Malaria Diagnosis and the New Treatment Protocol

A training manual for health workers in Papua New Guinea

Yumi Rausim Malaria
PNG NATIONAL MALARIA CONTROL PROGRAM

NCT
National Competency Training

Malaria Diagnosis and the New Treatment Protocol

A training manual for health workers in Papua New Guinea

National Competency Training Project
Divine Word University

NCT
National Competency Training

diwai pacific

© National Competency Training Project,
Published in 2010

Requests and enquiries concerning use of this material should be addressed to:

National Competency Training Project
c/- Divine Word University,
PO Box 483,
Madang
Papua New Guinea

Telephone: +675 422 2937
Facsimile: +675 422 2812

Edited by: Neil Nicholls and Kichawen Chakumai
Produced by: Birdwing Publishing

ISBN: 978-9980-948-48-9

This manual, developed specifically for the competency training of health workers in Papua New Guinea, has been produced by the National Competency Training Project in collaboration with the Faculty of Health Sciences, Divine Word University, WHO (PNG), and the National Department of Health, with support from Rotarians Against Malaria. This not-for-profit publication is funded by *The Global Fund to Fight AIDS, Tuberculosis, and Malaria*, under its Round 8 support to Papua New Guinea to reduce morbidity and mortality due to malaria.

Contents

Figures

Graphs

Tables

Foreword

Malaria continues to be a major health problem in Papua New Guinea, with a growing resistance to existing treatment regimes being observed. However, with the introduction by the National Department of Health of a revised *Malaria Treatment Protocol* in late 2009, the key issues of drug resistance and the need for prompt, effective diagnosis of malaria are being addressed. In line with some seventy countries, PNG will use a new anti-malarial drug regimen employing artemisinin-based combination therapy (ACT) as the first-line treatment, and there will be a greater use of rapid diagnostic tests to detect malaria parasites in the blood.

To be effective, these protocol changes require training, but with more than 6000 health workers scattered throughout Papua New Guinea, the task of retraining them is both daunting and expensive. It is fortunate, therefore, that a Round 8 grant of *The Global Fund to Fight AIDS, Tuberculosis, and Malaria* now supports a multi-faceted malaria control program in PNG.

Divine Word University, along with its partners, the National Department of Health, Rotarians Against Malaria, Population Services International, and the Papua New Guinea Institute of Medical Research, is part of a concerted national effort to help reduce malaria morbidity and mortality in PNG. Its part, to be carried out by the university's consultancy arm, Diwai Pacific Limited, is to train health workers nationwide in the new treatment and diagnostic protocols. It is a mammoth task, and this manual has been designed not only as an essential training aid to update and re-skill the health workers, but also as a handy reference source for those health professionals who treat malaria patients in remote aid posts or district health centres in Papua New Guinea on a daily basis. It is to them that this manual is dedicated.

Neil Nicholls, Team Leader,
National Competency Training Project
Divine Word University,
Madang, May 2010

Acknowledgment

This manual is not the work of one individual, but the result of the tireless efforts of a number of key contributors. The outline of the manual was prepared by Kichawen Chakumai, the Deputy Dean of the Faculty of Health Sciences at Divine Word University in Madang, Papua New Guinea. From those beginnings, Dr Gawrie Galappaththy, WHO consultant and Consultant Community Physician of the National Malaria Control Programme of Sri Lanka, worked diligently with Kichawen to flesh out the manual.

Once the manual was completed in draft form, it was peer reviewed by National Department of Health and WHO (PNG) staff in Port Moresby. Then it was the turn of Robin Bishop, Education Adviser, to provide a competency training perspective and add structure to the modules.

Other individuals contributed to the text, particularly Professor Francis Hombhanje, Faculty of Health Sciences at DWU, and Dr Zhang Zaixing, Malariologist at the WHO Office in Port Moresby. Their contributions and helpful suggestions are reflected in the manual.

As for the content, the manual draws on a number of key sources for its information. First and foremost, the National Department of Health's recently revised *Malaria Treatment Protocol* provided much of the information on the treatment of malaria; the excellent publications from WHO helped enormously in the preparation of the drawings in the chapter on rapid diagnostic test kits and for the sample tests; and Population Services International and PNG Institute of Medical Research allowed us to use their pictures and artwork. These sources, and others, are duly thanked and acknowledged.

At the publishing stage, the manual finally received critical editorial comments, as well as professional graphics and design work, from Birdwing Publishing, whose task it has been to bring the manual to completion. Without their enthusiastic help and forbearance, and the support of others, this manual would not have completed.

Acronyms

ACT	Artemisinin-based combination therapy
AL	Artemether-lumefantrine
AP	Aid post
AS	Artesunate
bd	Twice daily
CQ	Chloroquine
DDT	Dichlorodiphenyltrichloroethane
DP	Dihydroartemisinin-piperaquine
G6PD	Glucose-6-phosphate dehydrogenase
HC	Health centre
IM	Intramuscular
IMCI	Integrated management of childhood illnesses
IRS	Indoor residual spraying
ITN	Insecticide treated net
IV	Intravenous
kg	Kilogram
LD	Loading dose
LLIN	Long-lasting insecticide treated net
MD	Maintenance dose
MEP	Malaria Eradication Programme
MFT	Mass Fever Treatment
mg	Milligram
Pf	*Plasmodium falciparum*
Pm	*Plasmodium malariae*
PNG	Papua New Guinea
Po	*Plasmodium ovale*
PQ	Primaquine
Pv	*Plasmodium vivax*
QN	Quinine
RDT	Rapid Diagnostic Test
SP	Sulphadoxine/pyrimethamine (Fansidar)
tds	Three times a day
WHO	World Health Organisation

Introduction

Welcome

Welcome to this training manual for health workers in Papua New Guinea.

It focuses on the use of Rapid Diagnostic Tests (RDT) for the diagnosis of malaria and the use of new anti-malarial drugs to treat malaria, in line with the revised *Malaria Treatment Protocol,* produced by the National Department of Health, Papua New Guinea. The chapter on IMCI was prepared with assistance from the PNG Paediatric Society. We trust that you will enjoy the manual and that it meets your needs to upgrade your knowledge and skills.

The development of this manual is part of a broader National Competency Training Project, undertaken by Diwai Pacific Limited, the consultancy arm of Divine Word University, with support from Rotarians Against Malaria. It is funded by *The Global Fund to Fight AIDS, Tuberculosis and Malaria,* and aims to implement and strengthen the new treatment for malaria in Papua New Guinea. This will be achieved through the implementation of the following inter-related activities:

- Nationwide training of health workers on new diagnostic and treatment protocols;
- Training of Medical Laboratory Assistants and Rural Laboratory Assistants.

This component of the National Competency Training Project focuses on introducing nationally a new malaria treatment protocol to improve the quality of diagnosis and treatment skills in the public health workforce.

Overview of the manual

This manual has been developed for health workers working in the hospitals, provincial health offices, health centres and sub-centres, and aid posts in Papua New Guinea. It aims to help health workers to:

- recognise the symptoms of malaria;
- explain the life cycle of malaria;
- correctly apply Rapid Diagnostic Tests (RDTs);
- correctly prescribe the new anti-malarial drug, artemether-lumefantrine (AL);
- understand the National Health Information System reporting requirements;
- explain the different methods of malaria prevention;
- apply the *IMCI Checklist* for all sick children.

The manual contains the following broad topics:

1. Malaria and the malaria situation in PNG

- General introduction to malaria.
- Life cycle of malaria and the action of drugs.

2. Diagnosis of malaria

- Clinical and parasitological diagnosis of malaria.
- Rapid Diagnostic Tests (RDTs).
- Using RDTs.

3. Anti-malarial drugs and treatment

- Current anti-malarial drugs.
- Artemether-lumefantrine (AL).
- New treatment guidelines.
- Data collection for malaria cases, RDT and AL reporting.

4. Integrated management of childhood illnesses (IMCI) and prevention of malaria

- *IMCI Checklist* for ALL sick children.
- Different methods for malaria prevention.

Participants

Health workers from the hospitals, provincial health offices, health centres and sub-centres, and aid posts will be mobilised to central locations where they will undergo training on malaria diagnosis and treatment. A total of 25 hospital staff from each provincial hospital, 20 provincial health office staff in each province, and 60 health workers in each of the 89 districts in PNG, are to be trained.

Delivery methodology

Training in **Malaria Diagnosis and the New Treatment Protocol** will be delivered in a two day workshop by qualified trainers.

The training method used is based on learning by problem-solving and the sessions will be participant-led as much as possible.

Participants will take part in practical activities and discussions in groups to share knowledge and experiences.

Testing your learning

This manual provides activities which will help trainers assess your knowledge and skill. There will also be three checks of your learning.

1. A quick Test Your Learning on the first day where you will be asked to complete some questions.
2. A checklist will be used to check that you can correctly conduct the RDT.
3. At the end of Day 2 you will complete a quick Test Your Learning to see what you have learnt during the workshop.

What is this manual for?

This manual will help you to:

- plan your study;
- build your skill as a learner;
- plan ways to apply and practise what you learn ('use it, or lose it').

What is provided in the manual?

What is covered	What to do
The outcomes to be achieved in each topic in a self check	• You can use these as a self check before you start to find areas you need to concentrate on. • You can use these at the end to check that you have covered everything and are now competent.
The topics to be covered	• This is the content you should read and work through.
Activities	• These topic activities are scattered throughout the learning materials and are designed to help you learn as well as to check your progress.
Glossary	• This is an alphabetical list that explains key words or terms to help your understanding of the content.
Check your learning	• Answers to the topic activities in the module.

Learning Tips

Here are some simple tips for getting the results you want and making the most of your learning. Try using the *Checklist* to assess yourself as an effective learner at a few points during the module.

- *Clarify the module requirements and training times at the beginning.*
- *Manage your time. Be organised.*
- *Look through the materials and get the big picture first.*
- *Use this manual as a reference.*
- *Use and build on the experience and skills you already have.*
- *Ask questions when you need to clarify any point.*
- *Make sure you complete/participate in the topic activities.*
- *Review each section as you go - how the learning relates to your job.*
- *Talk to others – colleagues, friends - about what you are learning.*
- *Use what you learn in the workplace while it is fresh in your mind.*
- *Look for specific practical ways to use your learning beyond the module.*
- *Reflect and think critically about what you have learnt, done or shared.*
- *Practice. Think about changes to the way you work.*

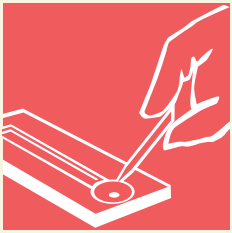
Additional resources for the manual

There are some resources that will be useful to you as you study this manual. These include:

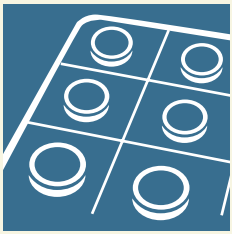
- *Malaria Treatment Protocol*, August 2009
- Job aids posters on Rapid Diagnostic Tests
- *IMCI Checklist* posters
- *IMCI Checklist* flip charts.

Workshop timetable

Day 1

8:00 – 12:00 am **Session 1** 	**Welcome and Introductions** **Test Your Knowledge** **Malaria and the malaria situation in Papua New Guinea** **Topics:** 1.1 What is malaria? 1.2 Malaria situation and endemicity of malaria in PNG. 1.3 Life cycle of the malaria parasite and action of drugs. 1.4 Classification of malaria patients.
1:00 – 5:00 pm **Session 2** 	**Diagnosis of malaria** **Topics:** 2.1 Importance of malaria diagnosis. 2.2 Difference between clinical and parasitological diagnosis of malaria. 2.3 What are RDTs and their importance to malaria control? 2.4 Advantages and disadvantages of microscopy and RDTs. 2.5 How to use the Rapid Diagnostic Test (RDT).

Day 2

8:00 – 12:00 am **Session: 3** 	**Anti-malarial drugs and treatment** **Topics:** 3.1 Current anti-malarial drugs used in PNG. 3.2 Artemisinin-based combination therapy (ACT) including the new drug AL. 3.4 New treatment guidelines for the treatment of malaria patients including prescribing of anti-malarials with special emphasis on AL. 3.5 Treatment of malaria. 3.6 Data collection of malaria cases, RDT and AL reporting.
1:00 – 5:00 pm **Session: 4** 	**IMCI and prevention of malaria** **Topics:** 4.1 Management of childhood illness. 4.2 Different methods for malaria prevention. Test Your Learning. Evaluation of the workshop. Workshop close.

Self Check

Before you start you can use this self check to find areas you need to concentrate on in the manual. You can also use the self check to make sure you are competent in all the areas covered by **Malaria Diagnosis and the New Treatment Protocol**.

Assessment Criteria **I can:**	**Yes**	**No**
Explain the parasitic disease malaria		
Describe the malaria situation and endemicity of malaria in PNG		
Explain why malaria is such a major public health problem in PNG		
Explain the life cycle of the malaria parasite		
Describe the clinical signs of malaria		
Explain the importance of malaria diagnosis		
Describe the difference between clinical and parasitological diagnosis		
Demonstrate competency in the use of Rapid Diagnostic Tests (RDTs)		
Identify the reasons for replacing some currently used anti-malarial drugs		
Describe use of AL (artemether-lumefantrine) in malaria treatment		
Demonstrate competency in prescribing AL, based on diagnosis and classification of malaria infection		
Demonstrate competency in data collection of malaria cases, AL and RDTs, and reporting, using the new National Health Information System Monthly Report Form		
Describe the algorithm of IMCI including malaria diagnosis		
Explain the different methods of malaria prevention		
Describe how a treated bed net could be effectively deployed and maintained during its life		

1. Malaria and the Malaria Situation in PNG

Topic outcome

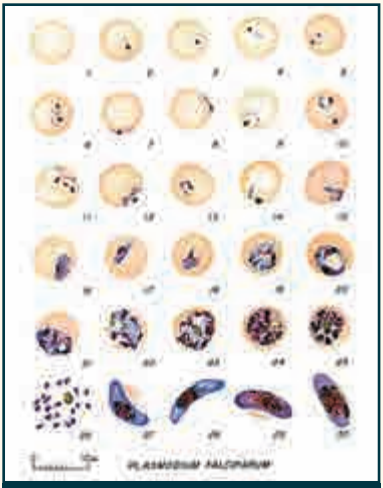
On completion of the topic you will be able to:

- explain the parasitic disease malaria;
- describe the malaria situation and endemicity of malaria in PNG;
- explain why malaria is such a major public health problem in PNG;
- explain the life cycle of the malaria parasite;
- describe the clinical signs of malaria.

1.1 What is malaria?

Malaria is one of the most common parasitic diseases and a major public health problem in many tropical and subtropical countries. The World Health Organisation's *World Malaria Report 2009* estimates that in 2008 there were 243 million cases of malaria worldwide, with 85% in the African region, 10% in South East Asia, and 4% in the Eastern Mediterranean. Malaria accounted for an estimated 863,000 deaths in 2008, of which 89% were in the African region. Malaria remains endemic in 109 countries in the world, including Papua New Guinea.

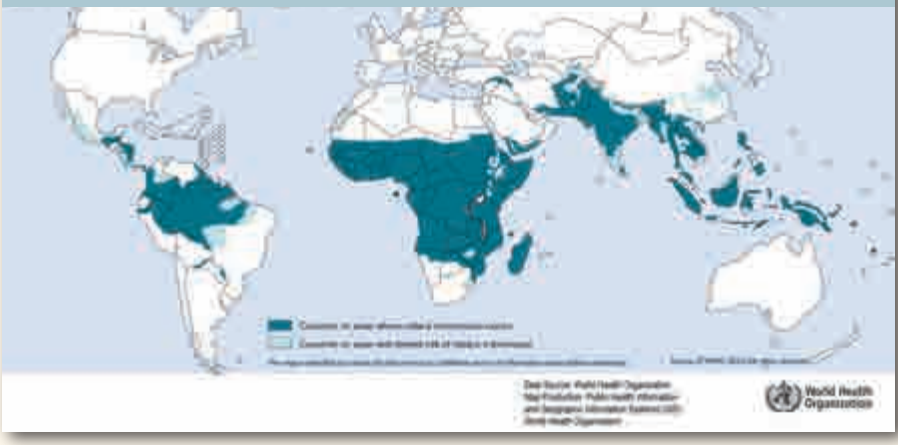
Malaria is a disease caused by a parasite of the genus *Plasmodium*. The four species infecting humans are *Plasmodium falciparum (Pf)*, *Plasmodium vivax (Pv)*, *Plasmodium ovale (Po)*, and *Plasmodium malariae (Pm)*.



Stages of P. falciparum in thin blood smears. (Courtesy of Coatney, Collins, Warren, Contacos)

Plasmodium falciparum infections can be seen mostly in African countries, Papua New Guinea and to a lesser degree in South East Asia. *Plasmodium vivax* can be seen mainly in South East Asian countries and South America. *Plasmodium ovale* prevails mainly in Latin American countries and to a lesser degree in African countries. *Plasmodium malariae* infections are common in all malarial areas.

