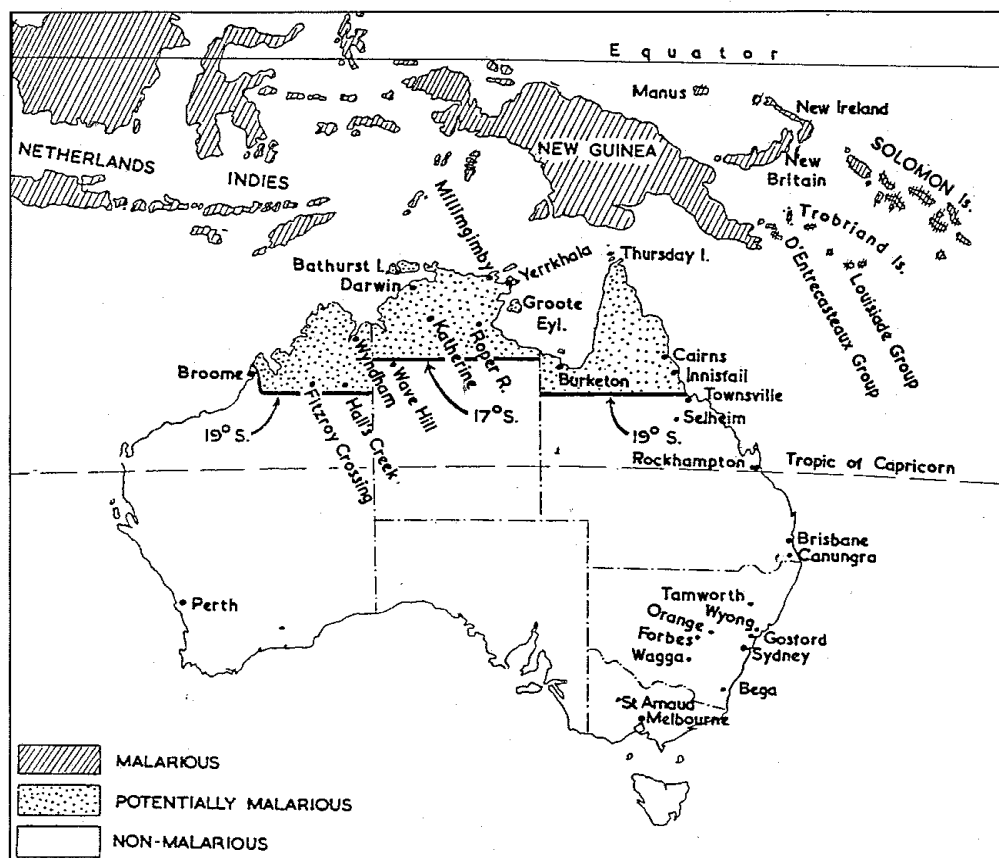
Undiagnosed and untreated malaria could lead to malaria being introduced and re-established in the Torres Strait. If malaria should become re-established, the WHO would have to consider revoking Australia's malaria free status.

1.3.4 Responsibilities of all health staff in the Torres Strait

There are two important responsibilities:

- To suspect malaria in all patients with a fever. An urgent examination of the blood of a suspect patient should lead to a prompt diagnosis and treatment. This could be lifesaving.
- To identify when local transmission of malaria occurs, i.e. to recognise malaria in a person who has not recently travelled outside the Torres Strait. Prompt investigation and control measures should prevent further local spread of malaria. This too could be lifesaving.

Figure 2. Map showing the malaria-receptive region of Australia



This map, drawn in 1949, is still used to define the malaria-receptive region of Australia.

Table 2. Locally acquired malaria cases in Far North Queensland since 1990

Date	Place	Details
1991	Saibai	Locally acquired cases
1996	Cairns	One case of Airport Malaria <i>P. vivax</i>
1996	Community FNQ	One locally acquired case <i>P. vivax</i>
1997	Badu	Two locally acquired cases <i>P. vivax</i>
2000	Saibai	30 imported cases and one locally acquired case
2001	Erub (Darnley)	Two imported and one locally acquired case <i>P. falciparum</i>
2002	Camping ground 95km north of Cairns	One imported and 10 locally acquired cases <i>P. vivax</i>
2004	Saibai	Three locally acquired cases <i>P. falciparum</i>
2011	Saibai	7 imported and 9 locally acquired cases (and 5 cases uncertain whether imported or locally acquired) <i>P. falciparum</i> and <i>P. vivax</i>

2 CDC Guidelines

Information about malaria, malaria notification and details of action to be taken for individual notifications is set out in the *Queensland Health Control of Communicable Disease Guideline Manual*.

The section of the *Queensland Health Control of Communicable Disease Guideline Manual* dealing with community outbreaks / epidemics is reproduced below.

2.1 Community Outbreaks / Epidemics

- Locally acquired malaria in the outer islands of the Torres Strait is not infrequent. The current protocol is not to respond to a single outer island acquired *P. vivax* case, but to respond to clusters of *P. vivax*, and to single locally acquired cases of *P. falciparum*.
- The response to locally acquired malaria in other areas of Queensland will vary according to location and circumstance, but all outbreaks will require further epidemiological (e.g. contact tracing) and entomological (e.g. *Anopheles* surveys) investigations.

2.2 Definitions

2.2.1 Case Definition for Locally Acquired Malaria

A laboratory confirmed malaria case who has not travelled outside Australian territory within the intrinsic incubation period.

Approximate Human (intrinsic) incubation periods are given below

1. 9-14 days for *P. falciparum*
2. 12-18 days for *P. vivax*** and *P. ovale*
3. 18-40 days for *P. malariae*
4. 10-12 days for *P. knowlesi*

**From 8-10 months with some strains of *P. vivax* from temperate areas.

2.2.2 Definition Of Outbreak/Epidemic

One locally acquired case of falciparum malaria, or more than one locally acquired case of vivax malaria within one month.

(Vivax malaria is more difficult to ascribe to local transmission, because of possible long incubation period and later relapses from liver stages).

2.3 Laboratory Diagnosis

2.3.1 Laboratory Definitive Evidence

Definitive Criteria

- Detection and specific identification of malaria parasites by microscopy on blood films with confirmation of species by an approved reference laboratory¹
- OR
- Detection of *Plasmodium* species by nucleic acid testing.

¹ RBWH laboratory is the only approved reference laboratory in Queensland

Suggestive Criteria

- Detection and specific identification of malaria parasites by microscopy on blood films other than by an approved reference laboratory

OR

- a positive result with a rapid immunodiagnostic (immunochromatography or antigen detection EIA) test.

A diagnosis by a rapid immunodiagnostic test should be confirmed whenever possible by microscopy or nucleic acid testing, but should not delay treatment. A negative rapid test does not necessarily mean absence of malaria, especially in the case of low blood parasite levels of *P. vivax*.

2.4 CDC Outbreak Guidelines

Aims

1. To prevent further cases of malaria and minimise morbidity and mortality.
2. To rapidly bring the outbreak (local transmission) to an end.

Objectives

1. Confirm that there is an outbreak and inform relevant parties
2. Early identification and adequate treatment of cases
3. Define area of outbreak
4. Prevent further transmission
5. Document cases and control measures to inform future action
6. Decide when the outbreak is over
7. Advise on future action and revision of procedures.