Figure 1: World map showing malaria endemic countries



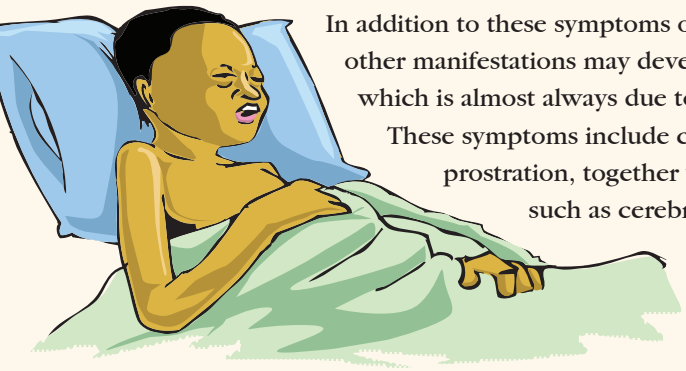
Usually *Plasmodium vivax*, *ovale* and *malariae* give mild infections, whereas *Plasmodium falciparum* can cause severe malaria with complications. *Plasmodium vivax* and *ovale* parasites can stay in the liver in a dormant form called hypnozoites, causing the infection to re-occur. The time of activation of these hypnozoites differs from one strain to another. In Papua New Guinea, this activation time can be as short as 2 months.

Malaria is transmitted by a mosquito from an infected person to another person. Several species of *Anopheles* mosquitoes transmit the malaria parasite. The species of *Anopheles* varies from country to country.

There are 400 species of *Anopheles* vectors in the world, of which 60 are proven malaria vectors. The *Anopheles* vectors prefer to breed in clean, sunlit, slow moving or stagnant water.

The Anopheles mosquito is responsible for transmitting malaria. (Courtesy of Dept. Medical Entomology, ICPMR)

Among the clinical signs and symptoms associated with malaria, the most prominent symptom is fever, which is often accompanied by chills, perspiration, anaemia, headache, vomiting, malaise, and diarrhoea.



In addition to these symptoms of uncomplicated malaria, other manifestations may develop that signal severe malaria, which is almost always due to *Plasmodium falciparum*. These symptoms include confusion or drowsiness with prostration, together with severe manifestations such as cerebral malaria, severe anaemia, pulmonary odeoma and others.

Activity 1.1

Malaria

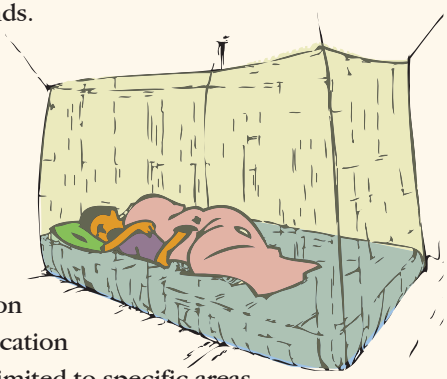
Answer the following questions:

1. Name four parasites that cause malaria. Which is the most dangerous one among them and why?
2. List mosquito breeding places in your area.
3. Can all mosquitoes transmit malaria?
4. What are the signs and symptoms of uncomplicated malaria?
5. What are the signs and symptoms of severe/ complicated malaria?

1.2 Malaria situation and endemicity of malaria in PNG

1.2.1 Malaria situation in Papua New Guinea

Malaria is one of most important public health problems in Papua New Guinea, with perennial transmission in most coastal and island regions, and seasonal transmission of unstable malaria with outbreaks in the highlands.



In 1957, PNG joined the Global Malaria Eradication Programme, with countrywide Indoor Residual Spraying (IRS) with Dichlorodiphenyltrichloroethane (DDT) and Mass Drug Administration (MDA) using chloroquine.

But late in the 1970s, it was clear that eradication objectives would not be achieved and the eradication programme was abandoned. In 1975, IRS was limited to specific areas, and responsibilities for implementing programme activities were integrated into the general health services. Untreated bed nets were introduced to the county for the first time. Further, in 1984, while retaining the responsibility for setting policy standards, provinces took on the role of providing technical support to the districts. This resulted in the decentralisation of services. As a consequence, malaria control lost its priority status and multiple gaps were created within the government structure. In 1986, PNG launched its first trial of insecticide-treated bed nets for malaria control.

In 2000, national treatment guidelines were changed from chloroquine or amodiaquine for small children to chloroquine plus Fansidar as the first line treatment. Artemether and Fansidar combination therapy were introduced as the second line treatment therapy.

Malaria is still the main cause of morbidity in lowland areas, and is increasingly responsible for epidemics in highland areas. Malaria affects over 90% of the population in Papua New Guinea. The number of reported suspected malaria cases and deaths in 2007 was 1.6 million and 559 respectively.

Malaria morbidity and mortality ranks third among all the diseases in PNG. The morbidity ranges from 10.6% to 13.8% of all hospital admissions, and mortality accounts for 11% to 18% of hospital deaths.

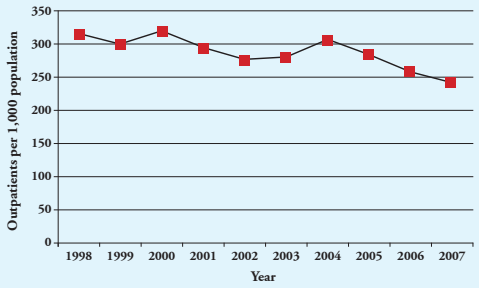
The predominant species is *Plasmodium falciparum*, accounting for 60% of cases in the highlands to 80% on the coast, followed by *Plasmodium vivax*, accounting for 15–35%, and *Plasmodium malariae* with about 2–10%.

Pv or *Pm* sometimes occur as mixed infections with *Pf,* whilst *Po* is rare. Over 70% of *Pf* cases show varying degrees of resistance to chloroquine. Increased mobility in recent years has contributed to increased malaria transmission (especially *falciparum* malaria) in the highland areas through frequent introduction of infections from the lowland areas. Surveys conducted in two lowland areas (Madang and Maprik) revealed that malaria was responsible for between 4–17% of child mortality.

The main vectors that transmit malaria in PNG are *Anopheles farauti, Anopheles punctulatus* and *Anopheles koliensis.* These mosquitoes breed in river banks, marshes, and lagoons in low-lying areas. All malaria vectors in PNG are anthropophylic (prefer human blood) and they feed both outside and inside houses.

Anopheles farauti and Anopheles punctulatus. (Courtesy of Burnet Institute and Richard C. Russell)

Graph 1: Reported Annual Incidence of malaria in PNG since 1998



Graph 2: Reported malaria case fatality rate in PNG since 1998

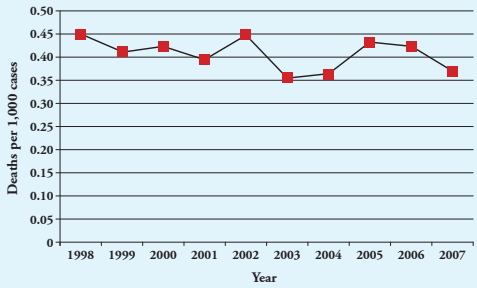
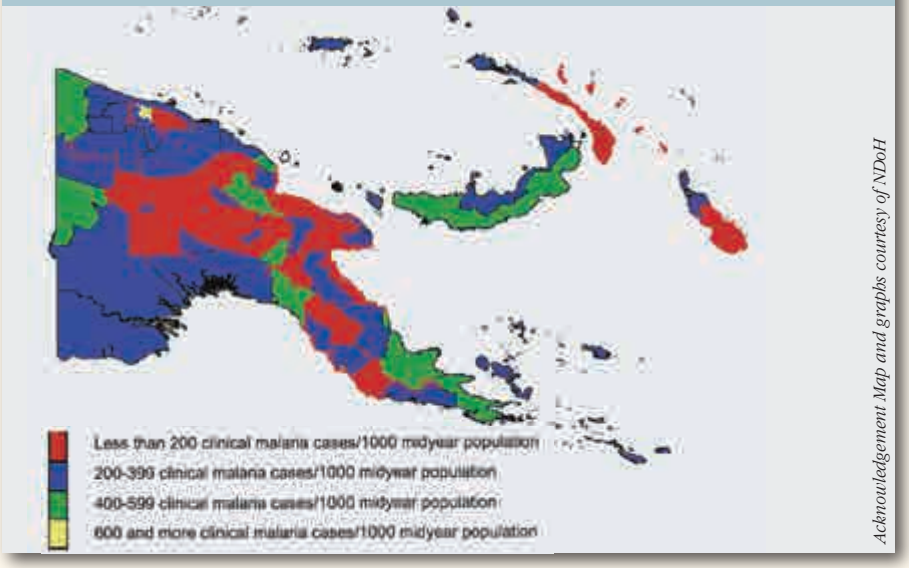


Figure 2: Map showing malaria incidence rate per 1000 population in PNG, by district, 2007



Acknowledgement Map and graphs courtesy of NDoH

1.2.2 Malaria endemicity in Papua New Guinea

1.2.2.1 Malaria endemicity in coastal and island areas

The coastal and islands areas of PNG, which cover about three quarters of its land mass and almost two thirds of its population, have a malaria endemicity that varies from hyperendemic to holoendemic, except in the mountainous parts of the Oro Province and West Sepik Province.

In the hyperendemic areas, such as the Trobriands and mountain slopes in Milne Bay, Morobe, Madang, East Sepik and West Sepik, occasional epidemics occur over and above the existing endemicity. People in these areas can contract malaria a number of times and as a result have developed partial immunity that protects them from severe malaria. Very young children, pregnant women and immigrants into the area, having no immunity to malaria, suffer most from severe complications of the infection.

Currently, the following strategies are employed to control malaria: early diagnosis of malaria patients and prompt treatment; chemoprophylaxis to pregnant women, itinerant workers and immuno-suppressed persons; and LLIN.

1.2.2.2 Malaria endemicity in highland areas

Malaria transmission does not occur above 1600 metres. Malaria cases, however, can be reported during the whole year as a result of importation of malaria from the lowlands. In areas below 1300 metres, such as river basins, transmission of malaria may occur at very low levels throughout the year. Between these two elevations, malaria transmission can occur during warm humid periods of the year.

People living in highland areas infrequently experience malaria, and their immunity is very low. Therefore, when they contract malaria, the disease is more often severe and can cause death. Effective case management, especially of severe malaria cases, administering chemoprophylaxis to pregnant women and travellers to coastal areas, and IRS, are the main malaria control strategies.

Activity 1.2

Malaria situations

Answer the following questions:

1. Name the most common malaria parasite in PNG.
2. Why are people living in highland areas more prone to severe malaria?
3. How would you respond to a malaria epidemic?

1.3 Life cycle of the malaria parasite and action of drugs

1.3.1 Life cycle of parasites in mosquitoes

When an *Anopheles* mosquito bites a person already infected with malaria, female and male gametocytes enter the body of the mosquito. Then exflagellation of gametocytes occurs and ookinetes form. Subsequently, the ookinetes penetrate the mid gut wall of the mosquito to develop into oocytes. When the oocyte ruptures, sporozoites invade the salivary glands of the mosquito. When the mosquito bites a healthy person, sporozoites enter the blood of the human. With the formation of sporozoites, the life cycle of the parasite in the mosquito ends, and to continue the life cycle, sporozoites must enter a human host.

1.3.2 Life cycle of parasites in humans

After a bite from an infected *Anopheles* mosquito, sporozoites enter the human blood and within approximately 30 minutes, penetrate the liver cells. In the liver cells, sporozoites multipy, and form merozoites, and then develop into schizonts (exo-erythrocytic schizogony). When the liver cells rupture, the merozoites penetrate the red blood cells. In *vivax* and *ovale* malaria, the development of some of the sporozoites is halted and they form into hypnozoites. These hypnozoites can remain dormant in the liver cells and, depending on the species, become activated years after initial infection.

When the merozoites enter the red blood cells, the erythrocytic schizogony (asexual blood forms) cycle starts and several stages of parasites occur in the red blood cells (ring forms, trophozoites etc). When the erythrocyte ruptures, merozoites enter new red blood cells. This marks the increase of the body temperature due to release of cytokinase and other toxic products. Infections with *vivax* and *ovale* can be identified with well-defined malarial paroxysms, in which fever spikes, and chills and rigors occur at regular intervals. At the same time, some of the merozoites develop into macro- and micro-gametocytes (sexual blood forms). With the formation of gametocytes, the life cycle of the malaria parasite ends in the human body.

1.3.3 Effects of medicine on malaria transmission

Medicine can reduce malaria transmission in two ways;

1. **Early and effective treatment of malaria blood infection with anti-malarials.** Basically anti-malarials such as chloroquine, amodiaquine, Fansidar and artemisinin derivatives are effective against the asexual blood stages. Effective treatment of the asexual blood stages will eliminate the source of the gametocytes. The faster the clearance of asexual blood parasites, the greater the effect in reducing infectivity. In *P. vixax*, *P. malariae* and *P. ovale*, gametocytes have a short development period of 2-3 days and mature gametocytes have a short life span. In the *P. falciparum*, gametocytes take longer to develop, usually about 12 days and mature from young parasites (merozoites). In the peripheral circulation, mature gametocytes may remain infective for up to several weeks. Therefore the infectivity of *P. falciparum* infection could remain for weeks after the patient has been successfully treated unless a specific anti-gametocyte medication such as primaquine is used.

2. **By lowering the parasites infectivity through either direct effect on gametocytes (gametocytocidal effect) or on the parasite developmental stages in mosquitoes (sporonticidal effect).**

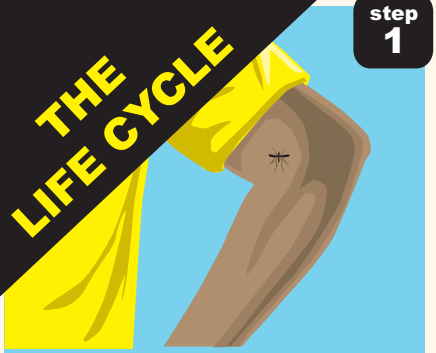
   Chloroquine acts against young gametocytes but has no effect on the infectivity of mature infective gametocytes.

   Artemisinin is the most effective gametocytocidal drug currently in the market which is used to treat asexual blood infection. Artemisinin destroys young gametocytes, therefore preventing infective gametocytes from entering the circulation, but it has less effect on mature gametocytes which may be present in the circulation at the time of treatment.

   Primaquine, which is an hypnozoiticidal drug used for the prevention of relapses in *P. vivax* is the only anti-malarial drug acting on mature gametocytes and it accelerates gametocyte clearance. The combination of primaquine and ACT in the treatment of *P. falciparum* infections is beneficial because primaquine acts on mature infective gametocytes where artemisinin has little or no effect.

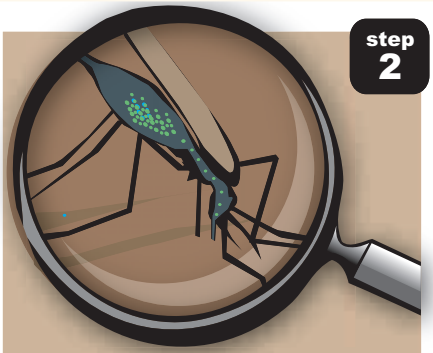
THE LIFE CYCLE

step 1



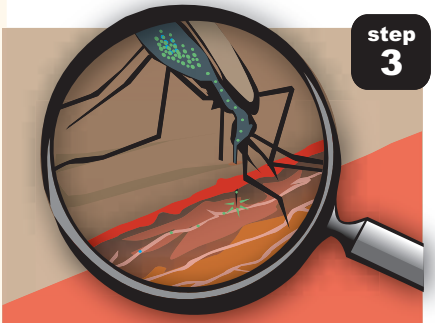
The parasites, in sporozoite form, are carried in the mosquito's saliva.

step 2



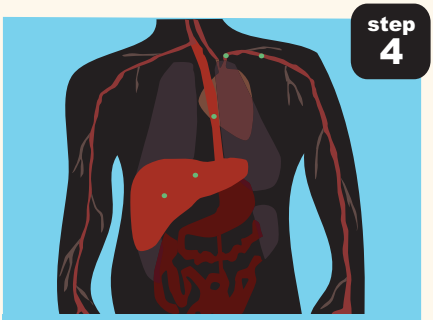
The female mosquito injects the saliva and sporozoites into a blood vessel as it starts to suck in blood.

step 3



Some sporozoites travel through the blood stream and settle in the liver, about 30 minutes after the bite.

step 4

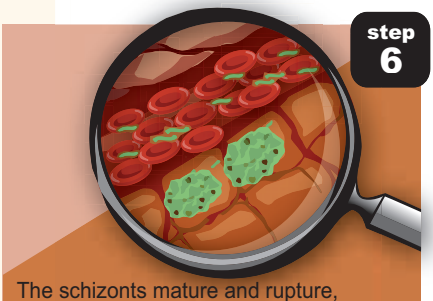


In the liver, the parasite starts reproducing rapidly, forming schizonts. The schizonts contain merozoites, which fill the liver cells.

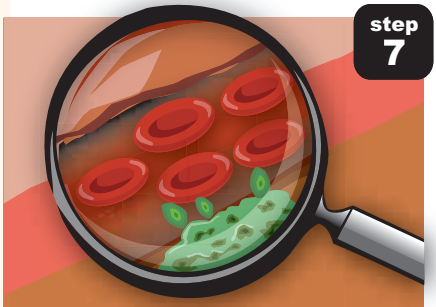
step 5

The schizonts rupture, releasing the merozoites into the bloodstream. The merozoites invade red blood cells, where they eat the hemoglobin in the cell and reproduce, forming more schizonts

step 6

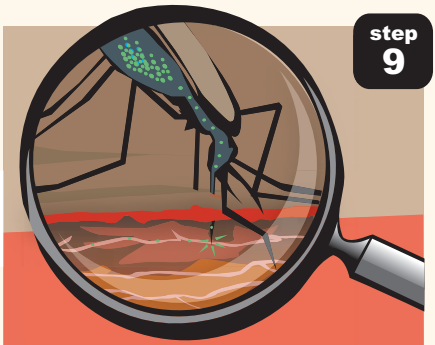


The schizonts mature and rupture, releasing more merozoites into the bloodstream. More red blood cells become infected, rupture and release more merozoites to invade even more blood cells.

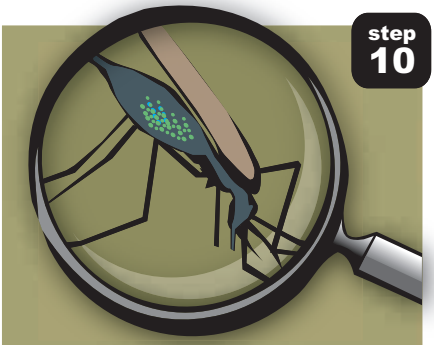


Then the blood cells rupture, and the infected person develops the symptoms of malaria. The person needs to be treated with special drugs, or the disease can be fatal, especially in children, pregnant women and the elderly.

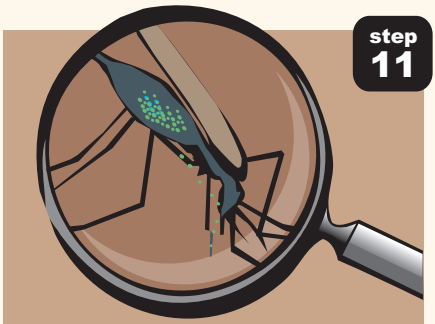
Some merozoites become male and female gametocytes, which travel in the bloodstream.



A mosquito bites an infected person and takes the gametocytes into her gut.



In the body of the mosquito, the gametocytes develop into sporozoites.



The sporozoites move into the mosquito's salivary glands, ready for the next bite.

The mosquito injects the saliva and sporozoites into a blood vessel of ANOTHER human and so the cycle continues.

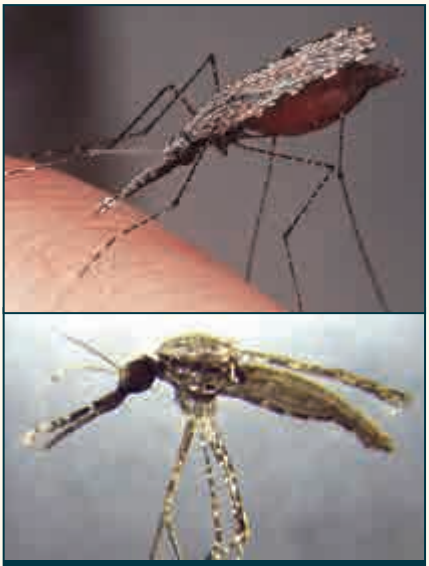
Activity 1.3

Life cycle of Malaria

Answer the following questions:

1. List the stages of the parasite in the human body.
2. After a bite from an infected mosquito which organ does the parasite enter?
3. What are the two species that can stay in liver cells for a long time?
4. When does fever occur?
5. Look at the Life cycle diagram on page 24 and discuss with the group the life cycle of malaria parasites in the human and mosquito.
6. Fill in the table below:

   Write in each box the effect of drugs on the stages of the parasites.



Anopheles farauti and Anopheles punctulatus courtesy Burnet Institute and Richard C. Russell

- Write ++ if you think the drug has a strong effect on the parasite stage.
- Write + if you think it has some effect.
- Write - if you think it has no effect and
- Write ? if you are not sure.

Drug	Hypnozoites	Asexual blood forms	Gametocytes
Chloroquine			
Amodiaquine			
Quinine			
Primaquine			
Fansidar			
Artemisinin			
Artemether			
Artesunate			

Key Learning Points

Malaria and malaria situation in PNG

- *Malaria is a major public health problem and remains endemic in 109 countries in the world, including PNG.*
- *It is caused by a parasite of the genus Plasmodium. The four Plasmodium species which affect humans are Plasmodium falciparum, Plasmodium vivax, Plasmodium malariae and Plasmodium ovale. These species are all found in PNG.*
- *Malaria is endemic in coastal and island regions of PNG.*
- *The highland areas of PNG normally have very little malaria but can experience malaria outbreaks.*
- *Malaria is transmitted by the anopheles mosquito.*
- *Malaria parasites develop in both the human and mosquito.*
- *Anti-malarials work on different stages of the malaria parasite, and also in different organs of humans.*

1.4 Classification of malaria patients

Malaria is basically categorised into two groups, uncomplicated malaria, and severe or complicated malaria. All the four species of malaria parasites can cause uncomplicated malaria. There are also at least two types of severe malaria which are: severe *falciparum* malaria and severe *vivax* malaria.

It is important to know the different types of malaria because each case will be treated differently.

1.4.1 Uncomplicated malaria

Uncomplicated malaria is usually characterised by fever. Other features may include chills, profuse sweating, muscle pains, joint pains, abdominal pain, diarrhoea, nausea, vomiting, irritability and refusal to eat. These features may occur singly or in combination.

The classical symptoms of malaria are the cycle of sudden coldness, followed by rigor and then fever and sweating lasting four to six hours, occurring every two days in *Pv* and *Po* infections and every three days for *Pm*. In *Pf* infection, there can be recurrent fever every 36 – 48 hours, or less pronounced and almost continuous fever.

1.4.2 Severe malaria

If treatment is delayed, or ineffective anti-malarials are given to a patient with malaria, the disease may progress to severe malaria in a couple of hours. There are at least two types of severe malaria which are severe *falciparum* malaria and severe *vivax* malaria.

Severe malaria is the life threatening manifestation of malaria, and is defined as the detection of *P. falciparum* asexual parasites in the peripheral blood, in the presence of any of the clinical or laboratory features (singly or in combination) listed below:

- Prostration (inability or difficulty sitting upright or standing or walking without support in a child normally able to do so, or inability to drink or breast-feed);
- Alteration in the level of consciousness (ranging from drowsiness to deep coma);
- Multiple generalised convulsions (2 or more episodes within a 24 hour period);
- Severe pallor – Severe anaemia (Hb <5g/dl or Hct < 15%);
- Looks very sick;
- Vomiting everything.

Activity 1.4

Classification of Malaria Patients

Answer the following questions:

1. What are the key features of severe malaria?
2. What are the signs or symptoms of uncomplicated malaria?
3. In sick children under five years old, there are danger signs of severe illness that must be regarded as a sign of severe malaria. Name three of these signs.

Child suffering from malaria. (Artwork courtesy of PSI)

Key Learning Points

Classifications of malaria

- *If treatment is delayed, or ineffective anti-malarials are given to a patient with malaria, the disease may progress to severe malaria in a couple of hours.*
- *Uncomplicated malaria is usually characterised by fever. Other features may include chills, profuse sweating, muscle pains, joint pains, abdominal pain, diarrhoea, nausea, vomiting, irritability and refusal to eat. These features may occur singly or in combination.*
- *P. falciparum and P. vivax can both cause uncomplicated or severe malaria.*
- *There are at least two types of severe malaria: severe falciparum malaria and severe vivax malaria.*
- *Knowing the different types of malaria is important because they will have to be treated differently.*
- *Children under 5 years old who are suspected or confirmed with malaria and who have one of the following danger signs of severe illness must be regarded as having severe malaria and treated accordingly:*
  - *Inability to drink or breast-feed;*
  - *Vomiting everything;*
  - *Recent history of convulsions;*
  - *Lethargy or unconsciousness;*
  - *Inability to sit or stand up in a child normally able to do so.*

2. Diagnosis of Malaria

Topic outcome

On completion of the topic you will be able to:

- explain the importance of malaria diagnosis;
- describe the difference between clinical and parasitological diagnosis;
- demonstrate competency in the use of the Rapid Diagnostic Test (RDT).

2.1 Importance of malaria diagnosis

The current practice is that every patient with fever is given anti-malarials because malaria is endemic in the country. Treating fevers caused by other diseases with anti-malarials means that these patients will not get better and, as the correct treatment is not been provided, their condition may worsen. Fever can be caused by malaria as well as other infections such as otitis media, pneumonia, measles, meningitis and Japanese encephalitis. This policy is expensive because many people are treated for malaria even if they do not have the disease. Misdiagnosis of malaria infections results in significant morbidity and mortality, and in the unnecessary use of anti-malarial drugs, which in turn increases the cost of malaria control in the country.

Early rapid diagnosis of malaria is an important strategy in malaria endemic countries, including PNG, because of the increasing costs of anti-malarials and the need to reduce malaria morbidity and mortality. In 2010, the World Health Organization (WHO) recommended parasitological confirmation either by microscopy or RDTs before treatment of all suspected malaria cases. Anti-malarial treatment on the basis of clinical suspicion should only be used in situations where parasitological diagnosis is not available, especially in vulnerable populations e.g. children under 5 years, pregnant women and in severe malaria cases.

Activity 2.1

Microscopy and RDT

In your group compare an RDT test with microscopy, and then fill in the following table.

PNG's new malaria treatment protocol requires that all suspected cases of malaria must be **confirmed** before treatment can be given. PNG is also scaling up diagnostic facilities using Rapid Diagnostic Tests, and every clinical health worker should know how to perform an RDT.

	Microscopy	RDT
Requirements		
• Equipment		
• Electricity		
• Supplies		
• Training		
Performance		
• Test duration		
• Labour intensiveness		
• Subjectivity		
• Robustness		
Direct cost		
• Cost per test		
Technical specifications		
• Detection threshold		
• Detection of all 4 species		
• Quantification		
• Differentiation between *Pv, Po, Pm*		
• Differentiation between sexual and asexual stages		
• Antigen persistence		

2.2 Difference between clinical and parasitological diagnosis of malaria

Rapid Diagnostic Test Kit

Current practice in Papua New Guinea is to diagnose malaria patients either clinically or microscopically, or by using Rapid Diagnostic Test Kits. Microscopic diagnosis is done only where there are facilities for microscopy (microscopist, reagents, equipment etc). In most health facilities in the rural areas of Papua New Guinea, health workers use clinical judgement, based on the signs and symptoms of the patient, to diagnose malaria.

In all hospitals and in some major health centres in the country, microscopic diagnosis is performed. The careful examination by an expert microscopist of a well-prepared and well-stained blood smear remains currently the "gold standard" for detecting and identifying malaria parasites.

RDT being performed

This is done by examining a stained thick and thin blood smear for the presence of malaria parasites. Thick smears are recommended for parasite detection and quantification, and can be used to monitor response to treatment. Thin smears are recommended for species identification.

RDTs were recently introduced into PNG and many provinces are using RDTs. This testing method will be used for diagnosis in most rural facilities and urban clinics.

2.3 What are RDTs and what is their importance in malaria control?

An RDT is a method to test patients for malaria. It has been developed in a number of different test formats – eg: dipstick, card, pad, cassette. This latter format is proving more satisfactory as it is easier to carry out and is regarded as safer to use in the field. These rapid test kits require a minimum level of training of health workers to enable the results to be correctly interpreted.

All the test kit formats are designed to detect the malaria parasite's antigens in the patient's blood. If the malaria antigen is present, the patient will test positive. If the malaria antigen is absent, the patient will test negative. These antigens cause microscopic particles to stick to a band on the RDT kit, which is seen as a coloured line in the test area.

Most of the RDT tests available are specific for *P. falciparum*. However, there are a few tests with the ability to differentiate between *P. falciparum* and non-*falciparum* malaria (*vivax*, *malariae* and *ovale*). RDTs are simple to use, and can be performed in about 15 minutes.

Use of RDTs which employ the antigen HRP2 are not recommended for follow-up as most of these types of tests remain positive for up to two weeks following effective anti-malarial treatment and clearance of parasites. They also cannot be used to determine parasite density. It is important that RDT test kits are stored in a cool, dry place at 2°C to 30°C.

Since the new malaria treatment policy has changed, all patients must be confirmed before administering anti-malarials if diagnostic tools are available. RDTs will play an important part in this change. Proper diagnosis before treatment will prevent or delay occurrence of resistance to malaria drugs and also reduce morbidity and mortality.

2.4 Advantages and disadvantages of microscopy and RDTs

Advantages of microscopy:

- It is a sensitive test. When used by a skilled microscopist, microscopy can detect parasitaemia as low as 5 to 10 parasites per µl of blood. But in field conditions, microscopy can detect 100 parasites per µl of blood.
- It can differentiate all 4 species of malaria parasite.
- It is relatively inexpensive (K0.36 to K1.20 per test).
- It can be used with other disease control programs.

Disadvantages of microscopy:

- It is labour intensive and time consuming.
- Test results depend on the skills and experience of the microscopist.

Advantages of RDTs:

- The result will be available 15 to 20 minutes.
- Minimal training of the health worker is required.
- It can be available to all health facilities, including those in remote areas.

Disadvantages of RDTs:

- It has a detection threshold of 40 to 100 parasites per µl blood.
- It cannot detect all malarial species. Only some RDTs can.
- It costs about K1.80 to K6.00 per test.
- The supply of RDT test kits may not be reliable.

Blood sample collection for molecular diagnosis of malaria

Malaria microscopy

Papua New Guinea is introducing artemisinin-based combination therapy (ACT) as part of its malaria control strategy, and there is increasing support for parasite-based diagnosis rather than clinical (presumptive) diagnosis. Using RDTs to differentiate malaria from fevers caused by other illnesses is important because:

- ACT is more expensive than other available anti-malarials such as chloroquine, amodiaquinine, and Fansidar. Rather than give this expensive combination drug to all fever patients, RDTs can help target patients who really have malaria;
- Many other life threatening infections like meningitis and Japanese encephalitis cause similar symptoms to malaria. Treating all febrile illnesses with anti-malarials means that these patients may not receive the correct treatment;
- Proper diagnosis before treatment will prevent or delay resistance to the new anti-malarials.

2.5 How to use the Rapid Diagnostic Test (RDT)

There are numerous different RDTs available. Most will test for *P. falciparum* specifically and will show the presence of other malaria parasites but will not be able to identify the malaria species. There are also some RDTs that can identify all malaria parasites.

The RDT kit which is currently in circulation in some health facilities in PNG, can identify *Plasmodium falciparum* and also detect malaria infection from the other three species.

It is very important to remember that a health facility may receive a restock of test kits that differ from those supplied previously. This is because of tender requirements, where a different company may win the bid. However, similar principles must be followed when using RDTs and it is very important for you if you are not familiar with the particular RDT supplied to **check the instructions** before using it as there may be differences in how the test is carried out and interpreted.

It is not possible in training to cover all the different types of RDT. However, the format used here is a cassette RDT. These RDTs come in boxes of 25 kits and include the following items:

New unopened test packets

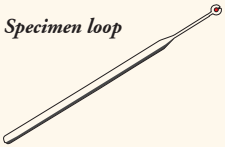
New unopened alcohol swabs

Buffer solution

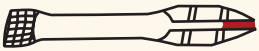
Sterile lancets

The items you will find inside the test packet are:

1. A **means to collect blood** from the patient. Some test kits will have a plastic capillary tube which is straight, with a black line at one end of it to indicate the correct amount of blood to be collected. Other test kits use a pipette which is slightly bigger at one end with markings indicating the correct amount of blood to collect. A specimen loop is also used to collect blood. No matter which type you have, all are designed so that the correct amount of blood can be collected. (see below)



Specimen loop

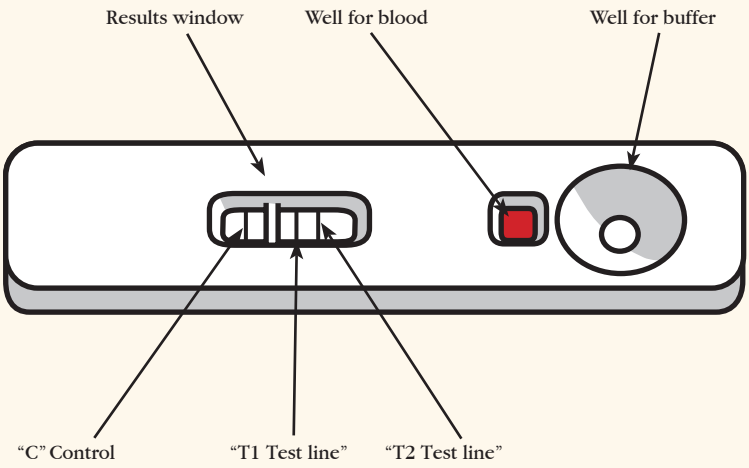


Pipette

Capillary tube

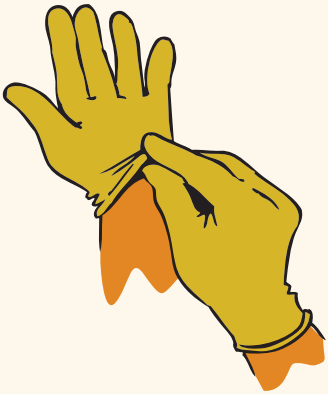
2. The **desiccant sachet** protects the test from humidity before the pack is opened. Once the packet is opened safely discard the desiccant sachet, because this can be harmful if swallowed, and it should be kept away from children.