2.4.1 Action to confirm that there is an outbreak and inform relevant parties

- Confirm diagnosis in consultation with laboratory and clinician
- Determine species, parasite density
- Confirm if gametocytes present in blood
- Confirm travel history (and travel companions)
- Ascertain if malaria was locally acquired
- Confirm past medical history, including malaria and medication
- Confirm normal place of residence
- Confirm treatment given and planned
- Create line listing (see appendix 1)
- Inform local PH nurse and PHMO urgently if possibly locally acquired case is identified

2.4.2 Early identification of cases

- Initiate active case finding guideline
- Initiate health promotion measures (to encourage early presentation)
- Inform local professionals and laboratories
- Reinforce urgent notifications of malaria (including of suspected cases)

2.4.3 Define area of outbreak

- Decide where control measures should be undertaken. This will be based on a risk estimate derived from information on the cases.

2.4.4 Prevent further transmission

Develop and implement an incident action plan that includes:

- Vector management in risk area

- Health promotion in risk area (to promote protective behaviours)
- Active case finding in risk area
- Identify people in vulnerable groups (children under five years of age and pregnant women) using community mapping, to actively assist the adoption of protective behaviours, access to resources such as bed nets, and access to early medical support if unwell.
- Appropriate treatment to render cases non infectious
- Provide screens, nets, mosquito repellent in risk area
- Provide travel advice for those travelling to risk area (precautions unlikely to include drugs for malaria prophylaxis, due to low risk and good surveillance)

2.4.5 Document cases and outbreak control measures to inform future action

- Daily update of line listing
- Daily review of cases
- Daily review of progress of outbreak control measures
- Daily reporting on progress of outbreak (number of cases and area/s)
- Evaluation of interventions throughout the incident

2.4.6 Decide when the outbreak is over

- When there have been no new onsets of cases for one month, review whether the outbreak is over.

2.4.7 Advise on future action and revision of procedures

- Formal review of response
- Prepare report for distribution to:
 - Local health service
 - Communicable Disease Branch
 - Other interested parties.

3 Management Arrangements and the Incident Management Team (IMT) Process

Management arrangements for a malaria outbreak will be determined at the time.

If there is one or more locally acquired cases of malaria, the Public Health Medical Officer (PHMO) at Cairns Public Health Unit (CPHU) will consider the need for an IMT.

Normally an IMT would be constituted with participation by the district (hospital doctors, Community Health and Public Health) and Tropical Regional Services – the Cairns Public Health Unit.

Because the response to a malaria outbreak requires considerable expertise in Public Health, including entomology, CPHU should be the lead agency.

4 Clinical Guidelines

4.1 Diagnosis

- It is crucial that health staff in the Torres Strait have a low threshold for malaria testing during the peak malaria season from January to June (inclusive).
- Any patient for whom a diagnosis of malaria is being considered must be discussed with a Medical Officer.
- NB: Particular care must be paid to children under 5 and pregnant women who present with fever.

4.1.1 Diagnosis: Non-Outbreak setting

Diagnosis in local residents

- Consider malaria in anyone who presents with fever $>38^{\circ}\text{C}$ in an adult, $>38.5^{\circ}\text{C}$ in a child.
- The symptoms of malaria are often non-specific and may include:
 - sweats, chills, malaise, headaches, anorexia, myalgia, vomiting, pallor, cough, diarrhoea, abdominal pain, jaundice, confusion and/or seizures.
- Consider malaria if there is no other obvious cause for fever (upper respiratory tract infection, tonsillitis, otitis, urinary tract infection, skin infection). Beware malaria can mimic other diseases such as pneumonia and meningitis
- Ask about travel (especially to PNG) in the past three months.
- Ask about any recent antibiotic or antimalarial use.
- If malaria is suspected, perform the following tests:
 - Rapid diagnostic test (RDT) for malaria at point of care (under telephone supervision if necessary). 'BinaxNow' is the RDT used at present. False positive tests are unlikely, but false negative results may occur, especially with low parasite levels).
 - Two thick and two thin blood malaria smears prepared on site (under telephone supervision if necessary) (see appendix 2).
Staff should have received appropriate training in use of RDTs and preparation of blood smears. If in doubt about either procedure, discuss with laboratory.
 - EDTA tube for full blood count (FBC), parasite count (and additional smears if required by lab) – at least 2ml for an adult, at least 1ml for a child.
 - UEC, LFT, BSL
 - Also request 'Malaria antigen test' from laboratory
 - Pregnancy test- in women of child-bearing age
- If first RDT negative, also test for dengue fever. Perform other pathology tests as appropriate to exclude other causes of fever.
- If RDT and films are negative, but there is strong clinical suspicion of malaria, discuss with laboratory whether to perform a PCR test.

Diagnosis in PNG nationals

- Follow above diagnostic considerations, but have a lower threshold for investigating for malaria in people from PNG, where the disease is endemic.
- Malaria commonly co-exists with other diseases, and asymptomatic malaria carriage is possible.
- Sometimes malaria can present as neurologic or behavioural change in an afebrile person from an endemic area.

4.1.2 Diagnosis: Malaria Outbreak setting

- If there is an outbreak of malaria, the approach to diagnosis is different.
- Various measures will be implemented to identify cases, and to prevent further spread.
- In this setting, in addition to the above considerations, anyone who presents to the clinic with a fever greater than 37.8°C should be tested as follows (and have other clinically indicated tests, based on their presentation):
 - RDT for malaria at point of care.
 - Two thick and two thin blood films and 'Malaria antigen test'

If these are negative and the patient remains febrile, repeat the following tests daily for three days (in addition to any other measures taken):

- RDT (at point of care, if available, or at lab- request 'Malaria antigen test')
- Two thick and two thin blood films

4.1.3 Some points on history taking

It is crucial to determine where the malaria was acquired, i.e. was the malaria 'imported' back from PNG or was it acquired locally ('introduced')?

If local transmission is not controlled malaria could become re-established as an endemic disease.

The majority of malaria seen in the Torres Strait is acquired in one of the PNG coastal villages. Since the incubation period (the time for infection until the onset of symptoms) is 11-14 days in a non-immune patient (i.e. Torres Strait residents) it is possible to determine where malaria was acquired by obtaining an accurate travel history. PNG nationals have some immunity to malaria - this prolongs the incubation period.

It is also important to determine whether the person with *P. falciparum* malaria has taken any drugs that can suppress malaria 'recently' as these drugs may prolong the incubation period of the illness. These drugs include:

- chloroquine
- 'Fansidar'
- primaquine
- tetracyclines (including doxycycline)
- cotrimoxazole ('Bactrim', 'Septrin', 'Resprim').
- erythromycin, azithromycin

The key questions are:

- When did you first become ill? (obtain date of the first fever)
- When did you last visit PNG? (obtain dates)
- What medicines have you taken recently? (names)

These questions need to be repeated several times until consistent answers are obtained. The answers should be verified by checking with relatives, Health Workers or other local contacts.

The travel drug history should be noted on the pathology request forms that are sent to the laboratory with any malaria blood slide taken from a fever patient. The information should also be included on the patient's clinic or hospital records, and it should be passed on to the doctor-on-call as soon as positive diagnosis is made (i.e. on the day of diagnosis).

P. falciparum malaria in a Torres Strait resident without a history of travel to PNG within the past two weeks probably indicates that local transmission is occurring and that further investigation and control measures need to be started urgently.

4.2 Management

4.2.1 Notification

- Notify confirmed and probable cases to local Public Health staff by phone. Include details of:
 - travel
 - date of onset
 - test results
 - place of residence
 - past history of malaria or malaria treatment.
- Notification should be considered urgent if local transmission is suspected.
- Notification should be made to the District Public Health Nurse and PHMO

4.2.2 Decisions about Admission and Treatment

Considerations:

- Does the patient need to be admitted to hospital?
- What treatment does the patient require?