3. The **test cassette** which is used to conduct the test comes in different sizes and shapes but all have a test window, a well for the blood and another well for the buffer. Following, is an example of a test cassette. Other cassettes may have a slightly different layout.

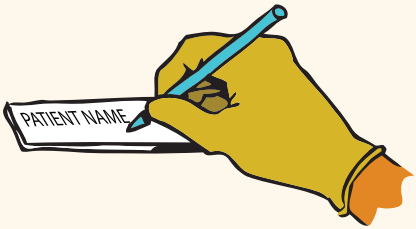


Procedure to perform RDT

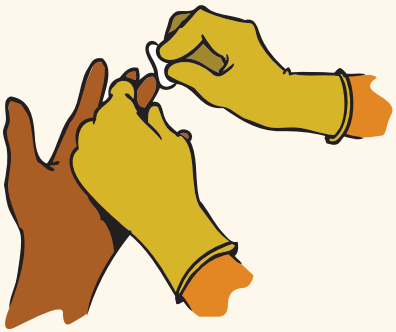
1. Check the expiry date on the test packet before opening it. If it is out of date, discard it.
2. Put on a **new** pair of disposable gloves. Wearing gloves protects blood samples from being contaminated, and also protects the health worker from contracting blood borne diseases, such as HIV and hepatitis. **It is very important to use one pair of gloves for each new patient**.



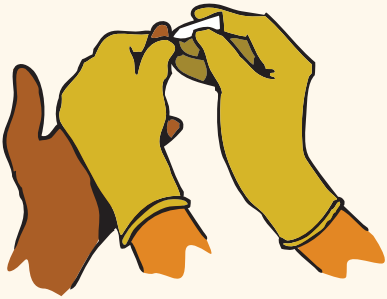
3. Open and remove the contents of the test packet.
4. Write the patient's name on the cassette before beginning the test. It is important not to confuse blood samples and patients.



5. Open the alcohol swab and clean the patient's 4th finger. If the patient is left handed, choose the 4th finger on their right hand and vice versa. This is to minimize the inconvenience to patients if the pricked finger becomes sore. If the patient is a child less than one year, you can also take blood from the toe or heel. After cleaning the finger with the alcohol swab, it must be allowed to air dry. The finger must not be dried by blowing on it or wiping it with a piece of cotton or cloth or paper, otherwise you may introduce infection.



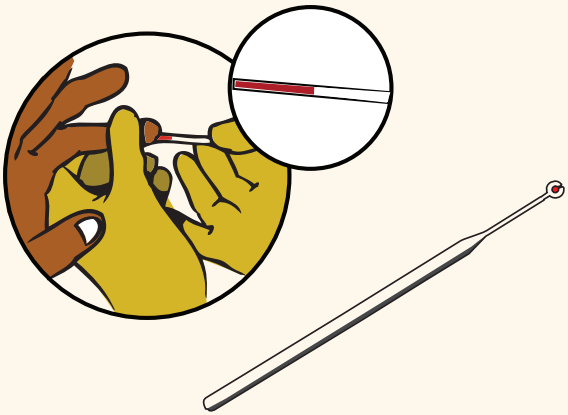
6. After using the alcohol swab, place it on the wrapper to use it again to stop blood after collecting a sample from the patient.
7. The lancet should open from the "non point" side of the pack, to avoid an accidental finger-prick.



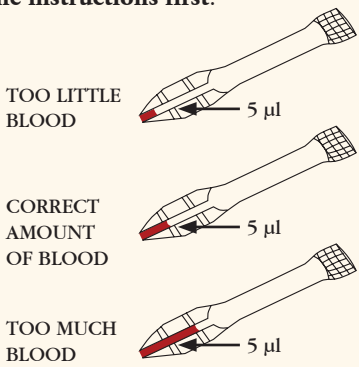
8. Used lancets should be discarded immediately and safely into a sharps disposable bin to prevent accidents. Remember: any accidental pricks have the potential to transmit other infections such as HIV. **Never use a lancet more than once**.

Sharps container

9. To collect the blood droplet, use the pipette, specimen loop or capillary tube provided. Turn the patient's arm so their palm is facing downward. It is important to collect the correct amount of blood in the pipette, loop or tube. To get more blood gently push down towards the tip of the finger by squeezing along the finger towards the prick. In the diagram below, two examples of collecting blood are shown, a capillary tube and a specimen loop.



10. The correct amount of blood must be taken into the pipette, capillary tube or specimen loop so that the test results will not be compromised. If you are using a pipette, the illustration below shows how to gauge how much blood is collected. Remember: if you are unclear about how to use the test, **read the instructions first**.



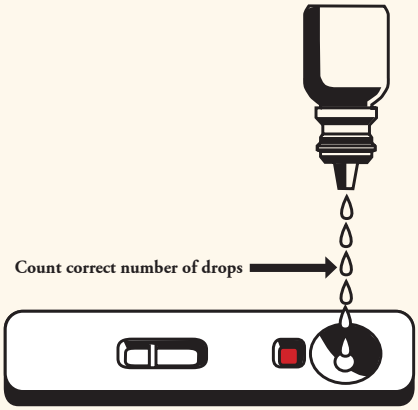
11. Once you have collected the correct amount of blood, put the previously used cotton swab on the pricked finger and ask the patient to apply pressure on the swab to stop any bleeding.

12. Transfer blood to the test cassette by touching the pipette nozzle to the blood well and gently squeezing the pipette bulb. It is important that the blood should touch the base of the well and not the walls of the well.

13. Discard the pipette, loop or tube in the non-sharps box immediately after transferring the blood to the well of the test kit.

14. Add the **specified number of drops of buffer solution** to the **buffer** well in the cassette. There are a variety of RDT kits and some kits will require different numbers of drops. To add buffer solution correctly and to ensure correct drop size, hold the bottle vertically. **Note that an incorrect amount and size of drops will compromise the test result**. The example on the next page shows six drops of buffer being used. Remember: Your type of RDT may require a different number of drops so **check the instructions if you are unfamiliar with the RDT**.

Remember that the buffer amount in the bottle is calculated for the exact number of RDTs in the box. Make sure you do not waste buffer solution.



15. Write on the cassette the time the test is to be read. Wait for the required length of time **after** adding buffer solution before you read the test results. It is important the results must be read at this time and no later. **NB: in this example, this type of test requires 15 minutes before a result is given. Reading the test result earlier or later than the required time will give a false result**.

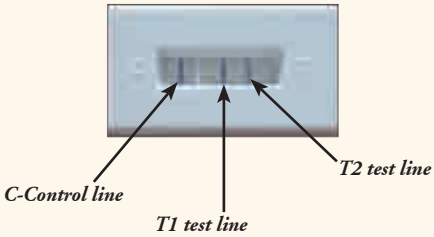
16. After the blood is put into the well, the blood will begin to wick up the strip, and start disappearing from the hole where it was added. It will begin to appear in the results window, where it will eventually disappear, leaving only the control line and, if the patient is positive, the result or test line(s). **The role of buffer solution is to wash out the blood which is why timing for reading the result is important**. If there is too much blood left in the results window, this may obscure the test lines.

17. Remove gloves and discard them safely in a non-sharps disposable bin. If another test is going to be performed on another patient, **a new pair of gloves should be worn.**

18. **Important:** Remember to record your test results in your National Health Information System (NHIS) Outpatient Tally Sheet and the Health Facility Malaria Register. Make sure also to transfer your tally to the monthly NHIS Monthly report form so that the data can be forwarded to the Provincial Health Information Officer. **These statistics are vital, not only to assess trends and for restocking purposes, but also for the future planning of health services**.

Malaria Generic Pf-Pan RDT Results Guide (Type D)

Arrangement of test lines



The eight possible results for **this type** are as follows:

NB: Other test kits may have a different arrangement of control and test lines. Check the instructions for your type of RDT.

1. A line in "T1" and a line in "C" – positive for *Pf* infection (the test is positive, even if the test line is faint).

2. A line in "T2" and a line in "C" – positive for non-*falciparum* infection (*Pv, Po, Pm*) or mixed infection of these (the test is positive, even if the test line is faint).

3. Lines in "T1", "T2" and a line in "C" – positive for *Pf* or mixed infection (the test is positive, even if the test line is faint).

Activity 2.2

RDT

Answer the following questions and complete the following activities:

1. Select a partner and perform an RDT test on your partner. Wait the required length of time and read the result of the test. Once completed, change roles.
2. How many buffer drops must be put into the test cassettes?
3. Why is it important to wear gloves when performing an RDT?
4. When should you read the test results, and why?

4. No line in "T1" and "T2" but a line in "C" – negative.

5. No line in "T1" and "T2" and no line in "C" – invalid.

6. Lines in "T1" and "T2" and no line in "C"- invalid.

7. Line in "T1" and no line in "C" - invalid.

8. Line in "T2" and no line in "C" - invalid.

Invalid results mean that the RDT is damaged and the results may be incorrect. In this situation the test result has to be discarded and the test repeated.

In case of a positive result the patient should be treated.

If the test result is negative the patient should not be treated for malaria. Find other causes of the fever. The PNG Paediatric Society advises that in the case of a child exhibiting dangerous signs of severe malaria, or "TOO SICK" signs, the child should be treated with anti-malarial drugs even if an RDT proves negative. Please refer to *Chapter 4.1 Management of Childhood Illness* and follow the *IMCI Checklist*.

Activity 2.3

RDT Quiz

1. The next three pages show RDT results. Do them yourself and then discuss your answers with your group.

Quiz # 1

1

2

3

4

5

6

7

8

9

10

Quiz # 2

1

2

3

4

5

6

7

8

9

10

Quiz # 3

1

2

3

4

5

6

7

8

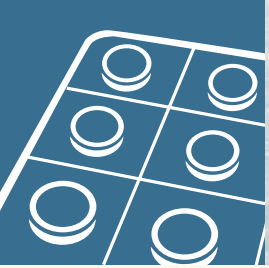
9

10

Key Learning Points

Diagnosis of malaria

- *Fever can be caused by other infections, such as pneumonia, measles and otitis media.*
- *Misdiagnosis of malaria results in a significant increase in morbidity and mortality and unnecessary use of anti-malarials. This increases the cost of malaria control.*
- *PNG's new treatment protocol requires that all malaria suspects must be confirmed before treatment is given.*
- *All malaria suspects must be confirmed either by microscopy or Rapid Diagnostic Test. RDTs should be available in all health facilities, and all clinical health workers must know how to use an RDT.*
- *The PNG Paediatric Society advises that in the case of a child exhibiting dangerous signs of severe malaria, or 'TOO SICK' signs, the child should be treated with anti-malarial drugs even if an RDT proves negative. Please refer to Chapter 4.1 Management of Childhood Illness and follow the IMCI Checklist.*
- *With RDTs, check and make sure you follow the instructions if you are unfamiliar with the test kit you are using.*
- *RDT test results should be recorded in the National Health Information System Outpatient Tally Sheet and the Health Facility Malaria Register, and later, details entered into the NHIS Monthly Report form.*



3. Anti-malarial Drugs and Treatment

Topic outcome

On completion of the topic you will be able to:

- identify the reasons for replacing some currently used anti-malarial drugs;
- describe the use of AL (artemether-lumefantrine) in malaria treatment;
- demonstrate competency in prescribing AL, based on diagnosis and classification of malaria infection;
- demonstrate competency in data collection of malaria cases, AL and RDTs and reporting, using National Health Information System forms.

3.1 Current anti-malarial drugs used in PNG

Commonly used anti-malarial drugs in PNG are: chloroquine, amodiaquine, quinine, Fansidar, artemether and artusenate. Fansidar is a combination drug of sulphadoxine and pyrimethamine. Chloroquine or amodiaquine combined with Fansidar are used for uncomplicated malaria. Quinine and Fansidar are used for severe malaria in combination with artesunate or artemether.

First line treatment - currently chloroquine plus Fansidar are used for the treatment of *P. vivax*, *P. ovale* and *P. malariae* and *P. falciparum* infections in adults. Amodiaquine plus Fansidar are used for the treatment of *P. vivax*, *P. ovale*, *P. malariae* and *P. falciparum* infections in children.

Second line treatment - artesunate or artemether plus Fansidar are used. Quinine is used as the life-saving drug for patients with severe malaria resulting from *P. falciparum* infections.

Activity 3.1

Current anti-malarial drugs used in PNG

With the colleagues in your group discuss the use of current anti-malarial drugs then write in the table below the dosage, regimen and whether they are used for uncomplicated or severe/ complicated malaria. For this example, consider an adult patient weighing 51kg.

The prevalence of drug-resistant *falciparum* malaria has increased in some countries, including PNG. Chloroquine, for example, is no longer effective and patients are returning uncured after completing their treatment.

The impact of these patients on health workers, the health service and patients is as follows:

- health workers will be demoralised as they feel they are not capable of effectively treating patients;
- cost of treating malaria will increase because health workers are wasting drugs treating patients who are not responding to first line anti-malarials;
- cost to patients will also increase due to multiple attendances at health facilities, and
- patients will also feel that their health workers are incompetent because they are not able to cure their illnesses.

Drug	Dose	Regimen	Use for uncomplicated malaria	Use for severe malaria	Effectiveness of the drug

3.2 New treatment guidelines for malaria

The anti-malarials used in PNG were effective in the past but, because they were not used or administered correctly, the prevalence of drug resistant *falciparum* malaria to all of the available anti-malarial drugs has increased, except for artemisinin and its derivatives.

For patients with *falciparum* malaria, which is resistant to chloroquine, Fansidar, mefloquine and quinine, the use of artemisinin and its derivatives is essential.

Artesunate/artemether is derived from the wormwood plant which is native to China.

Many countries in the world where malaria is endemic have experienced drug resistance and have changed their treatment guidelines to include ACT. PNG has also changed its treatment protocol to include ACT.

The artemisinin-based combinations have several benefits:

- They kill the parasite quickly and the patient will feel well.
- They help to prevent transmission of malaria to other people.
- The drug is well tolerated.
- Combination drugs also reduce the potential for drug resistance.

Using more than one anti-malarial has the advantage of attacking malaria parasites in the liver and circulating in the blood, and at different stages of development. The current treatment protocol in PNG has some anti-malarial combinations. There are artemisinin combinations as well as non-artemisinin combinations on the market.

Activity 3.2

Anti-malarial Combinations

Write down the possible anti-malarial combinations and identify artemisinin combinations from non-artemisinin combinations.

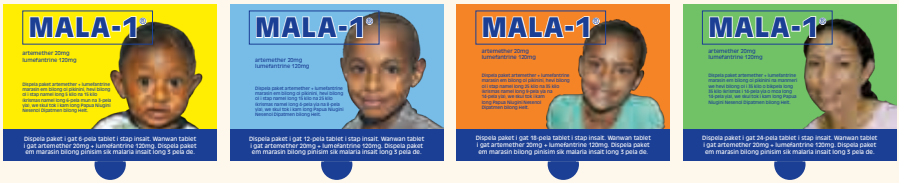
3.3 Artemether-lumefantrine (AL)

Artemether-lumefantrine (AL), as one of the combination of artemisinin derivatives, is going to be introduced into PNG in late 2010. AL comes in a combination of artemether (20mg) and lumefantrine (120mg) per tablet. AL has been successfully used to treat *falciparum* malaria, mainly in Africa and Asia. In the new treatment protocol, all patients with fever must be tested and confirmed as having malaria before anti-malarials are given. All patients must be weighed before prescribing AL according to weight. The single drug, artemisinin, is no longer recommended to be used to treat malaria patients in PNG.

Artemether-lumefantrine is a fixed combination of an artemisinin derivative which has been both widely studied and registered for the treatment of acute multi-drug resistant *falciparum* malaria. Lumefantrine is not available as a monotherapy, and has never been used by itself for the treatment of malaria.

AL is a combination drug acting on different stages of parasite development. Artemether acts quickly clearing up parasites and thus reducing fever and other malaria symptoms within hours. Lumefantrine, which has a longer life, ensures complete parasite clearance after Day Three. This greatly reduces the chances of parasites developing and spreading.

AL comes in blister packs in four colours.



Artwork courtesy of PSI

The blister packs, which protect the AL from humidity and rain, need to be stored in temperatures between 2ºC -30ºC. Each packet contains the required number of tablets which all need to be taken for the full course of treatment. It is important that the patient completes his/her treatment even if he/she feels better.