Does the patient need to be admitted?

General Considerations:

- *P. falciparum* and *P. vivax* are the only malaria parasites that have been isolated in patients in the Torres region to date.
- *P. falciparum* malaria can be a serious illness, and is potentially fatal.
- PNG nationals may have partial immunity, and can even be well despite *P. falciparum* malaria. They still require treatment, but sometimes this can be as an outpatient.
- All children under 10 years of age with malaria should be admitted for treatment.

People with malaria who may not require admission

- Local people who may not require transfer and admission must satisfy all of the following criteria:
 - not pregnant
 - older than 10 years of age
 - low parasite count (<0.5%)
 - *P. vivax* malaria
 - tolerating oral medications and fluids
 - clinically unwell for less than 48 hours
- PNG nationals who are well must satisfy the following criteria:
 - not pregnant
 - older than 10 years of age
 - low parasite count (<1%)
 - tolerating oral medications and fluids
- For these people, it may be reasonable to commence treatment, and keep them in the community if they remain well.
- They must be *directly observed* taking the first dose of medicine and monitored for 1 hour to ensure they don't vomit the medicine.
- The medicine is best taken with food or full-cream milk.
- If the medicine is vomited, the dose needs to be repeated with a further one hour observation.

- Repeated vomiting is an indication for admission.
- Anyone being treated as an outpatient who remains febrile and unwell 12 hours or more after the first dose of medication should be admitted
- All patients should be advised about mosquito avoidance measures (including repellent and bed nets).

People who require admission

- Anyone diagnosed with malaria who does not meet the above criteria should be transferred and admitted.
- In particular:
 - Cases of malaria diagnosed in children (especially under 10 years of age), pregnant women and people over 60 years of age should be admitted.
 - All local people with *P. falciparum* malaria should be considered for admission.

Additional comments about admission

- The hospital should take measures to minimise mosquito exposure for the patient: an air conditioned or screened environment (window screens or bed nets) and use of mosquito repellent.
- Blood films do not need to be repeated routinely once diagnosis made, unless the parasite count was high (to confirm response).
- Daily FBC is only required if clinically indicated.

4.3 Treatment

- See attached Antibiotic Therapeutic guidelines excerpt (page 20), version 14 (amended to local situation) for medications and dosages.

A patient with presumed malaria - fever, malaise, headache - should be started on treatment as soon as a blood film has been taken. Discuss the patient's illness with a doctor URGENTLY.

Severe malaria occurs almost always as a result of delay in diagnosis or treatment.

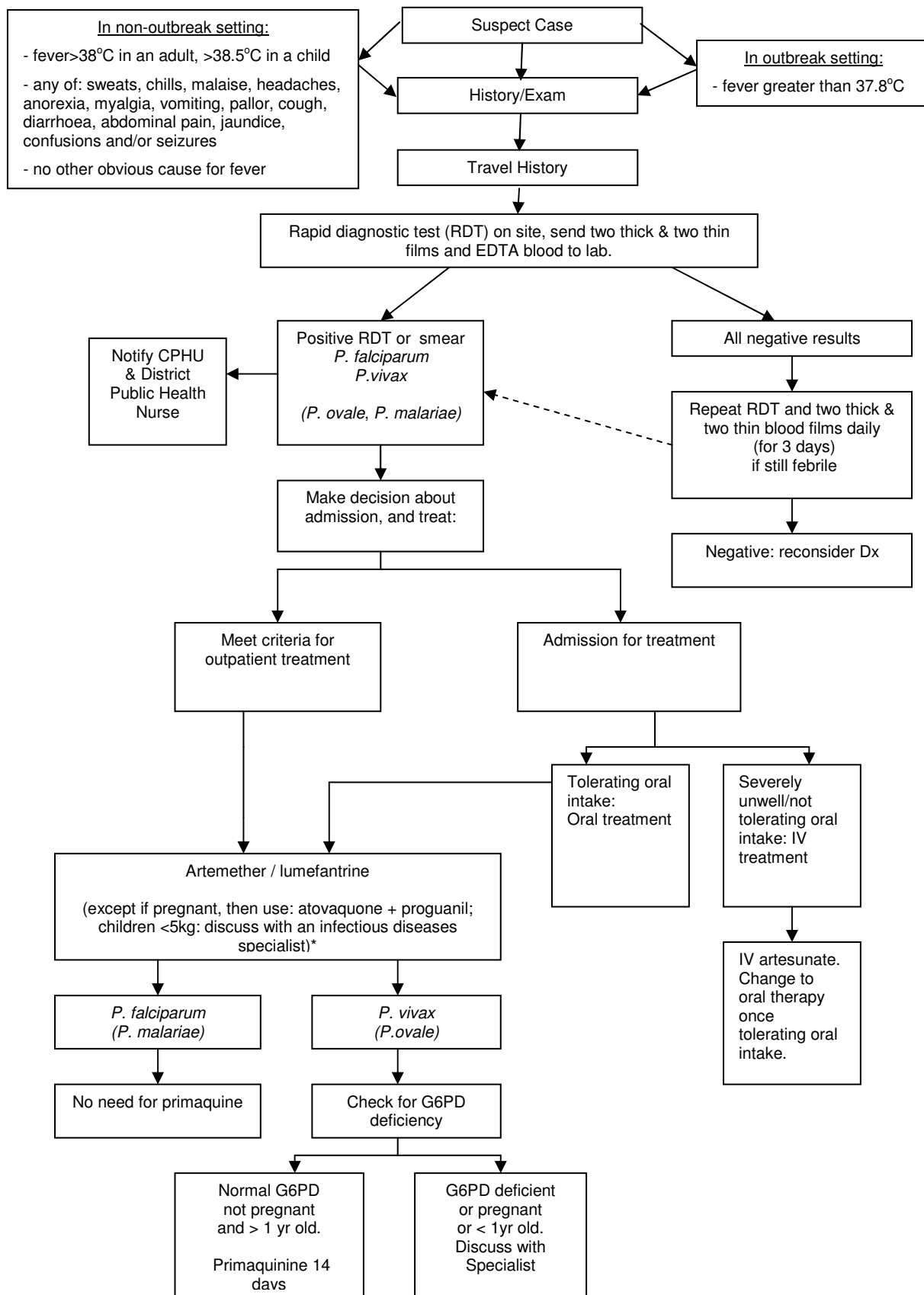
- Oral treatment:
 - Artemether +lumefantrine (20+120mg) = Riamet.
 - This medication is preferably given with fatty foods.
 - Full course is a total of 6 doses over 3 days.
 - Dosing times are based on first dose at "0 hours", which is then used to calculate timing of future doses.
 - People who are initially treated with IV medication then change to oral medication still need to complete the full 6 dose course of artemether + lumefantrine (or a total of 7 days of quinine-IV or PO).
- IV Treatment:
 - Artesunate does not require dosage adjustment in renal/hepatic impairment.
 - No known interactions with other drugs.
 - No known contraindications, including pregnancy (but is often avoided in pregnancy).
 - No need for cardiac monitoring unless clinical condition dictates.
 - Monitor BSL (disease related, not therapy).