AL packets are available as:

Yellow pack: 5kgs to less than 15kgs,
(approx 6 months to 2 years),
- 1 tab bd for 3 days;

Blue pack: 15kgs to less than 25kgs,
(approx 3 – 7 years),
- 2 tabs bd for 3 days;

Orange pack: 25kgs to less than 35kgs,
(approx 8 – 10 years),
- 3 tabs bd for 3 days;

Green pack: 35kgs and over,
(approx 11 years and over)
- 4 tabs bd for 3 days.

If the health worker is not able to weigh patients he/she can use age as a guide.

Activity 3.3

AL Treatment

Answer the following questions;

1. What are the benefits of introducing AL for the treatment of malaria?
2. Explain the colour code of the packs.
3. Name the ACT that PNG has included in the new *Malaria Treatment Protocol.*
4. Where are you going to store AL in the health facility?

Note: **For children weighing less that 5kgs,** there is no blister packet for them. Therefore the yellow packet must be used as follows:

Cut a tablet in half, crush it and pour into a cup of previously boiled and cooled water, stir and give to the child. The dose for children less than 5kgs is 0.5 tablets bd for 3 days.

You should be able to use three tablets from the packet and the other three should be discarded. It is important that AL should be taken with fatty food to aid absorption.

Challenges of using AL

- AL are packed into four different weight groups in four different colour blister packs.
- There is a danger of running out of a particular weight group if stocks are not calculated properly.
- AL needs to be taken with fatty food to aid the absorption of lumefantrine.
- Weighing scales may not be available in health facilities.

3.4 New treatment regimen for malaria

Administration of treatment regimen based on confirmatory parasitological diagnosis

Chloroquine resistance to *Pf* is widespread in Papua New Guinea and is the main reason for introducing ACT as part of the malaria treatment in PNG. Monotherapy of artemisinin and its derivatives or any of the combination partner medicines is not recommended for the treatment of *falciparum* malaria as it increases the risk of the *Pf* parasite developing resistance to these effective anti-malarials.

PNG's new malaria treatment protocol requires that all suspected cases of malaria must be confirmed before treatment can be given. PNG is also scaling up diagnostic facilities using Rapid Diagnostic Tests, and every clinical health worker should know how to perform an RDT.

When malaria patients are confirmed by microscopy, select and administer the treatment regimen based on the species of malaria parasites as prescribed in Table 1: *Summary of first and second line treatment of malaria in PNG*.

When malaria patients are confirmed by RDTs, select and administer the treatment regimen for *falciparum* malaria if the diagnostic results are "*falciparum"* or *"falciparum* or mixed infection". If the diagnostic results are "non-*falciparum (Pv, Po, Pm* or a mixed infection of these)", then treat those patients with AL plus PQ.

Please note however, that for the treatment of children with fever and exhibiting the general danger signs of severe illness, the PNG Paediatric Society has advised that the *IMCI Checklist* should be followed. (See *Chapter 4.1 Management of Childhood Illness*).

Treament of returning patients

When a patient is first diagnosed with malaria, he/she is given the first line treatment according to Table 1. As most health workers will not have the facilities to enable them to diagnose a treatment failure of the first line drug, it is recommended second line treatment should only be prescribed to patients returning to the health facility **within 14 days**. However, patients who come back **after 14 days** should be considered new cases and treated with the first line drugs.

Table 1: Summary of first and second line treatment of malaria in PNG

			Conditions	First line treatment	Second line treatment
Uncomplicated		1	Uncomplicated *P. falciparum* malaria	AL tablets	DP tablets
		2	*P. malariae* malaria		
		3	Uncomplicated *P. vivax* malaria	AL plus PQ tablets	DP plus PQ tablets
		4	*P. ovale* malaria		
		5	Mixed infection of *Pf/Pv/Pm/Po*	Same as treatment of uncomplicated *falciparum* malaria; treat with PQ for 14 days if *Pv* or *Po* infection confirmed	
Severe		6	Severe malaria (both *P. falciparum* and *P. vivax*)	Artesunate IV/IM or artemether IM, followed by AL when patients can swallow	QN injection, followed by QN and doxycycline tabs when patients can swallow
Pregnancy	Uncomplicated	7	1st trimester of pregnancy	QN tablets plus Fansidar tablets	
		8	2nd and 3rd trimesters of pregnancy	AL tablets	QN tablets plus Fansidar tablets
	Severe	9	1st trimester of pregnancy	Artesunate IV/IM or QN IM, followed by QN plus Fansidar when patients can swallow	
			2nd and 3rd trimesters of pregnancy	Artesunate IV/IM, artemether IM or QN IM, followed by QN plus Fansidar when patients can swallow	

3.4.1 Uncomplicated malaria

3.4.1.1 Treatment schedule for children and adults

Treatment of children under 5 years old with fever and/or general danger signs of severe illness

PNG is an area of high malaria transmission. Children under 5 years old with fever should always be treated for malaria (AL), and especially those with general danger signs of severe illness should always be treated for severe *falciparum* malaria, instead of basing treatment on an RDT or microscopy result. While treating with anti-malarials, you should search for other causes of fever using the *IMCI Checklist* (See *Chapter 4.1 Management of Childhood Illness*).

The PNG Paediatric Society recommends that for the treatment of malaria in children, health workers must refer to the *Standard Treatment for Common Illnesses of Children in Papua New Guinea* manual and the *IMCI Checklist.*

First line treatment for uncomplicated *P. falciparum* and *P. malariae* infections

Treat with artemether-lumefantrine (AL) tablets twice a day for three days according to weight (see Table 2a).

0 hours is the time when the first dose of AL treatment is given. The second dose must be given 8 hours after the first dose. It must not be earlier than 8 hours. If the patient vomits within one hour after the medication, the dose should be repeated. Babies less than 5kgs should be treated under medical supervision.

Illustrations taken from the new MALA-1 (AL) package for Papua New Guinea. (Courtesy of PSI)

First line treatment for uncomplicated *P. vivax* and *P. ovale* infections

- Treat with artemether-lumefantrine (AL) tablets, plus;
- Primaquine (see Table 2b). The dose of primaquine is 0.25mg/kg daily for 14 days after the completion of AL.

The PNG Paediatric Society has advised that the use of primaquine for children with malaria will be further detailed in the new *IMCI Checklist.*

Primaquine is not recommended for children less than one year old and for those children with G6PD deficiency. If the G6PD deficiency status is not known, the patient is advised to take the first dose and check the colour of urine. If the urine is dark (reddish brown), the patient must be advised to stop taking primaquine immediately and to return to the health facility/clinic. Other medication should be continued if not completed. As an option, the first dose of primaquine can be given at the clinic and the patient should be asked to stay at the clinic for one hour.

Table 2a: AL tablets for first line treatment of uncomplicated *falciparum* malaria by weight

Days and doses		Weight (kg)				
		<5	5 – 14.9	15 - 24.9	25 - 34.9	>35
Day 1	1st dose at 0 hrs	1/2	1	2	3	4
	2nd dose after 8 hrs	1/2	1	2	3	4
Day 2	3rd dose after 24 hrs	1/2	1	2	3	4
	4th dose after 36 hrs	1/2	1	2	3	4
Day 3	5th dose after 48 hrs	1/2	1	2	3	4
	6th dose after 60 hrs	1/2	1	2	3	4

- 0 hours is the time when the first dose of AL treatment is given. The second dose must be given 8 hours after the first dose. It must not be earlier than 8 hours.
- If patients vomit within one hour, the dose should be repeated.
- For babies less than 5 kg, it is recommended that the dose of 2mg/kg/dose (A) & 12mg/dose/kg (L) be used. This will amount to half of one tablet. These very small infants should be treated under medical supervision as malaria is not a common cause of fever in this age group and so they should be properly investigated.

Table 2b: Primaquine tablets for first line treatment of uncomplicated *vivax* malaria by weight

Primaquine						
Days and doses	**Weight (Kg)**					
	10 – 14.9	**15 – 19.9**	**20 – 29.9**	**30 – 39.9**	**40 – 49.9**	**50 +**
Once a day, for 14 days	½ tab	½ tab	1 tab	1 tab	1 ½ tabs	2 tabs

Second line treatment for uncomplicated *P. falciparum, P. vivax, P. ovale* and *P. malariae* infections

The drug of choice is dihydroartemisinin-piperaquine (DP). The fixed dose combination contains 40mg of dihydroartemisinin and 320mg of piperaquine.

The dose is 2.1mg/kg of dihydroartemisinin and 17.1mg/kg of piperaquine, daily for 3 days. Refer to Table 7 for dosage.

For *vivax* and *ovale* infections, primaquine should be administered for 14 days after the completion of DP course.

3.4.1.2 Treatment schedule of *P. falciparum, P. vivax, P. malariae* and *P. ovale* malaria in pregnancy

First line treatment for uncomplicated malaria in pregnancy

First trimester of pregnancy:

Quinine plus Fansidar

Quinine tablets at 10mg/kg per dose every 8 hours for 7 days and Fansidar *stat* dose (see table 3a, on the next page).

- Quinine tablets (300mg base)
  - Small adults (< 50kgs) 400mg, 1.5 tabs tds for 7 days
  - Large adults (≥ 50kgs) 600mg, 2 tabs tds for 7 days, and
- Fansidar a single dose (two tablets irrespective of the weight of the pregnant woman) on the first day.

Second and third trimester of pregnancy:

The drug of choice is AL, bd for three days, according to weight (see Table 2a).

Second line treatment for uncomplicated malaria in pregnancy

All trimesters:

Oral quinine plus Fansidar.

- Quinine (300mg base)
  - Small adults (< 50kg) 400 mg, 1.5 tabs tds for 7 days
  - Large adults (≥ 50kg) 600 mg, 2 tabs tds for 7 days
- Fansidar a single dose (two tablets irrespective of the weight of the pregnant woman) on the first day.

(See Table 3a)

Primaquine is contraindicated during pregnancy and until 6 weeks after delivery.

Table 3a: QN and Fansidar tablets for first line treatment in pregnancy

Weight (kg)	QN				Fansidar		
	Formulation	Tabs/ dose	Total tabs/ day	Duration	Formulation	Tabs single dose	Total tabs
50<	300 mg/tab	1.5	4.5	7 days	500 mg of sulfadoxine and 25 mg of pyrimethamine/ tab	2	2
≥50		2	6	7 days		2	2

3.4.2 Severe/complicated malaria

3.4.2.1 Treatment schedule for children and adults

First line treatment for severe *P. falciparum* and *P. vivax* infections

Artesunate injections (IV or IM) or artemether IM (See Table 5) is first administered and then followed by a full course of AL when patients can tolerate oral therapy. Even when patients are able to tolerate oral therapy, they should continue intravenous treatment for another 24 hours before switching to oral therapy.

Dosage of artesunate (AS) IV or IM

AS injection 60 mg, dose 2.4 mg/kg per dose

Although the dosage in mg is the same for IV and IM use, the concentration of the mixtures is different because of the different ways in which the mixtures are prepared.

- For IV use, the mixture is 60mg in 6ml;
- For IM use, the mixture is 60mg in 3ml;

For preparation of artesunate injection, (see below).

Commence AS IV/IM, 2.4mg/kg per dose (see Table 2a).

Give a dose on admission, the next dose 12 hours later and then one dose daily.

Give for a minimum of 2 doses and continue until the patient can swallow, then complete full course of AL (see Table 1).

Preparation of artesunate injection

Each pack of artesunate injection should contain:

- artesunate 60mg vial.
- sodium bicarbonate 1ml.
- sodium chloride 5ml.

Artesunate powder for injection is difficult to dissolve and care must be taken to ensure that it is completely dissolved before IV or IM use.

For intravenous use:

- Add 1ml of sodium bicarbonate to the artesunate powder for injection. SHAKE WELL until the solution becomes clear.
- Add 5ml of sodium chloride and SHAKE WELL again.
- This gives a concentration of 60mg in 6ml.
- The required amount should be given by slow IV injection over 2 - 3 minutes.

For intramuscular use:

- Add 1ml of the sodium bicarbonate to the artesunate powder for injection and SHAKE WELL until the solution becomes clear.
- Add 2ml of the sodium chloride and SHAKE WELL again.
- This gives a concentration of 60mg in 3ml.

Important points when using artesunate injection.

- The prepared artesunate injection should always be used immediately.
- Partially used vials should be discarded.
- If the solution is cloudy or a lump is present, it should be discarded.
- After giving AS injections, all the needles, vials, syringes must be discarded in a sharps disposable bin.

Second line treatment for severe *P. falciparum*, and *P.vivax* malaria

The indications for second line treatment are:

- treatment failure of the ACT, or
- allergy to the ACT.

The drug for second line treatment is a quinine injection followed by quinine tablets plus doxycycline (3.5mg/kg body weight daily for 7 days) when the patient is able to swallow. The formulation of quinine for adults is 600mg in 10ml ampoule. The first dose should be administered as a loading dose (LD) and after 12 hours start the maintenance dose (MD).

Continue administering maintenance doses at specified intervals of 8 hours after start of previous MD until patient can take oral treatment. Quinine injection should be given in 5% dextrose drip to avoid hypoglycaemia. When a patient can take oral treatment, give quinine tablets (Refer to *Standard Treatment Book* for dosages).

Dosages

Quinine 600mg in 10ml injection.

- Loading dose (LD): IM 20mg/kg, or IV 20mg/kg given over 4 hours, infused slowly.
- Maintenance dose (MD): IM 10mg/kg, or IV 10mg/kg given over 2 hours, infused slowly.
  - Children: give MD 12 hours after START of LD.
  - Adults: give MD 8 hours after START of LD.
- Continue giving MD at specified intervals of 8 hours after START of previous MD until patient can take oral treatment.

When the patient can swallow, give QN tablets at 10mg/kg every 8 hours for 7 days plus **doxycycline** tablets (3.5mg/kg of body weight daily, 200mg/day for adults for 7 days).

3.4.2.2 Severe malaria in pregnancy

First trimester of pregnancy

Artesunate injection (IV/IM) is first applied daily for 7 days (see Table 4) or Quinine injection (IV/IM) (see Table 8), followed by quinine tablets; plus Fansidar (two tablets, irrespective of the patient's body weight), when the patient is able to swallow.

Second and third trimester

First option – artesunate (IV/IM) injections for 7 days (see Table 4).

Second option – artemether (IM) injection for 7 days (see Table 5).

Third option - quinine injection (IV/IM) (see Table 8).

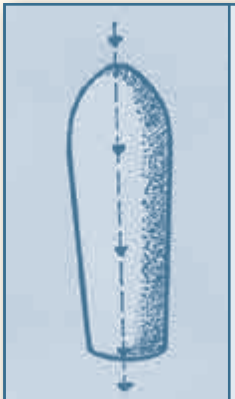
All options should be followed by quinine tablets plus Fansidar (two tablets db for three days, irrespective of the patient's body weight) when the patient is able to swallow.

3.4.3 Pre-referral medication

In the event of a severe malaria patient who needs to be referred to a hospital urgently, you can administer an artesunate suppository while waiting for transportation. The dose of the artesunate suppository is 10mg/kg body weight administered once (see Table 6). The suppositories are available in 50mg and 200mg sizes, but sometimes you may have to cut the suppository in half before inserting.

If immediate referral is not possible, you can insert another suppository after 24 hours and then continue AS suppository daily until referral becomes possible, or if the patient is able to swallow, start a full course of AL.

In the case of adults, it may be necessary to insert 3 or 4 suppositories as a single dose. In this instance, insert one suppository and wait at least 10 minutes before inserting another.



- Wash hands.
- Put on gloves.
- Remove the suppository from its package and place on a clean surface.
- Using forceps, hold the suppository in the horizontal position.
- Using a clean/sterile blade, cut on the long axis of the suppository to get equal halves.
- Administer half of the suppository as required and discard unused half.

If the suppository is expelled within 10 minutes, insert another one. Prevent this by holding the buttocks of children together for 10 minutes after insertion.

Artesunate suppositories will be available in health centres and hospitals.

For severe malaria in aid posts and sub health centres, give artesunate (AS) suppositories and refer to the nearest health centre or hospital.

3.4.4 Malaria prophylaxis

3.4.4.1 Chemo-prophylaxis in pregnancy

Intermittent Preventive Treatment in pregnancy with Fansidar

Intermittent Preventive Treatment in pregnancy (IPTp) is the administration of a single curative dose of an efficacious anti-malarial drug at least twice during pregnancy, regardless whether or not the woman is infected. Intermittent Preventive Treatment in pregnancy with Fansidar (IPTp-SP) refers to the administration of Fansidar (See Table 3b).

Table 3b: Standard course for intermittent preventive treatment of malaria in pregnancy with Fansidar

Drugs	Daily dose (tabs)	Duration of treatment	Total tablets
Sulphadoxine 1500mg and Pyrimethamine 75mg	3 tabs in single dose	Repeated 3 times (at first ANC visit, 2nd and 3rd trim.)	9

The first dose should be administered after quickening, or after 18 -20 weeks. Following doses should be given at least one month apart. IPTp-SP doses should not be given more frequently than monthly.