- Artesunate is available under the Special Access Scheme at TI Hospital. (Need to follow up after treatment with TI pharmacist, for Medical Superintendent or DMS approval).
- Primaquine
 - Primaquine is used to treat the liver forms of *P. vivax* and *P. ovale* (hypnozoites). This is used in addition to artemether +lumefantrine.
 - Cases with *P. vivax* malaria should receive a 14 day course of oral primaquine (see Therapeutic Guidelines – Antibiotics - page 166 for dosage) after excluding G6PD deficiency.
 - Cases with *P. falciparum* malaria who are not treated with gametocytocidal drugs (e.g. Riamet/ artemether +lumefantrine), require a single dose of primaquine unless contraindicated, after testing for G6PD: Adult, 45 mg; Child >1 year, 0.7–1 mg/kg.
 - Primaquine commonly causes GI upset.
 - Administer on a full stomach or with food.
 - If there is significant nausea, the dosage can be given as a divided dose, twice daily.
 - For patients who are not admitted to hospital the first dose of primaquine must be directly observed to ensure that patient is able to tolerate without vomiting.
 - Primaquine is contraindicated in G6PD deficiency. A G6PD level must always be checked before administering primaquine, because of the risk of massive haemolysis in someone with severe G6PD deficiency. G6PD deficiency is relatively common in PNG.
 - Primaquine is **contraindicated in pregnancy and in children under one year old** because of the risk of haemolysis. The drug is also contraindicated in conditions predisposing to granulocytopenia, including active rheumatoid arthritis and lupus erythematosus.
 - **Drug interactions:**
 - Primaquine should not be administered with any other drug that may induce haematological disorders.
 - **Overdosage from primaquine:**
 - Gastrointestinal symptoms, weakness, methaemoglobinaemia, cyanosis, haemolytic anaemia, jaundice and bone marrow depression may occur with overdosage. There is no specific antidote and treatment is symptomatic.
- *P. malariae* and *P. ovale*
 - These are rarely seen in the Torres Region/Western Province of PNG.
 - Although chloroquine is still effective for *P. malariae* and *P. ovale*, artemether +lumefantrine is recommended in this protocol for simplicity.

4.4 Discharge

- People who are admitted and treated for malaria are suitable for discharge once they meet the following criteria:
 - asymptomatic and afebrile for 24 hours
 - tolerating, or have completed oral therapy
 - gametocytocidal medications given, if required
- On discharge, patients should be advised to return if they become unwell again in the following months. A small proportion of people may experience a recrudescence of their disease.

Figure 3. Diagnosis and Treatment of Malaria Flow Chart



* Cases with *P. falciparum* malaria who are not treated with gametocytocidal drugs (riamet/ artemether +lumefantrine), require a single dose of primaquine (unless contraindicated), after excluding G6PD deficiency: Adult, 45 mg; Child >1 year, 0.7–1 mg/kg.

RDT = Rapid diagnostic test, currently using “Binax Now”.

Island clinics need to send thick/thin films to the lab at TI. Best results are obtained if films can be prepared on site. Always send an EDTA “purple top” tube for FBC, and in case the lab also needs to make smears (but smears from EDTA blood more than a few hours old are less easy to interpret).

Send notification paperwork to CPHU in Cairns or via District Public Health RN.

4.5 Treatment of Malaria (Antibiotic Therapeutic guidelines)

This is an excerpt from Antibiotic Therapeutic guidelines version 14, updated June 2010 (minor amendments for local Torres Strait situation). This section will need to be reviewed when the next version of the Antibiotic Therapeutic guidelines is released.

4.5.1 Uncomplicated *Plasmodium falciparum* malaria

Artemether+lumefantrine is the drug of first choice for the treatment of uncomplicated *Plasmodium falciparum* malaria. Initial treatment in hospital is recommended. Use:

- 1 artemether+lumefantrine tablets 20+120 mg
adult and child more than 34 kg: 4 tablets (child 5 to 14 kg: 1 tablet; 15 to 24 kg: 2 tablets; 25 to 34 kg: 3 tablets) orally with fatty food or full-fat milk, at 0, 8, 24, 36, 48 and 60 hours, making a total adult dose of 24 tablets in 6 doses

OR

- 2 atovaquone+proguanil tablets 250+100 mg (adult formulation)
adult and child more than 40 kg: 4 tablets (child 11 to 20 kg: 1 tablet; 21 to 30 kg: 2 tablets; 31 to 40 kg: 3 tablets) orally with fatty food or full-fat milk, daily for 3 days

OR THE COMBINATION OF

- 3 quinine sulfate 600 mg (adult less than 50 kg: 450 mg) (child: 10 mg/kg up to 600 mg) orally, 8-hourly for 7 days [Note 1]

PLUS EITHER

doxycycline 100 mg (child more than 8 years: 2.5 mg/kg up to 100 mg) orally, 12-hourly for 7 days, which need not commence on day 1

OR (for pregnant females or children)

clindamycin 300 mg (child: 5 mg/kg up to 300 mg) orally, 8-hourly for 7 days

Atovaquone+proguanil should not be used for treatment of malaria in patients who took these drugs as prophylaxis.

4.5.2 Severe malaria

Urgent treatment of severe malaria is essential if the patient has any of the following:

- any degree of altered consciousness, jaundice, oliguria, severe anaemia or hypoglycaemia
- a parasite count above 100 000/mm³ (greater than 2% of red blood cells parasitised)
- the patient is vomiting or clinically acidotic.

Chloroquine-resistant *Plasmodium falciparum* must be assumed to be the infective agent. Once mandatory IV therapy has been started, seek expert advice. A large multicentre randomised controlled trial has shown mortality in severe *P. falciparum* malaria is lower when IV artesunate [Note 2] is used rather than IV quinine [Note 3]. Artesunate should be used in preference to IV quinine only if it is immediately available. Use:

- 1 artesunate (adult and child) 2.4 mg/kg IV, on admission and repeat at 12 hours and 24 hours, then once daily until oral therapy is possible. When patient is able to tolerate oral therapy, give a full course (6 doses) of artemether+lumefantrine, as for uncomplicated *Plasmodium falciparum* malaria
OR (if parenteral artesunate is not immediately available)
- 2 quinine dihydrochloride IV, as outlined below.

If quinine is used, an initial loading dose should be given unless the patient has received 3 or more doses of quinine or quinidine in the previous 48 hours, or mefloquine prophylaxis in the previous 24 hours, or a mefloquine treatment dose within the previous 3 days. Frequent measurements of blood pressure and blood glucose are required as quinine stimulates insulin secretion and can cause hypoglycaemia. Cardiac monitoring is advised if there is pre-existing heart disease.

For loading dose, use:

- 1 quinine dihydrochloride (adult and child) 20 mg/kg IV over 4 hours
OR
- 2 quinine dihydrochloride (adult and child) 7 mg/kg IV over 30 minutes, followed immediately by 10 mg/kg IV over 4 hours.

For maintenance dose, use:

quinine dihydrochloride (adult and child) 10 mg/kg IV over 4 hours, 8-hourly, commencing 4 hours after loading regimen is completed and continuing until the patient is able to begin oral treatment (see below).

If IV quinine is required for longer than 48 hours, seek expert advice as a dose adjustment may be necessary especially in patients with renal impairment (see [Table 2.31](#)).

When the patient has clinically improved, oral treatment can be commenced. Give a full course (6 doses) of artemether+lumefantrine, as for [uncomplicated *Plasmodium falciparum* malaria](#). If artemether+lumefantrine is not available, use oral quinine combined with doxycycline or clindamycin, as for [uncomplicated *Plasmodium falciparum* malaria](#), to complete a total of 7 days of treatment with quinine.