HIV-infected pregnant women in malaria endemic areas who are already receiving cotrimoxazole prophylaxis should not receive IPTp-SP.

3.4.4.2 Prophylaxis for travellers

Queries on malaria prophylaxis for travelling in PNG and abroad should be addressed to the Malaria and Vector-borne Disease Control Unit, Disease Control Branch, National Department of Health.

For inbound travellers, the options are:

Malarone

- Malarone is a fixed-dose combination of atovaquone 250mg + proguanil hydrochloride 100mg in a tablet. Take 1 tablet daily beginning 1–2 days before exposure, throughout exposure, and continuing for 7 days after departure from the malaria risk area.

Doxycycline

- 100mg daily tablet of a monohydrate doxycycline salt for adults. Start taking doxycycline 1 day prior to travel and continue for 4 weeks after departure from malarious areas.

The WHO website should be consulted for more information.

IMR officers conducting a malaria survey

3.4.5 Dosages for anti-malarials

Table 4: Artesunate injections (ml) for 1st line treatment of severe *falciparum* malaria by weight

Formulation	Days & doses	Dose in ml	Weight (kg)							
			3 – 5.9	6 – 9.9	10 – 14.9	15 – 19.9	20 – 29.9	30 – 39.9	40 – 49.9	50+
IV 60mg in 6ml	Day 1: 1st dose & 2nd dose (12h)	Dose in ml	1	2	3	4	6	8	10	12
	Day 2: onwards once a day	Dose in ml	1	2	3	4	6	8	10	12
IM 60mg in 3ml	Day 1: 1st dose & 2nd dose (12h after)	Dose in ml	0.5	1	1.5	2	3	4	5	6
	Day 2: onwards once a day	Dose in ml	0.5	1	1.5	2	3	4	5	6

Table 5: Artemether injections (ml) for treatment of severe *falciparum* malaria by weight (artemether 80mg/ml)

		Weight (kg)							
		3 – 5.9	6 – 12.9	13 – 18.9	19 – 24.9	25 – 30.9	31 – 36.9	37 – 43.9	>44
Day 1	Dose in ml	0.25	0.5	0.75	1	1.25	1.5	1.75	2
Day 2 – 7	Dose in ml	0.25	0.25	0.5	0.5	0.75	0.75	1	1

Table 6: Artesunate suppository for pre-referral treatment by weight

	Weight (kg)							
Formulation	**3 – 5.9**	**6 – 9.9**	**10 – 14.9**	**15 – 19.9**	**20 – 29.9**	**30 – 39.9**	**40 – 49.9**	**50+**
50mg	1/2	1	2	2	-	-	-	-
200mg	-	-	-	-	1	1.5	2	4

For children with body weight lower than 3kg , malaria is not common, other causes of fever must be fully investigated and managed before suspecting malaria in the first instance.

Table 7: Number of DP tablets for second line treatment of uncomplicated *falciparum* malaria by weight

	Weight (kg)								
	<5	**6 – 10.9**	**11 – 20.9**	**21 – 30.9**	**31 – 40.9**	**41 – 45.9**	**46 – 55.9**	**56 – 65.9**	**66 & above**
Day 1	¼	½	1	1.5	2	2.5	3	3.5	4
Day 2	¼	½	1	1.5	2	2.5	3	3.5	4
Day 3	¼	½	1	1.5	2	2.5	3	3.5	4
Total	¾	1.5	3	4.5	6	7.5	9	10.5	12

Table 8: Quinine injections (ml) for second line treatment of severe *falciparum* malaria by weight

	Weight (kg)							
Quinine	**3 – 5.9**	**6 – 9.9**	**10 – 14.9**	**15 – 19.9**	**20 – 29.9**	**30 – 39.9**	**40 – 49.9**	**50+**
LD (20mg Salt/kg)	1	2	4	5	8	10	15	20
MD (10mg salt/kg)	0.5	1	2	2.5	4	5	7.5	10

Table 9: QN and Fansidar tablets for second line treatment of severe *falciparum* malaria by weight

Weight (kg)	QN				Fansidar		
	Formulation	Tabs/ dose	Total tabs/ day	Duration	Formulation	Tabs single dose	Total tabs
50<	300 mg/tab	1.5	4.5	7 days	500 mg of sulfadoxine and 25 mg of pyrimethamine/ tab	2	2
≥50		2	6	7 days		2	2

Artwork courtesy of PSI

Key Learning Points

Anti-malarial drugs and treatment

- *The prevelance of drug resistant falciparum malaria has increased in some countries, including PNG.*
- *Many malaria endemic countries in the world that have experienced drug resistance have changed their treatment guidelines to introduce ACT. In 2010 PNG will also change its treatment protocol to include ACT.*
- *AL should be administered only after a malaria diagnosis is confirmed.*
- *AL is the new treatment for malaria. It is given bd for 3 days. The second dose must be given 8 hours after the first dose.*
- *AL needs to be taken with fatty food to aid the absorption of lumefantrine.*

First line drugs:

- *AL for uncomplicated falciparum malaria.*
- *Artesunate or artemether injection followed by AL for severe malaria (both vivax and falciparum).*
- *AL plus primaquine for uncomplicated vivax malaria.*
- *Quinine plus Fansidar for 1st trimester and AL for 2nd and 3rd trimester of pregnancy.*

Second line drugs:

- *Dihydroartemisinin-piperaquine(DP) for uncomplicated falciparum malaria.*
- *Quinine plus doxycyline for severe malaria (both falciparum and vivax).*
- *DP plus primaquine for uncomplicated vivax malaria.*
- *Quinine tablets plus Fansidar for 1st, 2nd and 3rd trimesters.*

Activity 3.4

Treatment of Malaria

Answer the following questions;

1. What is the treatment for simple/uncomplicated malaria in PNG? How would you prescribe AL, and in what dosages and regime?
2. Look at different colour packs and write down the number of tablets to be given in each dose, how often, and how many days according to the weight of the patient.
3. Can a mother breastfeed while on AL?
4. A pregnant woman in her first trimester who is 48kgs in weight comes to your clinic with uncomplicated malaria. How would you treat this person?

3.5 Data collection of malaria cases, RDT and AL reporting

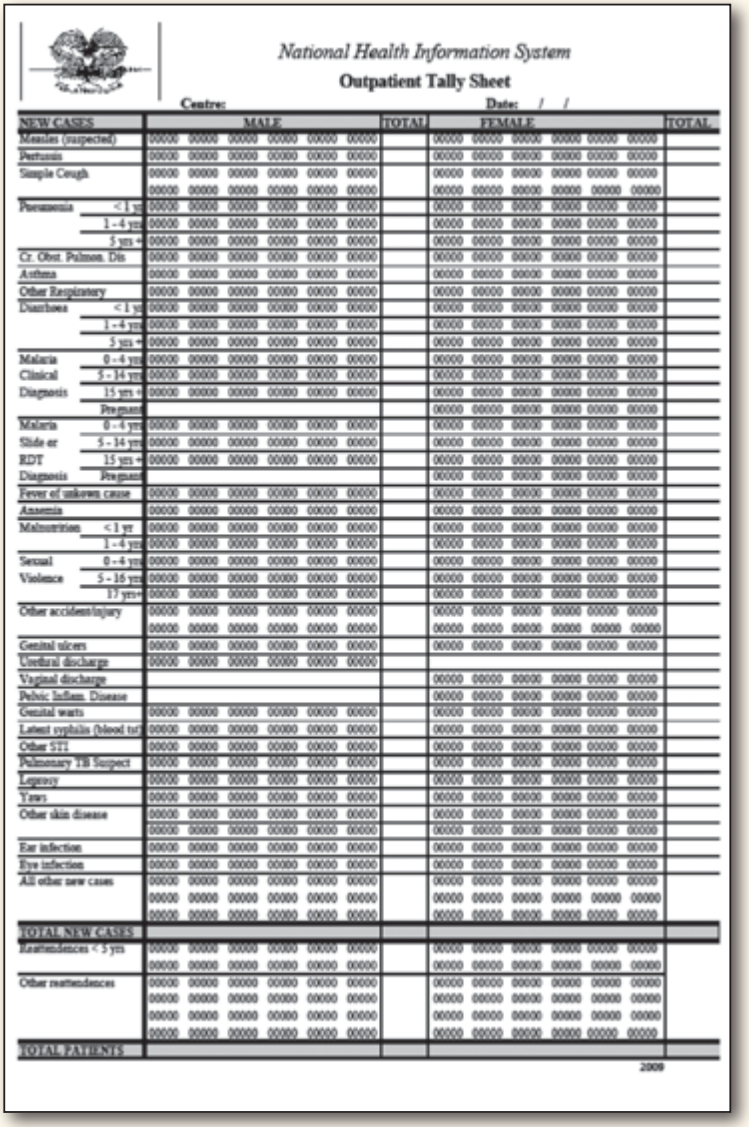
Reporting of malaria cases, and the use of RDT and AL, is essential and is required by the National Department of Health (NDOH). Information about malaria cases should be collected by aid posts and health centres on a daily basis on tally sheets and registers. A monthly form is used to collate the information from all the health facilities, and this form is then sent to the National Department of Health through the Provincial Health Information Officer.

Accurate reporting provides reliable information that can be used by NDOH to plan for malaria control programmes in the country. This information also ensures that the correct amount of drugs and tests are ordered. At the local level, the information can assist health managers to plan malaria control activities in their health catchment areas. It can also provide data for managers to take control of their stock and better manage the stock of drugs and supply, so that they are not short of supplies or over stocked (resulting in expiry of items and wastage).

There are three National Health Information System (NHIS) forms that need to be regularly filled in. All these forms record significant information about malaria cases:

Malaria testing in the village. (Courtesy of PNGIMR)

The Outpatient Tally Sheet – This needs to filled in on a daily basis by all health facilities. This form not only records malaria cases but also records the incidence of other diseases.



National Health Information System

Outpatient Tally Sheet

Centre: Date: / /

NEW CASES		MALE	TOTAL	FEMALE	TOTAL
Measles (suspected)		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Pertussis		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Simple Cough		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Pneumonia	< 1 yr	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	1 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	5 yrs +	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Cr. Obst. Pulmon. Dis		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Asthma		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Other Respiratory		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Diarrhoea	< 1 yr	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	1 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	5 yrs +	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Malaria	0 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Clinical	5 - 14 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Diagnosis	15 yrs +	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	Pregnant			00000 00000 00000 00000 00000 00000	
Malaria	0 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Slide or	5 - 14 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
RDT	15 yrs +	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Diagnosis	Pregnant			00000 00000 00000 00000 00000 00000	
Fever of unkown cause		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Anaemia		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Malnutrition	< 1 yr	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	1 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Sexual	0 - 4 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Violence	5 - 16 yrs	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
	17 yrs+	00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Other accident/injury		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Genital ulcers		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Urethral discharge		00000 00000 00000 00000 00000 00000			
Vaginal discharge				00000 00000 00000 00000 00000 00000	
Pelvic Inflam. Disease				00000 00000 00000 00000 00000 00000	
Genital warts		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Latent syphilis (blood tst)		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Other STI		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Pulmonary TB Suspect		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Leprosy		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Yaws		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Other skin disease		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Ear infection		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Eye infection		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
All other new cases		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
TOTAL NEW CASES					
Reattendences < 5 yrs		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
Other reattendences		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
		00000 00000 00000 00000 00000 00000		00000 00000 00000 00000 00000 00000	
TOTAL PATIENTS					

2009

The Health Facility Malaria Register – This form also needs to be filled in on a daily basis by all health facilities. It records the age and sex of the patient, as well as the type of test given, the result and the treatment prescribed. At the end of each month, the data is added up and used to complete page 2 of the NHIS Monthly report form.

National Health Information System

Health Facility Malaria Register

Province : ______________ Facility : ______________

District : ______________ Month/Yr : ______________

NO.	DATE	AGE	SEX	Diagnostic Tool Used	T. Result	Treatment (Full Course)
Total No. of Patients						

Explanatory Notes :

(1) The type of test used to confirm malaria cases eg. Blood Slide , RDT or Clinical Diagnosis
(2) State type of result eg. Pf, Pv, Po, Pm, Pf/mix, Neg or no Result (NR)
(3) State type of result eg. Pf, Pv, Po, Pm, Pf/mix, Neg or no Result (NR)

At the end of each calendar month, add up the number of people receiving ACT course and record on page 2 of the NHIS Monthly Report.

2009

The Monthly Report – this form collates all the information collected from aid posts and health centres. Collecting the information is essential as this is the only way that the NDOH can monitor the numbers of ACTs and RDTs used in the country, and ultimately, assess the effectiveness of the new *Malaria Treatment Protocol*;

The **first page** of the Monthly Report requires information on the disease patterns in the area. For malaria, the data that should be filled in are:

- Malaria cases diagnosed: clinically, by slide or by RDT;
- Age groups of the patients: 0 – 4 yrs; 5 – 14 yrs; 15 yrs and above, and pregnant women;
- The sex of the patient;
- Outpatient or inpatient.

The **second page** requires information on significant diseases - malaria, tuberculosis, leprosy, and HIV. For malaria, the information to be filled in comes under the following categories:

- Diagnosis by microscopy and RDT.
- By sex.
- Type of infection by parasitic species.
- By age groups: 0 – 4 yrs; 5 – 14 yrs; 15 yrs and above.
- Number of ACTs administered; a) outpatients and b) inpatients.

The **third page** provides information on maternal and child health services, school health and immunisation. This page does not concern malaria reporting.

The **fourth and last page** provides information on the management of the health facility, especially the storage of medical supplies and drugs. For malaria, the data required is as follows:

- The stock of anti-malarials held, especially chloroquine, quinine injections, primaquine, Fansidar, amodiaquine.
- ACT and RDT kits.

National Health Information System

Monthly Report

Health Facility | *District* | *Month/Year*

Aidposts

No. of aidposts open

No. of aidposts visited

Outpatients		**Male**	**Female**
Measles (suspected)			
Pertussis			
Simple Cough			
Pneumonia	< 1 yr		
	1 - 4 yrs		
	5 yrs+		
Chr. Obst. Pulmon. Dis.			
Asthma			
Other Respirat(			
Diarrhoea	< 1 yr		
	1 - 4 yrs		
	5 yrs+		
Malaria	(Clinical Diagnosis)		
	0 - 4 yrs		
	5 - 14 yrs		
	15 yrs+		
	Pregnant		
	or (Slide or RDT diagnosis)		
	0 - 4 yrs		
	5 - 14 yrs		
	15 yrs+		
	Pregnant		
Fever of unknown cause			
Anaemia			
Malnutrition	< 1 yr		
	1 - 4 yrs		
Sexual violence			
	0 - 4 yrs		
	5 - 16 yrs		
	17 yrs+		
Other accident/injuries			
Genital ulcers			
Urethral discharge			
Vaginal discharge			
Pelvic Inflam. Disease			
Genital warts			
Latent syphilis (blood tst)			
Other STI			
Pulmonary TB suspect			
Leprosy			
Yaws			
Other skin disease			
Ear infections			
Eye Infections			
All other new cases			
Total new cases			
Reattendances < 5 yrs			
Other reattendances			
Total reattendances			
Total attendance			

Inpatients		**Discharges**		**Deaths**	
		Male	**Female**	**Male**	**Female**
Diphtheria					
Neonatal Tetanus					
Acute Flaccid Paralysis					
Measles (suspected)					
Pertussis					
Neonatal Sepsis					
Pneumonia	< 1 yr				
	1 - 4 yrs				
	5 yrs+				
Chr. Obst. Pulmon. Dis.					
Other Respiratory I					
Diarrhoea	< 1 yr				
	1 - 4 yrs				
	5 yrs+				
Malaria	(Clinical diagnosis)				
	0 - 4 yrs				
	5 - 14 yrs				
	15 Yrs+				
	Pregnant				
	or (Slide or RDT diagnosis)				
	0 - 4 yrs				
	5 - 14 yrs				
	15 Yrs+				
	Pregnant				
Anaemia					
Malnutrition	< 1 yr				
	1 - 4 yrs				
All accidents/injuries					
Typhoid					
TB					
Leprosy					
Meningitis	<1 yr				
	1 - 4 yrs				
	5 yrs+				
Snakebite					
Skin disease					
HIV/AIDS	< 5 yr				
	5 - 14 yrs				
	15 - 24 yrs				
	25yrs+				
Ischaemic heart disease					
Cancer					
Hypertension					
Diabetes					
Other discharges/deaths					
Patients absconded					
Patients transferred out					
Total discharges/deaths					

All deaths occuring in the facility should be recorded

NHIS 2009

Page 2

Malaria diagnosis

Microscopy

Male	**0 - 4 Yrs**	**5 - 14 Yrs**	**15 Yrs+**
P. falciparum			
P. vivax			
P. malariae			
Mixed			
No. of slides examined			

Female	**0 - 4 Yrs**	**5 - 14 Yrs**	**15 Yrs+**
P. falciparum			
P. vivax			
P. malariae			
Mixed			
No. of slides examined			

Rapid Diagnostic Test

Male	**0 - 4 Yrs**	**5 - 14 Yrs**	**15 Yrs+**
P. falciparum			
P. vivax			
P. malariae			
Failed			
No. tested			

Female	**0 - 4 Yrs**	**5 - 14 Yrs**	**15 Yrs+**
P. falciparum			
P. vivax			
P. malariae			
Failed			
No. tested			

No. of Artemisinin combination (ACT) courses commenced (Outpatient)	
No. of Artemisinin combination (ACT) courses commenced (Inpatient)	

Leprosy

	PB	**MB**
Total new cases		
Child <15 yrs new case		
Disability Gr.2 new case		
Female new cases		

Finishing treatment this month

Treatment Completed		
Lost (includes default)		
Died		
Relapse		
Transferred out		
Total registered cases		

HIV Testing

	Tested		**HIV+**		**Referred Treatment**	
	Male	**Female**	**Male**	**Female**	**Male**	**Female**
Antenatal						
0 - 4 Yrs						
VCT						
Donor						
STI						
TB						
Others						

No. of patients currently on HIV treatment

	Male	**Female**
< 5 yrs		
5 - 14 yrs		
15 - 24 yrs		
25 yrs+		

Tuberculosis

No. of new TB patients of all types detected in the month	
No. of retreatment TB patients of all types detected in the month	

If the facility has any TB patients, be sure to complete the TB reporting each quarter.

Page 3

Clinics

	Planned	Held
Number of outreach clinics		
Static clinics		
Day mobile clinics		
Overnight clinics/patrols		

School health

Total no. of schools	
School visits planned	
No. of schools visited	
School entry T. Toxoid	
School leaving T. Toxoid	

Family Planning By Centre *(including clinics and outreach)*

	New	Re-accept
Brst fd pill		
Com. Pill		
Injection		
Ovulation		
Condom		
Loop/IUD		
Permanent T/ligation		
Vasectomy		
Referred		

Family Planning By Aidpost

	New	Re-accept
Brst fd pill		
Com. Pill		
Injection		
B Ovulation		
Condom		
Loop/IUD		
Permanent Vasectomy		
Referred		

Antenatal Care

1st Visit	
4th Visit	
Other	
1st dose Tet. Toxoid	
2nd dose Tet. Toxoid	
Booster	

Deliveries

Deliveries in health facility	
Deliveries with complications	
Transferred to hospital *(for pregnancy or delivery complications)*	
Birth weight <2500 gram	
Still births	
Maternal deaths (in facility)	
Maternal deaths (not in facility)	
Born before arrival	
Village births attended	
Village births with complications *(including unattended deliveries)*	(excluding deaths)

Well Baby Clinic

Child Attendances	New	Reattend
< 1 yr		
1 - 4 yrs		

Nutrition

< 1 yr	< 60 %	
	60 - 80 %	
	> 80 %	
1 - 4 yrs	< 60 %	
	60 - 80 %	
	> 80 %	

Immunization by Centre (including clinics and outreach)

BCG	Within 24 hrs of birth	
	< 1 Week	
	> 1 Week	
Hepatitis B	Within 24 hrs of birth	
	> 24 hrs	
DTP /Hib (Hep B)	1st dose < 1 yr	
	2nd dose < 1 yr	
	3rd dose < 1 yr	
	> 1 yr	
Sabin	1st dose < 1 yr	
	2nd dose < 1 yr	
	3rd dose < 1 yr	
	> 1 yr	
Measles	6 - 8 Months	
	9 - 11 Months	
	> 1 yr	
Vitamin A	6 Months	
	12 Months	
	> 1 yr	

Immunization done by Aidposts

BCG	Within 24 hrs of birth	
	< 1 Week	
	> 1 Week	
Hepatitis B	Within 24 hrs of birth	
	> 24 hrs	
DTP/Hib (Hep B)	1st dose < 1 yr	
	2nd dose < 1 yr	
	3rd dose < 1 yr	
	> 1 yr	
Sabin	1st dose < 1 yr	
	2nd dose < 1 yr	
	3rd dose < 1 yr	
	> 1 yr	
Measles	6 - 8 Months	
	9 - 11 Months	
	> 1 yr	
Vitamin A	6 Months	
	12 Months	
	> 1 yr	

Report all maternal deaths here, even if they occur in the village and complete a maternal death investigation form.
Send one copy of the maternal death investigation form to the Provincial Information Officer with your Monthly Report
All deaths in the facility, excluding still births, should be recorded on page 1 and in the discharge register.

Page 4

Shortage in the month: Circle any item with nil stock for at least a week

FP	Oral Pills	**CDD**	ORS	**Antibiotics**	Amoxicillin tabs
	Injection		HS Darrows		Amoxicillin caps
	Condoms				Chloramphenicol inj.
					Crystalline penicillin inj.
Maternal Health	Ergometrine	**TB**	Rifampicin		Co-trimoxazole
	Oxytocin		Isoniazid		
	Lignocaine		Ethambutol	**Malaria**	Chloroquine
	Iron/Folic		Pyrazinamide		Quinine injection
			Streptomycin		Primaquine
			Category 1 kits		Fansidar
Vaccine	BCG		Category 2 kits		Amodiaquine
	HEP B				Artemisinin combination
	Vitamin A	**General**	Paraldehyde		RDT test kit
	Sabin		Salbutamol		
	DTP/Hib		Pethidine	**Information System**	Tally sheets
	Measles		Oxygen		Daily summary book
	Tet. Toxoid		Paracetamol elixir		Health centre record
			Albendazole		Monthly report
HIV/AIDS	ART		Tinidazole		Quarterly TB report book
	Test kit				
				Family health	Baby/scale book
					Mother's health book

Other items (stock-out)

Supervision *Record the number of supervisory visits you have received this month*

Doctor	PHO	PDCO	Maternal/ child health	Chrch health secretary	Other

General *Use the space below for any other points you wish to raise with your DHO or PHO.*

Officer in Charge | **Signature** | **Date**

Activity 3.5

Reporting

1. In your groups discuss the difficulties experienced in the reporting of malaria cases, RDT, and AL, using the three NHIS forms. Report your findings to the main group.
2. Why is it important to report the number of slides examined and the number of RDTs used, and the number of AL courses commenced?
3. What information about malaria do you have to fill in on page 2 of the NHIS Monthly Report?
4. When and to whom should you send the NHIS Monthly Report?

Key Learning Points

Data collection of malaria cases, RDT, AL and reporting

- *Data for the National Health Information System Monthly Report must be collected and filled in accurately.*
- *The NHIS Outpatient Tally Sheet and the NHIS Health Facility Malaria Register must be completed daily.*
- *Completed NHIS Monthly Report forms must be submitted to the Provincial Health Information Officer at the Provincial Health Office.*
- *Accurate information.*
- *Minimises drug wastage caused by over stocking.*
- *Decreases mortality and morbidity by having drugs available when needed by patients.*
- *Allows better planning of health services.*
- *Enables NDOH to assess the effectiveness of their malaria control programmes.*

4. IMCI and Prevention of Malaria

Topic outcome

On completion of the topic you will be able to:

- describe the algorithm of IMCI, including malaria diagnosis;
- explain the different methods of malaria prevention;
- describe how treated bed nets could be effectively deployed and maintained during their life.

4.1 Management of childhood illness

The following guidelines and fever flowchart have been provided by the PNG Paediatric Society.

IMCI stands for Integrated Management of Childhood Illness. *The IMCI Checklist for ALL sick children* was developed by Department of Health and WHO and has been used in PNG for the last couple of years to classify childhood illnesses, assess their severity and decide on the management of a sick child. It is important to follow the sequence of the *Checklist* so that **no steps** are missed and the child is correctly diagnosed and treated.

The IMCI concept was developed to address the common conditions that are responsible for high morbidity and mortality of children in Papua New Guinea.

Activity 4.1

IMCI Checklist

1. Describe how to diagnose a child with malaria using the *IMCI Checklist*.
2. Why is it important to use the *IMCI Checklist*?

The diseases and conditions that can be identified using the *IMCI Checklist* are as follows: danger signs (known as "TOO SICK" signs), pneumonia, diarrhoea and dehydration, meningitis, malaria, measles, anaemia, otitis media, malnutrition and others.

The *Checklist* also provides an opportunity to check the immunisation history of the child and provides information for the health workers on how to counsel and do health education for the carer of the sick child.

Guidelines for using the *IMCI Checklist*:

Step 1 – TOO SICK signs:

- Always start at Step 1 when assessing a sick child. It is the most important step because it decides the severity of the condition and whether the child needs immediate treatment and referral.

Step 2 – Cough or difficult breathing:

- If the child is coughing and has difficulty in breathing, check the respiratory rate and for chest indrawing; decide if the child has pneumonia then assess its severity and treat accordingly.

Step 3 – Diarrhoea:

- If the child presents with diarrhoea, check for dehydration and dysentery and decide on the degree of dehydration and treat accordingly.

Step 4 – Fever:

- Fever is a common presenting sign of many infections, including malaria, meningitis, typhoid, urinary tract infection, infected sores or abscesses and others. It is important to classify the fever as some conditions, such as malaria and meningitis, have high fatality rates for children in PNG.
- Not only is the mortality high, but the morbidity from these conditions is also high. Repeated attacks of malaria and other infections contribute to anaemia and malnutrition. Meningitis may also cause brain damage leading to permanent disabilities if the proper treatment is delayed or not given.
- If health workers remember to check all children with fever for meningitis and malaria, early treatment can be provided and many deaths due to these conditions can be prevented.

- **Not all fever cases are due to malaria.** It is important to change our perception about fever cases as indiscriminate use of the new malaria drug (AL) will increase the probability of resistance to the new malaria treatment, and expose the child to the side effects of unnecessary therapy. These drugs are also expensive, and unnecessary use should be avoided. Therefore, fever cases must be carefully assessed for other causes and the diagnosis of malaria must be supported by either a Rapid Diagnostic Test (RDT) or a blood slide for malaria.
- Note that if a child with **fever** or with a **history of fever** presents with "TOO SICK" signs or "stiff neck" you have to classify such a child as having *Meningitis, Severe Malaria or Other Serious Febrile Disease*. Meningitis and *Plasmodium sp*. parasitaemia can overlap, and missing treatment for meningitis can be life threatening in these circumstances.
- Therefore, children with a clinical classification of *Meningitis, Severe Malaria or Other Serious Febrile Disease* need to be treated as meningitis and severe malaria, regardless of the results of the malaria test. In some cases, an RDT can give a false negative result in children with malaria as they are not 100% sensitive. As a child's condition can deteriorate very quickly, and the child may die if appropriate treatment is delayed, you do not have to do an RDT test.
- However, in all other fever cases, the health worker should use an RDT or microscopy to diagnose malaria and to decide on appropriate anti-malarial treatment.
- Note that at the hospital level, where diagnostic facilities are better, doctors can decide about differential diagnosis between meningitis and severe malaria. However, at the aid post or health centre level, where any mistake or delay in appropriate treatment can have fatal consequences for the sick child, such an approach is not recommended.

PNGIMR Nursing Officer taking a blood sample during a malaria prevalence survey.

Assess – ask & listen

- If a child has **fever** (by history, feels hot or has a temperature above 37.5ºC) assess the child for signs related to fever.
- Ask how long the child has had the fever.
- If possible, do an RDT or take a blood slide for malaria.

Assess – look & feel

- Look for signs of meningitis and malaria. Does the child have a stiff neck? Assess the child by gently bending the neck with a hand under the child's head, while the child is at rest and lying down. It is likely that a child with meningitis will feel pain and resist this movement.
- Neck stiffness is often not present in young infants with meningitis. In these children, check and feel for a bulging fontanelle.
- In an older child, if they are alert and cooperative, they will be able to respond to objects moved up and down in front of their eyes and show normal head movements if there is no stiff neck.

Classify – action

- Determine the cause of the fever. Decide whether the child is suffering from:
- **meningitis/severe malaria** (red classification),
- **uncomplicated malaria** (yellow classification) or,
- **malaria unlikely - other causes of fever** (green classification).

Use the fever flowchart (below) to decide on the classification and the treatment required.

In case of children without a stiff neck and "TOO SICK'' signs, do an RDT or blood slide for malaria if possible, to help you decide on the treatment. The RDT will be regarded as positive if it shows either *P. falciparum* malaria, non-*P. falciparum* malaria or mixed infections.

There are three classifications of malaria in Step 4. These are listed in the table on the next page.

Assess – Signs	Classify	Action
• Any of the "TOO SICK" signs and/or stiff neck	**Meningitis, severe malaria or other severe febrile disease** → **Yes**	• Give first dose of chloramphenicol IM or ceftriaxone IM and, • Give artesunate IV/IM or artemether IM or artesunate suppository • Give sugared water and encourage continued feeding • Admit or refer urgently
No → • None of the signs above and • Malaria test positive or • Malaria test is not available	**Uncomplicated malaria** → **Yes**	• Give AL tablets • Give first dose of paracetamol, if temperature is 38ºC or more • Treat other causes of fever appropriately, if present • Continue treatment at home • Ask mother to come back in 3 days if fever persists • Advise mother when to return immediately if the child's condition deteriorates • If fever persists during the follow up visit for more than 7 days, refer for assessment
No → • None of the signs above and • Malaria test is negative	**Malaria unlikely, other causes of fever** → **Yes**	• **Do not give AL** • Give first dose of paracetamol, if temperature is 38ºC or more • Treat other causes of fever, if present, with appropriate drugs • Advise mother when to return immediately if the child's condition deteriorates • Ask the mother to come back in 3 days for follow up • If fever persists for 3 days, give AL • If fever persists for more than 7 days, refer for further assessment

Note: <u>If the result of the RDT is positive</u> during the initial visit, do not repeat the test during the follow up visits because parasite antigens will still be present in the blood up to 14 days after the initial test and treatment.

After Step 4:

Follow the other steps in the *IMCI Checklist* (ear problem, measles and others). You should assess all children that do not need an urgent referral for anaemia and malnutrition. If the child is not referred, remember to weigh all the children and plot the weight on the graph and assess the growth curve of the each child. The children also should be checked for immunisation status.

- When all the steps have been completed, they need to be summarised; you need to start with the most severe condition and determine the treatment and other actions.
- Write the summary in the child's Health Record Book.

An updated version of the *IMCI Checklist* is in preparation, and will include guidelines for treating falciparum and non-falciparum malaria based on the RDT result, and also detail when primaquine can be used as part of the treatment of malaria in children.

You will learn more about diagnosis and treatment of malaria in children during your local IMCI training.

4.2 Different methods for malaria prevention

Malaria control activities have employed various strategies to prevent malaria transmission. These strategies have targeted both the mosquito and the parasites.

Common malaria prevention methods include:

- Treatment of sick people. Successful treatment of sick people helps prevent parasite transfer from humans to mosquitoes. During a malaria epidemic in places where malaria is not endemic, mass fever treatment may be used if directed by the appropriate health authorities. Special groups, such as pregnant women, are given prophylaxis to prevent transmission.

- Elimination of mosquitoes. One such strategy is the elimination of breeding sites, such as stagnant water in large areas, or water left by logging or mining activities. Although it is good community practice to ensure that household rubbish is disposed of properly (such as tin cans and other containers which may collect water and provide a breeding site for some types of mosquito) the Anopheles mosquito does not breed in this type of habitat.
- Another method is Indoor Residual Spraying (IRS). This method was used in PNG from the 1950s and was stopped in the 1980s because at that time it was not considered effective. However, if done properly (with more than 80% of the homes in an area sprayed once or twice each year) it can be highly effective. It can be used in areas where malaria is not endemic and in the event of a malaria epidemic. Although this prevention method is very expensive and labour intensive, IRS is still part of the government's National Health strategy for malaria control in the highland areas (and in areas where there is high economic activity). At the family level, household insecticides and repellents are also used.
- In the PNG context, the most practical preventive method is the consistent nightly use by all the family of mosquito nets, especially the Long Lasting Insecticide treated Nets (LLIN). LLINs are factory-treated nets with a safe, odourless and biodegradable insecticide that coats the netting fibres. The type distributed by Rotarians Against Malaria (RAM), on behalf of the National Department of Health, requires no re-treatment or dipping, and a dirt repellent is added to keep the net clean. The advantage of an LLIN is that not only does it repel and kill mosquitoes, it kills other insects such as spiders, head lice, fleas and bedbugs. The RAM net will last from three to five years if it is cared for properly, and the World Health Organisation has declared it effective for the prevention and control of malaria and other vector-borne diseases.

The following important information should be given to people using these nets:

Courtesy of PSI

- People receiving LLIN should hang the LLIN in the shade for 24 hours after opening from its packaging bag to allow chemicals that have built up in the packaging to be aired;
- Safely dispose of the packaging bags in a rubbish pit. Do not burn them or allow children to play with them;

- Hang LLIN with string or rope above the mattress or sleeping mat and ensure loose ends of the LLIN are well tucked in underneath the mattress or sleeping mat.
- Do not use nails or pins to hang the LLIN because they are easily torn.
- Hot objects like candles, lamps, flames or even cigarettes should not be placed near the nets as they can be easily damaged;

Family size mosquito net

- When you see openings or tears in the net, mend them with cotton or nylon threads, or better still, replace the net with a new one;
- LLIN should be washed with mild soap (do not use detergent, bleach, or lemon) when required and dried in the shade. Sunlight will destroy the insecticide, and the chemical will be washed away after the 20th wash;
- Where there are shortages of nets, priority usage should be given to pregnant women, children under 5 years, people living with HIV/AIDs, elderly people with low immunity, and vulnerable and displaced people.