4.5.3 Other forms of malaria

For *Plasmodium vivax* acquired in Indonesia, Timor-Leste or Pacific Island Nations (including Papua New Guinea, Solomon Islands and Vanuatu), and for *Plasmodium ovale* and *malariae*, use:

- 1 artemether+lumefantrine, as for uncomplicated *Plasmodium falciparum* malaria
OR
- 2 mefloquine 750 mg (child: 15 mg/kg up to 750 mg) orally, initially, then 500 mg (child: 10 mg/kg up to 500 mg) 6 to 8 hours later.

Mefloquine should not be used for treatment of malaria in patients who took this as prophylaxis.

If the patient is unable to tolerate oral therapy, which is best taken with food, treat as for [severe malaria](#) and seek expert advice.

To eliminate liver forms of all *P. vivax* infections, irrespective of where acquired, add:

primaquine 30 mg (child: 0.5 mg/kg up to 30 mg) orally, daily with food, or if nausea occurs 15 mg (child: 0.25 mg/kg up to 15 mg) orally, 12-hourly with food. Treat for a minimum of 14 days or, in adults more than 70 kg, until a total cumulative dose of 6 mg/kg is reached [[Note 4](#)].

NB. Primaquine is **contraindicated in pregnancy and in children under one year old** because of the risk of haemolysis, and in conditions predisposing to **granulocytopenia**.

To eliminate liver forms of *P. ovale* infections, add:

primaquine 15 mg (child: 0.25 mg/kg up to 15 mg) orally, daily with food for 14 days.

If the patient relapses after the primaquine treatment, seek expert advice.

Exclude glucose-6-phosphate dehydrogenase (G6PD) deficiency before using primaquine, as severe haemolysis may occur in these patients. If the patient is G6PD deficient, seek expert advice.

Note 1: Both quinine sulfate and bisulfate are available in 300 mg tablets. Quinine sulfate 600 mg is approximately equivalent to quinine bisulfate 900 mg. Although listed as Category D, quinine has been extensively used for treating *P. falciparum* malaria in pregnancy.

Note 2: Artesunate is an artemisinin derivative. It is not registered for use in Australia but is available via the [Special Access Scheme](#).

Note 3: Dondorp A, Nosten F, Stepniewska K, Day N, White N for the South East Asian Quinine Artesunate Malaria (SEAQUAMAT) group. Artesunate versus quinine for treatment of severe falciparum malaria: a randomised trial. *Lancet* 2005;366(9487):717-25. [[PubMed](#)]

Note 4: Primaquine failures can occur, especially when the infection has been acquired in Indonesia, Timor-Leste or Pacific Island Nations. Evidence indicates that primaquine failure and relapse with infection are more common when primaquine is not administered concurrently with the treatment for blood-stage infection, and/or if less than a total cumulative dose of 6 mg/kg is taken (eg only 14 days treatment in adults more than 70 kg).

5 Vector Control Guidelines

5.1 Vector Information

The most important vector of malaria in Australia is *Anopheles farauti*.

- The mosquito is an opportunistic feeder and will feed on humans, domestic animals, and other wildlife.
- It is active after dusk, and humans are most at risk of being bitten between 1800 and midnight.
- Although it will not usually fly nor lay eggs far from a blood source, it is capable of moving several kilometres over a few days.
- This mosquito feeds and rests both indoors and outdoors. It will enter houses in search of a blood meal. When found resting indoors, it appears to prefer areas within 1.5 m of the floor. It commonly rests outdoors within 50-100 meters of the animal shelters or human habitations that provide a blood source.
- Suitable resting sites outdoors include vegetation, leaf litter, fallen logs and any low-lying objects providing good shade.
- Adult *An. farauti* can survive for several weeks, but they usually do not survive for more than two or three weeks.
- The female mosquito will seek a host immediately after emergence from its breeding site. The extrinsic incubation period of the parasite (growth period within the mosquito) is approximately 12 days for *P. falciparum*. Thus, the mosquito can pick up and transmit the protozoan within two weeks of emergence.
- The larval and pupal stage completion requires a minimum of seven days (usually up to 10 days) dependent on environmental conditions.
- *An. farauti* larvae live in a huge variety of habitats, both fresh and brackish. Smaller, discrete sites can be treated with larvicides. Sometimes the main breeding areas will consist of coastal swamps. These will be difficult and costly to impact.

5.2 Vector management

Mosquito management is the responsibility of local government, and during a malaria outbreak, the public health unit and local government will work together.

5.2.1 Surveillance

Mosquito surveillance, species identification and monitoring for resistance to insecticides are integral parts of the vector control operation. It is generally recommended to perform surveillance before vector control operations commence, in order to ensure that the control tools deployed are optimally effective, but in some areas surveillance and vector control activities will need to be carried out in tandem.

Mosquitoes can be collected to detect the presence of parasites, but where there are only a few malaria cases and a large mosquito population, this is unlikely to yield a positive result.

Adult monitoring

The most appropriate surveillance tools are human landing catches and light traps. Light traps can be baited with CO₂ and/or octenol to increase their efficiency, but they can not be relied on to catch large numbers of mosquitoes (especially where they are competing with livestock or humans). When trapping in remote areas, careful planning is essential in maintaining a CO₂ source. The trap samples may require a great deal of sorting and identification, depending on the diversity and abundance of the other species collected.

Human landing catches are a useful way of determining quickly what the commonest biting anophelines are in an area. Caution must be used when trained vector control personnel are exposed to potentially infected mosquitoes; mosquitoes must not be allowed to begin feeding. Mosquitoes can be collected using a net and mechanical aspirator when near host. The

commonest malaria vector in North Queensland and the Torres Straits is *An. farauti* (species 1), but other potential vectors exist and *An. farauti* itself is part of a morphologically indistinguishable complex of species. Specimens of all anophelines should therefore be preserved for subsequent identification, either by expert vector control personnel or at other expert labs in Queensland.

Larval monitoring

An. farauti breeds in permanent and semi-permanent water bodies that may be amenable to identification, mapping and treatment. Tools for monitoring include the use of hand-held dipper. Counts would be included of the number of larvae per standard dip size. A subsample of late stage larvae and pupae should be maintained until emergence, in order to identify species.

5.3 Control operations performed by licensed technicians

5.3.1 Adult control

The goal of adult mosquito control is to reduce the age of the female mosquito population. The older the female, the greater the chance that it has fed on an infected human, incubated the parasite and is infective. The abundance of mosquitoes may not decrease, because new mosquitoes may be constantly emerging from breeding sites.

Residual Spray (RS)

Indoor RS is a valuable intervention in malaria control when the housing structure encourages mosquito resting (usually on interior walls or the underside of sleeping platforms), the majority of the vector population is endophilic, and the vector is susceptible to the insecticide in use. Although *An. farauti* is a highly exophilic vector in some locations, IRS remains a useful tool given that we know little about its behaviour in Australia and the Torres Strait. To be fully effective, as much area as possible should be treated. This may necessitate moving furniture and wall coverings. If the residues are undisturbed, the treatment can remain effective for 3-6 months. This application is best applied with a hand operated compression sprayer and utilises a large droplet size to thoroughly wet the target surface.

Exterior RS, also known as harbourage or barrier spraying (treatment of walls and vegetation surrounding the home, the underside of high set Queenslanders, etc) may be an effective control tool. *An. farauti* often rests outdoors in shaded, cooler, moister microclimates. The area treated will depend upon the typical resting distances of the insect from its blood sources (spraying within a 50m perimeter of houses or animal shelters is a reasonable rule of thumb).

Space spraying (non-residual)

Misting, thermal fogging or ULV space spraying have limited indications for malaria control. However, given the lack of effective control options for early biting, outdoor feeding and resting mosquitoes like *An. farauti*, it ought to be considered. It aims to kill older, potentially infected mosquitoes by targeting flying mosquitoes with airborne insecticides. Application must be timed to coincide with peak adult mosquito activity (1800-2200 in the case of *An. farauti*). Short control cycles (daily) are recommended over the entire outbreak area (radius of 500 m of the positive case address). Thermal fogging and cold fogging have specific formulation requirements, but generally involve the application of pyrethroids. The technique utilises very small, airborne droplets. The residual effect is therefore very limited as little of the insecticide lands locally, or in significant concentrations. The technique is only effective if climatic conditions are suited (i.e. the droplets must "hang" for a prolonged period and not be swept away by wind or thermals).

5.3.2 Larval control

In some areas the extent of the breeding area may be too large to contemplate treating (see surveillance, above). If treatment is recommended, short (weekly) treatment cycles with *Bacillus thuringiensis* and/or methoprene should be applied.

5.4 Prevention of bites – personal protection

5.4.1 Avoidance

During time of outbreak, try to avoid the habitats in which biting mosquitoes occur. For example, avoid night-fishing or other outdoor recreational activities after dusk.

5.4.2 Physical Barriers

1. Clothing: Long sleeves and long trousers help prevent bites. Garments made of polyester netting, designed to protect against blood sucking insects are commercially available.
2. Nets and screens over windows and doors provide physical barriers to mosquito entry. Mosquito bed nets are appropriate for indoor and outdoor use. Mosquito nets should be treated with pyrethroids, should cover sleepers completely when in use and be spacious enough that sleepers can avoid contact with the fabric. Nets should be let down before darkness and make complete contact with the floor, or be tucked under mattresses. In community campaigns, where access to treated bed nets may be limited, it is usual to prioritise high risk groups such as pregnant women and children under five years of age.

5.4.3 Chemical Barriers

Repellents can be used on skin, and permethrin and pyrethroids can be used on fabrics such as clothes, tents, bed nets, sleeping bags, ground sheets, etc. These can remain repellent for 12 months under some conditions.

Permethrin and related compounds are also found in vaporizing mats and coils. Where there is little air movement, these can be useful tools.

Repellents for use on skin must be approved for human use and should give protection for several hours even under conditions of high biting pressure. Products containing DEET, PMD (p Menthane diol) or picaridin tend to be most effective. Many off-the-shelf compounds are not very effective.

It is not recommended to treat babies under three months old with repellents, but chemicals such as DEET (<10%), PMD and picaridin can also be effective if applied to fabrics (such as clothing, the exterior of prams etc). Some products can damage plastic surfaces. Children should not be allowed to apply their own repellents, and carers should apply thin, even coverage to children's exposed skin when required.

5.5 Locally transmitted disease response

Public Health Unit collaborates with Local Government to coordinate a vector management response.

5.5.1 Local Government

- Prepare equipment and chemicals in liaison with CPHU
- Liaise with community about upcoming operations
- Request additional support as required

5.5.2 Public Health Unit

- Provide technical assistance and recommendations
- Augment local government when required
- Space spraying (see above)
- Residual spraying (see above)
- Assist public access to and use of personal protection measures (see above).

5.6 Imported disease response

A vector control response has immediate impact in preventing local transmission if conducted within 10 days of the patient arriving in Australia (before any mosquitoes infected by biting the patient have reached infective stage). However, in the outer Torres Strait islands where there is frequent movement of people to and from PNG, a vector control response is usually only instituted when there is evidence of local transmission.

5.7 Responsibilities in routine vector management

5.7.1 Community

- Wear repellent during periods of activity
- Sleep under treated mosquito bed net
- Screen or close windows and doors from dusk to dawn
- Use mosquito coils or plug-in repellent devices

5.7.2 Council

- Eliminate breeding areas or areas with poor drainage
- Education of community in malaria prevention
- Monitoring of mosquito populations
 - CO2 baited light traps
 - Larval sampling
- Control adult mosquitoes
 - Fogging at peak biting times
 - Residual harbourage spraying
 - Interior residual spraying

5.7.3 Queensland Health

- Education of community in malaria prevention
- Technical assistance / medical entomology advice on vector control methods

6 Guideline for active case finding for malaria

6.1 Active case finding

The purpose of this guideline is to facilitate the early detection and treatment of cases of malaria in the context of local transmission of malaria.

Early detection and treatment of cases is desirable to reduce the risk of continued transmission and to optimise treatment outcomes.

Active Case Finding refers to a nurse and a health worker actively seeking cases by door to door enquiry of the entire community, starting with high risk areas (i.e. areas close to the known cases and areas where there is a poor standard of accommodation affording low levels of protection from mosquito bites at night).

This is a structured, proactive process, and is completely different from opportunistically finding people who are sick, or waiting for people to present to the clinic with symptoms.

This guideline should be implemented in all households in the risk area on a regular basis until decided that it is no longer necessary.

All patients from the risk area attending a clinic should routinely be asked whether they have had a fever in the last 48 hours.

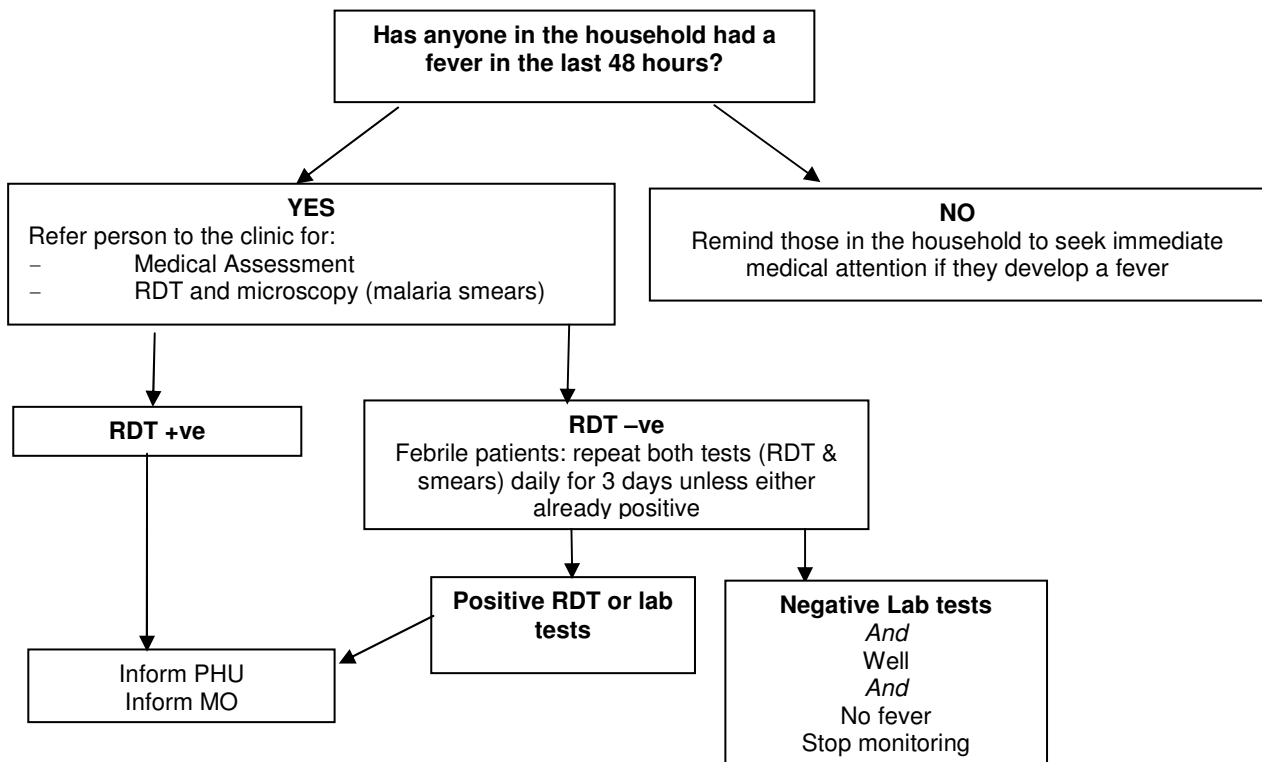
The decision whether to treat the case for malaria is a clinical decision to be taken by the medical officer.