Courtesy of PSI

Activity 4.2

Malaria prevention

1. Why can't you use lemon or detergent to wash LLIN?
2. Explain how using an LLIN protects people from getting malaria.
3. What messages should you tell the householders once they receive an LLIN?

Key Learning Points

IMCI and prevention of malaria

- *The IMCI Checklist is an important instrument to diagnose sick children.*
- *It is important that all steps in the chart are followed so that you can reach the most likely diagnosis, so that you can manage the patient correctly.*
- ***Not all fever cases are due to malaria.** It is important to change our perception about fever cases as indiscriminate use of the new malaria drug (AL) will increase the probability of resistance to the new malaria treatment, and expose the child to the side effects of unnecessary therapy.*
- *Children with a clinical classification of **Meningitis, Severe Malaria or Other Serious Febrile Disease** need to be treated as meningitis and severe malaria, regardless of the results of the malaria test. In some cases, an RDT can give a false negative result in children with malaria as they are not 100% sensitive. As a child's condition can deteriorate very quickly, and the child may die if appropriate treatment is delayed, you do not have to do an RDT test.*
- *However, in all other fever cases with children, the health worker should use an RDT or microscopy to diagnose malaria and to decide on appropriate anti-malarial treatment.*
- *Malaria can be prevented. Treated nets (LLIN) are the best prevention method.*
- *Where there is a shortage of mosquito nets in a house, priority should be given to pregnant women and children.*
- *People receiving LLIN should hang the LLIN in the shade after removing from its packaging bag to allow chemicals that have built up in the packaging to be aired.*
- *When you see openings or tears mend them with cotton or nylon threads.*

Glossary

Word	Explanation
Anaemia	Decrease in number of red blood cells and/or quantity of haemoglobin. Malaria causes anaemia through rupture of red blood cells during merozoite release.
Antigen	Any substance that the body regards as foreign or potentially dangerous and against which it produces an antibody.
Cerebral malaria	This grave complication of malaria happens at times with *P. falciparum* infection and involves malaria infection of the very small capillaries that flow through the tissues of the brain. This complication has a fatality rate of 15% or more, even when treated, and is extremely serious.
Chemotherapy	The prevention or treatment of diseases by use of chemicals or substances. The term is sometimes restricted to the treatment of infectious diseases with antibiotics or to the control of cancer with antibiotics and similar drugs.
Chemoprophylaxis	The prevention of disease using chemicals such as drugs.
Epidemic	A sudden, severe outbreak of a disease like malaria in an area or region, with the occurrence of more cases of the disease than would be normally expected during a given time period.
Endemic	Occurring frequently in a particular region or population; applied to a particular disease that is generally or constantly found among people in a particular area.

Erythrocyte	This is also called a red blood cell and is produced in the bone marrow. Red blood cells carry oxygen and iron in the form of haemoglobin.
Erythrocytic schizogony	The process of asexual reproduction of malaria parasites within red blood cells.
Gametocyte	The sexual reproductive stage of the malaria parasite. Gametocytes [macro- and micro-gametocytes] circulate in the blood stream, are picked up by the *Anopheles* mosquito, undergo sexual reproduction in the midgut of the mosquito, where they form an oocyst that eventually produces sporozoites.
Hemocoel	The body cavity in the mosquito that receives the sporozoites following asexual replication.
Holoendemic disease	In many communities, malaria is a holoendemic disease where a high prevalent level of infection begins early in life and affects most of the child population, leading to a state of equilibrium so that the adult population shows evidence of the disease much less commonly than do children.
Hyperendemic disease	A disease, such as malaria, that is constantly present in the community at a high incidence or prevalence rate and which affects all age groups equally.
Hypnozoite	A stage of malaria parasites found in liver cells. After sporozoites invade liver cells, some develop into latent forms called hypnozoites. They become active months or years later, producing a recurrent malaria attack. Only *P. vivax* and *P. ovale* species that infect humans develop latent stage hypnozoites. Primaquine is the only available drug active against hypnozoites.
Immuno-suppressed	A state where the immune level is reduced.

Macrogametocyte	The female form of the gametocyte.
Merozoite	An invasive asexual stage of the malaria parasite that attacks red blood cells.
Microgametocyte	The male form of the gametocyte.
Oedema	Excessive accumulation of fluid in the body tissues.
Oocyst	A stage in the malaria parasite development found in the stomach of an infected mosquito that produces sporozoites.
Pallor	Paleness.
Parasite organism	An organism that lives in or on, and takes nourishment from another organism.
Phophylaxis	A measure taken to prevent a disease or condition.
Schizonts	Mature malaria parasites in host liver cell (hepatic schizonts) or red blood cells (erythrocytic schizonts) that are undergoing nuclear division, a process called schizongony.
Sporozoite	The infective stage of the malaria parasite that is passed to the human host from the salivary glands of the mosquito. Sporozoites infect liver cells, disappearing from the bloodstream within 30 minutes. The mechanism for this amazingly rapid disappearance from the bloodstream to the liver is still unknown. Sporozoites are delicate and spindle- shaped stages that are released into the haemocoel of the mosquito when the oocyst ruptures. Some eventually find their way to the salivary glands of the mosquito.

Check Your Learning

Introduction

There are activities in each topic to assist you in applying your learning. This section provides you with some of the answers to these activities so you can check your progress.

Topic 1 Malaria and the malaria situation in PNG

Activity 1.1 Malaria

1. *Plasmodium falciparum, Plasmodium vivax, Plasmodium ovale* and *Plasmodium malariae*. The most dangerous one is *Plasmodium falciparum* because it causes cerebral malaria.
2. The *Anopheles* vector prefers to breed in clean, sunlit, slow moving or stagnant water, river banks, marshes, and lagoons in low lying areas.
2. No. Only the *Anopheles* mosquito.
3. Chills, profuse sweating, muscle pains, abdominal pains, diarrhoea, nausea, vomiting, loss of appetite.
4. Same as uncomplicated malaria, including inability to sit upright, stand or walk, drowsy or in coma, 2 or more convulsions within a 24 hour period, severe pallor and looks very sick.

Activity 1.2 Malaria situation

1. *Plasmodium falciparum*.
2. Because they have a low immunity level.
3. After the malaria epidemic is confirmed, follow the directions of the health authorities.

Activity 1.3 Life cycle of malaria

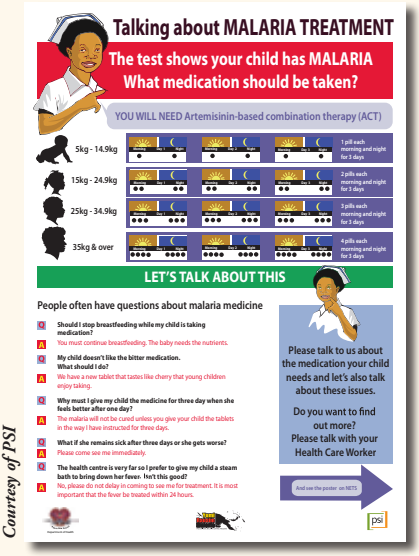
1. Sporozoites ⟶ merozoites ⟶ enter the red blood cells where several stages of parasites occur. Some merozoites develop in gametocytes.
2. Parasites rapidly go to the liver.
3. *Plasmodium vivax* and *Plasmodium ovale*.
4. When the erythrocytes (red blood cells) rupture and merozoites enter new red blood cells.
5. Discussion of Life Cycle in groups.
6.

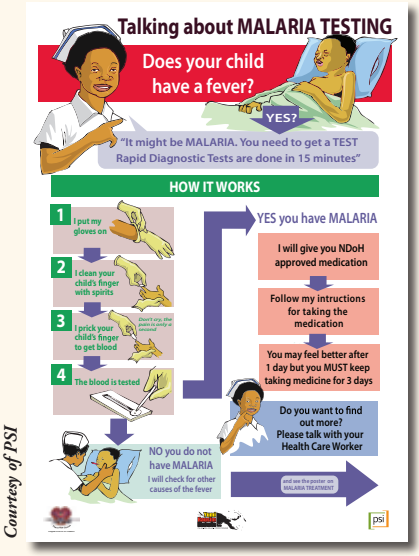
Drug	Hypnozoites	Asexual blood forms	Gametocytes
Chloroquine	-	++	-
Amodiaquine	-	++	-
Quinine	-	++	+
Primaquine	+	+ -	+
Fansidar	-	+	-
Artemisinin	-	++	+
Artemether	-	++	+
Artesunate	-	++	+

Courtesy of PSI

Activity 1.4 Classification of malaria patients

1. All the signs of uncomplicated malaria, including yellowish discolouration of eyes and skin, passing dark coloured urine or less amount of urine, and including any of the following signs: severe pallor, inability to drink or breastfeed, severe vomiting, recent history of convulsions, lethargy or unconsciousness, prostration (including a child not able to sit or stand up when normally able to do so).
2. Usually fever, other features may include chills, profuse sweating, muscle pains, joint pains, abdominal pain, diarrhoea, nausea, vomiting, irritability and refusal to eat. These features may occur singly or in combination.
3. Any three of the following answers: inability to drink or breastfeed, severe vomiting, recent history of convulsions, lethargy or unconsciousness and, in a child normally able to do so, an inability to sit or stand up.





Topic 2 Diagnosis of malaria

Activity 2.1 Microscopy and RDT test

In your group compare an RDT test with Microscopy then fill in the following table.

Comparison of microscopy and RDTs

	Microscopy	RDT
Requirements		
• Equipment	Microscope	None
• Electricity	Preferred but not necessary	None
• Supplies	Blood collection, water and reagent	Blood collection
• Training	Trained microscopist	Only minimal training
Performance		
• Test duration	60 minutes	15 –20 minutes
• Labour intensiveness	High	Low
• Subjectivity	High	Low
• Robustness	Average	High
Direct cost		
• Cost per test	K0.36 – K1.20	K1.80 – K7.50
Technical specifications		
• Detection threshold	5 – 10 parasites/µl blood	40 – 100 parasites/µl blood
• Detection of all 4 species	Yes	Only in some RDTs
• Quantification	Possible	Not possible
• Differentiation between *Pv, Po, Pm*	Possible	Not possible
• Differentiation between sexual and asexual stages	Possible	Not possible
• Antigen persistence	Not applicable	Some RDTs

Activity 2.2 RDT

1. This is an activity where you perform an RDT and your partner marks a *Checklist* provided.
2. The number of drops depends on the type of RDT available in the country. This may range from 3 – 6 drops.
3. To protect health staff from blood-borne diseases like hepatitis and HIV.
4. The required time may vary, depending on the type of test kit used. Generally between 15 – 20 minutes. Reading before the required time may give false results.

Activity 2.3 RDT Quiz

Quiz #1	Quiz #2	Quiz #3
1. *P. falciparum*	1. Negative	1. Invalid (No control)
2. Negative	2. Invalid (No control)	2. *P. falciparum*
3. Invalid (No control)	3. *P. falciparum*	3. Negative
4. Non-falciparum *(P. vivax, P. ovale, P. malariae,* or a mixed infection of these)	4. *P. falciparum* or a mixed infection	4. *P. falciparum* or a mixed infection
5. *P. falciparum*	5. Non-falciparum *(P. vivax, P. ovale, P. malariae,* or a mixed infection of these)	5. *P. falciparum*
6. Non-falciparum *(P. vivax, P. ovale, P. malariae,* or a mixed infection of these).	6. *P. falciparum*	6. *P. falciparum* or a Mixed infection
7. Negative	7. *P. falciparum*	7. Non-falciparum *(P. vivax, P. ovale, P. malariae,* or a mixed infection of these).
8. *P. falciparum*	8. Negative	8. *P. falciparum*
9. *P. falciparum*	9. *P. falciparum* or a mixed infection	9. Negative
10. *P. falciparum* or a mixed infection	10. Non-falciparum *(P. vivax, P. ovale, P. malariae,* or a mixed infection of these).	10. *P. falciparum*

Topic 3 Anti-malarial drugs and treatment

Activity 3.1 Current anti-malarials table

Drug	Dose	Regimen	Use for uncomplicated malaria	Use for severe malaria	Effectiveness of the drug
Chloroquine	4 tablets	Daily for 3 days	Yes	No	Chloroquine resistance is experienced in some cases
Primaquine	2 tablets	Daily for 14 days	Yes	No	Effective
Quinine	10 ml IM	Every 8 hours until improvement	No	Yes	Effective
Quinine	2 tablets	3 times a day for 3 days	No	Yes	Effective
Fansidar	3 tablets	Once at the last day of quinine treatment	No	Yes	Effective

Activity 3.2 Anti-malarial combinations

Non-artemisinin combinations:

- amodiaquine + Fansidar.
- quinine + Fansidar.
- quinine + doxycyline.

Artemisinin combinations:

- artesunate + amodiaquinine.
- artemether + Fansidar.
- artemether + lumefantrine.

Activity 3.3 Treatment

1. AL acts on different stages of parasitic development. Artemether acts quickly to clear parasites, thus reducing fever and other malaria symptoms within hours.

   Lumefantrine, which has a longer life, ensures complete parasite clearance after Day Three, which greatly reduces the chances of parasitic development and spreading.

2. Yellow pack for 5kg to less than 15kg; blue for 15kg to less than 25kg; orange for 25kg to less than 35kg and green for 35 kg and above.
3. Artemether 20mg/lumefantrine 120mg, (AL).
4. In a cool dry place between 2ºC to 30ºC.

Activity 3.4 AL treatment of malaria

1. AL twice a day for 3 days, according to weight.
2. Yellow pack: 5kg to less than 15kg, 1 tab bd for 3 days.

   Blue pack: 15kg to less than 25kg, 2 tab bd for 3 days.

   Orange pack: 25kg to less than 35kg, 3 tab bd for 3 days.

   Green pack: 35kg and above, 4 tab bd for 3 days.
3. Yes.
4. Treat with quinine and Fansidar. Give quinine 1.5 tablets tds for 7 days and Fansidar 2 tablets on the first day of treatment.

Activity 3.5 Reporting

1. This is a discussion in your group.
2. This information can be used for managing adequate stocks so that you are not over-stocking or under-stocking your drug supply.
3. Information on malaria diagnosis by microscopy and RDT, by parasite species, by age group, sex and number of ACT administered.
4. Send monthly reports at the end of the month to the Provincial Health Information Officer.

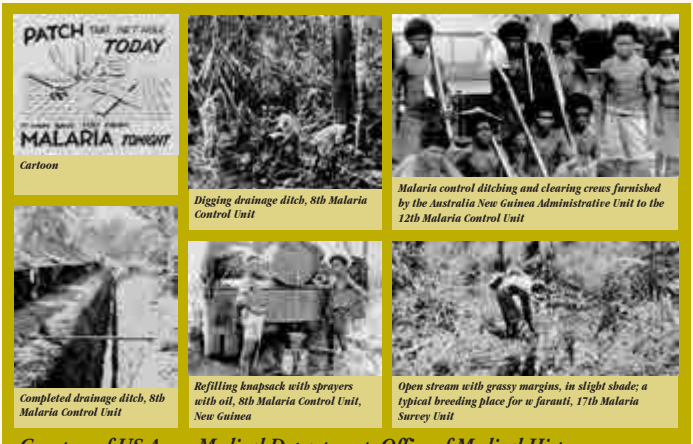
Topic 4 IMCI and prevention of malaria

Activity 4.1 IMCI Checklist

1. First do Step 1 to check if the child has "TOO SICK" signs. After that, follow Step 2 and 3, and decide on the fever classification according to the algorithm presented in Step 4.
   - If the child has the classification of ***Meningitis or Severe Malaria or other serious febrile disease*** refer or admit and treat as severe malaria and meningitis.
   - If the child does not have the above mentioned classification, decide on the anti-malarial treatment, based on the results of an RDT or microscopy.
   - After completion of Step 4, follow other steps to complete the assessment of the sick child.
2. It is important to use the *IMCI Checklist* so that conditions responsible for high mortality and morbidity of children are not missed, and are treated accordingly.

Activity 4.2 Malaria prevention

1. Lemon or detergent will destroy the insecticide.
2. The LLIN will kill and repel mosquitoes, if properly used.
3. Open the net and hang in the shade; Safely discard the package in the rubbish pit; Use rope and string to tie the net; When you see an opening or tear, repair it using cotton or nylon.



Cartoon

Digging drainage ditch, 8th Malaria Control Unit

Malaria control ditching and clearing crews furnished by the Australia New Guinea Administrative Unit to the 12th Malaria Control Unit

Completed drainage ditch, 8th Malaria Control Unit

Refilling knapsack with sprayers with oil, 8th Malaria Control Unit, New Guinea

Open stream with grassy margins, in slight shade; a typical breeding place for w farauti, 17th Malaria Survey Unit

Courtesy of US Army Medical Department, Office of Medical History