RDTs* must be used by a trained person and available at all outer island clinics.

All patients with positive RDT or positive microscopy should be counted as cases of malaria for public health purposes. This means they must be protected from contact with mosquitoes until they have either been discounted as a case of malaria or, for cases of malaria, until gametocyte clearance has occurred.

*RDT – Rapid diagnostic test (BinaxNow is the RDT for malaria currently used in Torres Strait. False positive tests are unlikely, but false negative results may occur, especially with low parasite levels).

Figure 4. Flow chart of Active Case Finding process



6.2 Daily Monitoring of Pregnant Women

Malaria is a potentially more serious disease in pregnant women in whom diagnosis may be difficult.

All pregnant women in the vicinity of cases should be closely monitored. They should have their temperature taken once per day.

If they have a fever of 37.8 or above the following bloods should be taken

- FBC
- LFTs
- Thick and Thin Films

Rapid test (RDT) should also be done; if positive report to PHU.

All pregnant women with a fever above 37.8 C should be reviewed by, or discussed with a medical officer.

6.3 Public Health Management of patients who are not resident in Australia

Patients not normally resident in Australia should be treated and given the appropriate gametocyte clearance therapy and advice before leaving Australia.

6.4 Other activities to be carried out while active case finding

- Health promotion
- Distribution of mosquito repellent
- Distribution of mosquito nets to vulnerable groups

- Identification of vulnerable persons
- Record keeping and documentation
- Mapping of cases.

7 Health Promotion Advice/ Guidelines

Health promotion advice to residents is crucial during a malaria outbreak to ensure that the spread of this disease is minimised. Communication needs to focus on two key messages:

- the importance of people presenting to a health clinic if experiencing symptoms such as fever, headache, muscle or joint pain. This message is particularly pertinent in the early stages of an outbreak to ensure as many cases are picked up as early as possible.
- preventing people from getting bitten by mosquitoes through adopting protective measures. These include:
 - use personal mosquito repellent particularly between dusk and dawn
 - sleep under chemically treated bed nets
 - wear light coloured clothing including long sleeved shirts and pants
 - avoid being outdoors during peak activity hours of mosquito feeding
 - install screens on doors and windows to prevent access to the house for mosquitoes
 - use repellent devices such as mosquito coils or plug-in repellent devices
 - use an aerosol based chemical (i.e. surface spray) application to reduce the number of adult mosquitoes inside the house.
 - use chemically treated curtains or mesh

Communication channels for promoting these messages need to be culturally appropriate and engaging to residents in affected areas. This may include:

- local radio station announcements
- community meetings
- use of recognised community leaders to promote the message
- newspaper advertisements/editorials
- posters and information disseminated through networks and community

Information should also be disseminated during active case finding by medical officers/nurses. Vector control/environmental health officers can assist with giving residents information during vector control inspections.

Targeted messages need to be developed prior to an outbreak and resources should be available for dissemination as soon as an outbreak occurs.

Mosquito repellent and mosquito nets need to be available and affordable for the community during an outbreak. Consideration must be given to those in affected areas who do not have access to these protective measures and priority given to those most vulnerable, including pregnant women and children.

Liaison should occur with the community, local councils and relevant state government agencies to identify homes with no or broken mosquito screens in at risk communities and develop sustainable initiatives to install/repair.

Post Outbreak

It is important to ensure that the community remains vigilant post outbreak to minimize the risk of local transmission of this disease. Communication messages need to be based on preventing mosquitoes from breeding in the community.

8 Appendix 1 – Line listing

If case(s) meet the definition of an outbreak, set up outbreak **line listing** to include the following headings:

Personal details

Name

DOB

Address

Country of residence

Dates

Date of onset

Dates and types of tests done

Date notified

Hospitalised

Where acquired

Travel history

Imported/unsure/locally acquired

Test results

RDT result

Smear results, density

Species

Outcome

Treatment completion

9 Appendix 2 – Preparing blood films

Preparation of ‘thick’ and ‘thin’ blood films for malaria diagnosis

Please make 2 thick and 2 thin blood films for malaria screening.

Labelling the Slides

It is essential that the film is correctly and appropriately labelled.

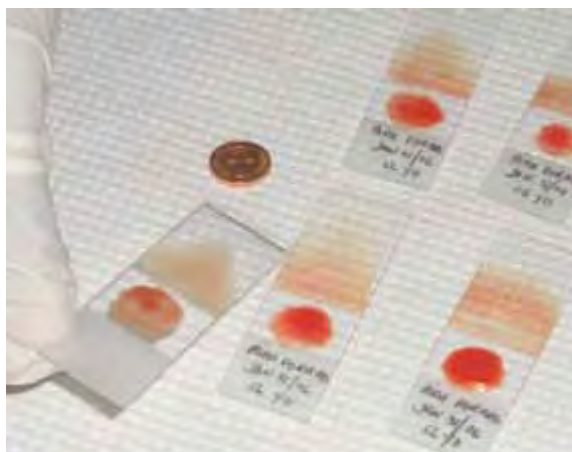
Slides must be labelled with the patient’s surname and one of the following - Patient’s UR No, or Patient’s date of birth (minimum 2 points of identification is MANDATORY) and date the slide was made.

Biosafety in the handling of blood specimens from patients

All blood samples must be considered as potentially infectious. Two of the more dangerous blood-borne diseases are hepatitis and HIV/AIDS. When blood samples are collected for diagnosis of malaria, biosafety guidelines must be followed. The major hazard to taking blood specimens is contamination of the mucous membranes of the eyes, nose and mouth by infectious blood. Such contamination occurs as a result of penetrating injuries caused by sharp objects, and the spilling or splashing of specimens. Personal protective equipment (PPE), i.e. gowns, gloves, eye protection etc, is required when handling blood specimens. Do not touch your eyes, nose or other exposed membranes or the skin with gloved hands. Wash your hands with soap and water after any contamination and after work is completed, after removing the gloves.

Making a ‘Thick’ blood film

Parasites are much more concentrated in a thick film. To make a thick film, several drops of native or EDTA-anticoagulated blood are placed in the centre of a slide and stirred with an orange stick, into a pool of blood of such a thickness that typescript or a watch face can be read through the blood. The blood can be spread in a circular or rectangular form with 3 to 6 movements. The circular thick films should be about 1 cm in diameter.

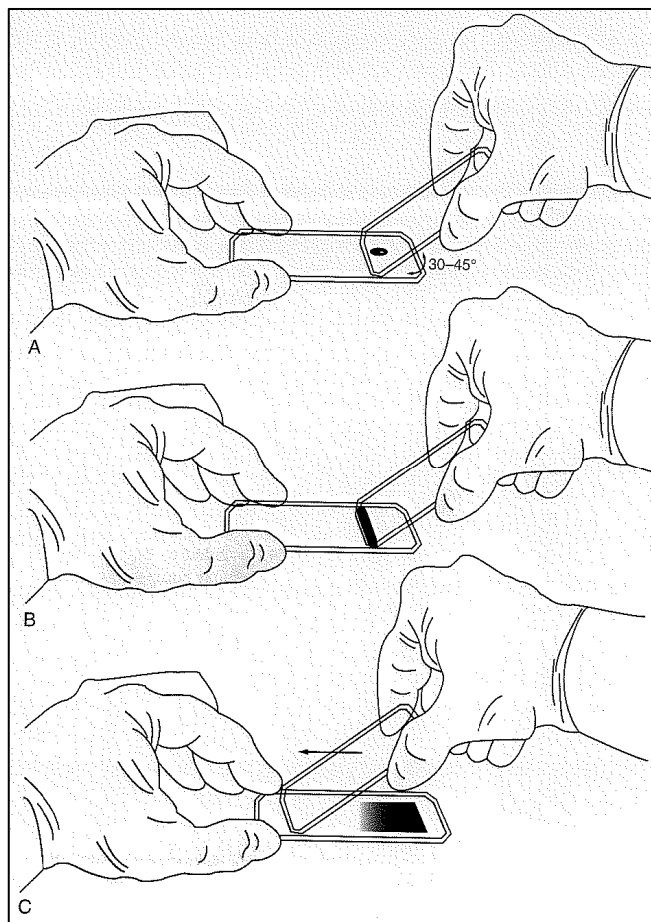


Making a ‘Thin’ blood film

- Select a clean and dry (frosted end) glass slide from storage box. (If necessary, slides should be wiped clean with lint free tissues before use).
- Correctly identify the blood specimen and ensure sample is adequately mixed thoroughly by gentle inversion (recommend 10 – 15 times) or equivalent.
- Place a small drop of EDTA blood in the centre line of a slide about 1-2 mm from the frosted end.

- Place the spreader at an angle of between 30 – 45° to the slide and move it back to make contact with the drop. The drop should spread out quickly along the line of contact of the spreader with the slide.
- Spread the film with a rapid, smooth, forward movement of the spreader towards the non- frosted end of the slide. Moving the spreader slide too slowly accentuates poor white cell distribution by pushing larger cells to end and sides e.g. monocytes.
- The film should be 3-4 cm in length and should have no ragged tails.
- Label the slide as per laboratory protocol – patient’s surname, patient’s UR No, and / or patient’s date of birth and / or sample laboratory No., date the slide was made and initial the slide (and label if attached) see – Section 7.3 for full details
- To make a thinner film, lower the angle of the spreader. For a thicker film raise the height of the spreader. Therefore for a high haematocrit, lower the angle; for a low haematocrit, raise the angle.
- The spreader should be washed with water and dried after use.
- Dispose of all other equipment used to make the film appropriately.
- Blood films should be completely dry before staining.

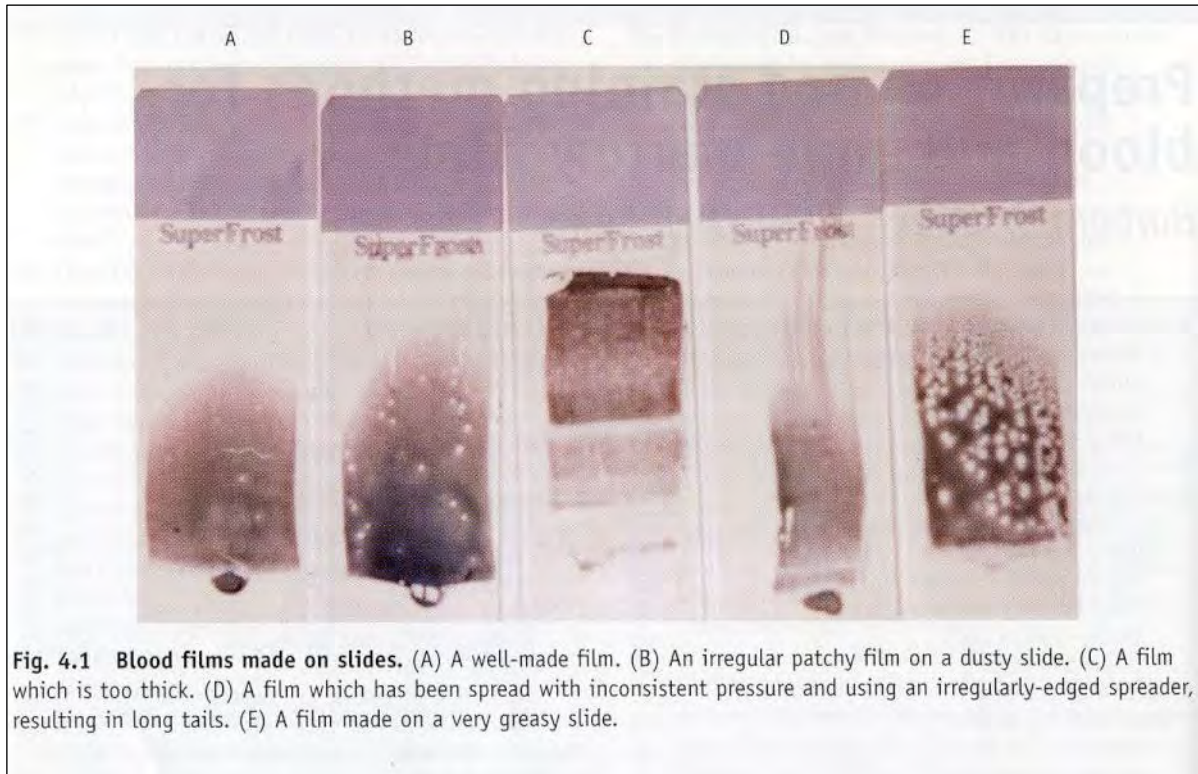
Figure 1: The wedge technique used to prepare a blood film. ³



A properly prepared blood smear has the following characteristics:

- Has a smooth, even surface without irregularities, holes, or streaks
- The whole drop is picked up and spread
- Ends in a feathered edge – slightly rounded, not bullet shaped
- Covers one half to two thirds of the slide.
- Has an appropriate thickness (is neither too thick nor too thin).
- Lateral edges of the smear should be visible

Figure 2: Some examples of well (A) and poorly made blood films (B-E).¹



Source: Julie Fielding, Pathology Queensland (Cairns). Graphics from: *Basic Malaria Microscopy* 2nd ed. WHO. p. 24, Carr, J.H. and Rodak, J.H. *Clinical Haematology Atlas* 2nd Ed. Elsevier Saunders St Louis Missouri 2004, p.3, Lewis, S.M., Bain, B. J. and Bates, I. *Dacie and Lewis Practical Haematology*, 10th Ed. Churchill Livingstone Philadelphia 2006, p.4.

10 Appendix 3 – Record keeping forms

Record keeping forms used by active case finders

Daily antenatal temperature and well-being checks

Lot no	Name	20-Apr	21-Apr	22-Apr	23-Apr	24-Apr	25-Apr	26-Apr	27-Apr	28-Apr	29-Apr

11 Appendix 4 – Ante natal monitoring record

Location: _____
 Active Case Finding Date _____

Lot No.	Name of Head of Household	No. people in house	No. of Preg	No. <5yo	Any febrile	Unwell	Rapid test	bloods	Notified	Nets	Spray/ Coils	Need nets	Health prom	Risks	Comments