Federal Democratic Republic of Ethiopia
Ministry of Health

Communicable Diseases

Part 1 General principles, vaccine-preventable diseases and malaria

Blended Learning Module for the Health Extension Programme

HEAT
Health Education and Training
HEAT in Africa

unicef
unite for children

The Open University

AMREF
Better Health for Africa

Federal Democratic Republic of Ethiopia
Ministry of Health

The Ethiopian Federal Ministry of Health (FMOH) and the Regional Health Bureaus (RHBs) have developed this innovative Blended Learning Programme in partnership with the HEAT Team from The Open University UK and a range of medical experts and health science specialists within Ethiopia. Together, we are producing 13 Modules to upgrade the theoretical knowledge of the country's 33,000 rural Health Extension Workers to that of Health Extension Practitioners and to train new entrants to the service. Every student learning from these Modules is supported by a Tutor and a series of Practical Training Mentors who deliver the parallel Practical Skills Training Programme. This blended approach to work-place learning ensures that students achieve all the required theoretical and practical competencies while they continue to provide health services for their communities.

These Blended Learning Modules cover the full range of health promotion, disease prevention, basic management and essential treatment protocols to improve and protect the health of rural communities in Ethiopia. A strong focus is on enabling Ethiopia to meet the Millennium Development Goals to reduce maternal mortality by three-quarters and under-5 child mortality by two-thirds by the year 2015. The Modules cover antenatal care, labour and delivery, postnatal care, the integrated management of newborn and childhood illness, communicable diseases (including HIV/AIDS, malaria, TB, leprosy and other common infectious diseases), family planning, adolescent and youth reproductive health, nutrition and food safety, hygiene and environmental health, non-communicable diseases, health education and community mobilisation, and health planning and professional ethics.

In time, all the Modules will be accessible from the Ethiopian Federal Ministry of Health website at **www.moh.gov.et**; online versions will also be available to download from the HEAT (Health Education and Training) website at **www.open.ac.uk/africa/heat** as open educational resources, free to other countries across Africa and anywhere in the world to download and adapt for their own training programmes.

Dr Kesetebirhan Admasu

State Minister of Health

Ethiopian Federal Ministry of Health

Acknowledgements

Communicable Diseases is the largest of the 13 Blended Learning Modules for the Ethiopian Health Extension Programme. Together with the practical skills training sessions that accompany each of the supported self-study texts, this programme will upgrade the Health Extension Workers who complete the curriculum to Health Extension Practitioners at Level-IV of the Ethiopian Occupational Standards. The upgrading programme is sponsored by the Ethiopian Federal Ministry of Health (FMOH) and the Regional Health Bureaus (RHBs). The FMOH gratefully acknowledges the receipt of funding for this programme from the Ethiopian Office of UNICEF (the United Nations Children's Emergency Fund), The Open University UK, the Alan and Nesta Ferguson Foundation Trust UK, and AMREF (the African Medical and Research Foundation). We are also thankful for the support of the Ethiopian Offices of Jhpiego and the World Health Organisation (WHO) for freely enabling their experts to participate in the development of this Module.

Communicable Diseases is in four separate Parts and was produced by a team of Ethiopian experts, who were trained and supported by experts in blended learning pedagogy from the HEAT (Health Education and Training) Team for Africa at The Open University UK. The contributors of original material are:

Dr Omar Abdulwadud, FMoH/AIHA-Twinning Centre, Ethiopia

Dr Gani A. Alabi, WHO Ethiopia

Dr Fessahaye Alemseged, Jimma University, Department of Epidemiology

Dr Amsalu Bekele, Addis Ababa University, School of Medicine

Dr Amare Deribew (Module Academic Coordinator), Jimma University, Department of Epidemiology

Dr Aschalew Endale, FMoH/WHO Ethiopia

Dr Samuel Habte, Le Monde Health and Development Consultants

Dr Daddi Jima, FMoH/Ethiopian Health and Nutrition Research Institute

Dr Yemane Ye-biyo Yihdego, Malaria and other Tropical Diseases Specialist

The Academic Editors of *Communicable Diseases* are Dr Basiro Davey, Deputy Director (Ethiopia), HEAT Team at The Open University UK, Dr Saroj B. Datta, Dr Kerry Murphy, Dr Ignacio Romero and Dr Jeff Thomas, all in the Department of Life Sciences at The Open University UK. The other members of the HEAT Team are:

Lesley-Anne Long, HEAT Programme Director

Alison Robinson, HEAT Programme Coordinator

Dawn Partner, HEAT Senior Production Assistant

Jessica Aumann, HEAT Programme Assistant

Ali Wyllie, HEAT Lead eLearning Adviser

We acknowledge the vital contributions of the Programme Coordinators within Ethiopia:

Ato Mohammed Hussein Abeseko, UNICEF Ethiopia and the Federal Ministry of Health

Ato Tedla Mulatu, AMREF Ethiopia

The cover design for *Communicable Diseases* is by Chris Hough, Learning and Teaching Solutions, The Open University UK. The cover photographs are reproduced with the permission of UNICEF Ethiopia, with acknowledgement to Indrias Getachew.

We particularly wish to acknowledge our use in this Module of adapted extracts and illustrations from the following World Health Organization (WHO) sources:

WHO (1991) *Basic Malaria Microscopy, Part I: Learner's Guide*, 2nd edition. This document can be found at: http://whqlibdoc.who.int/publications/1991/9241544309.pdf

WHO (1996) *Malaria: A Manual for Community Health Workers*. This document can be found at: http://whqlibdoc.who.int/publications/1996/9241544910_eng.pdf

WHO (1997) *Vector Control Methods for Use by Individuals and Communities*. This document can be found at: http://whqlibdoc.who.int/publications/1997/9241544945_eng.pdf

WHO (2006) *How to use a Malaria Rapid Diagnostic Test (RDT): A guide for training CHWs and other health workers*. The Quality Assurance Project (QAP) and the World Health Organization (WHO), Bethesda, MD, and Geneva. This document can be found at: http://www.wpro.who.int/NR/rdonlyres/A5557149-BB4E-4A26-9CBA-996DA92FC8A4/0/RDTgeneric4bgeneric.pdf

The opinions expressed in this Module are those of the authors and do not necessarily reflect the views of any of the donor organisations whose generous support made the production of *Communicable Diseases* possible.

Contents

Continued in Parts 2, 3 and 4

Introduction to the *Communicable Diseases* Module

Communicable diseases caused by bacteria, viruses, protozoa, fungi and parasites, make a huge contribution to the burden of disease, disability and death in low- and middle-income countries like Ethiopia. The emergence of HIV/AIDS as a global pandemic, the resurgence of tuberculosis co-infection with HIV, and the rapid spread of fatal outbreaks of influenza, have also brought communicable diseases back onto the agenda of health services in high-income countries. The six leading groups of infectious diseases (acute respiratory infections, HIV/AIDS, diarrhoeal diseases, tuberculosis, malaria and measles) together cause over 11 million deaths worldwide every year, and blight the lives of tens of millions more who are living with their chronic or recurrent effects. These high-profile diseases are relatively well publicised across the world, and are subject to major research into vaccines and treatments. By contrast, at least 1 billion people are affected by the so-called 'neglected tropical diseases', including leprosy and schistosomiasis, and/or by intestinal parasites such as tapeworm and hookworm.

Some communicable diseases are easily preventable through simple measures such as vaccination and changes in human behaviour (for example, handwashing with soap). However, the transmission of infectious agents will be difficult to reduce to the levels seen in wealthier nations without significant reductions in the proportion of people living in impoverished social circumstances, with poor nutrition that leaves them more vulnerable to infection, without housing that is secure from disease-carrying pests, and without access to clean drinking water, improved sanitation or the safe disposal of household waste. Strenuous efforts are being made to address these problems in Ethiopia, as elsewhere in Africa and in other developing countries.

To prevent or control the major communicable diseases in Ethiopia, a concerted effort by the nation's health workers, the government, development partners and community members is crucial. Together with the practical skills training associated with this Module, *Communicable Diseases* will help you to acquire the basic skills and knowledge to reduce the burden of mortality and morbidity in your community through the detection, prevention and treatment of common infections.

Communicable Diseases is divided into four Parts. In Part 1 (Study Sessions 1–12), you will first learn the basic concepts in the transmission, prevention and control of communicable diseases, which forms the foundation for all the sessions in later parts of the Module. Next we discuss some important vaccine-preventable diseases (neonatal tetanus, bacterial meningitis, measles, polio and hepatitis B). Part 1 then focuses on malaria and its mosquito vectors: its transmission, its diagnosis based on clinical signs and the malaria rapid diagnostic test (RDT), malaria case management, vector control methods, and the management of epidemics.

Part 2 (Study Sessions 13–19) deal with tuberculosis (TB) and leprosy, which are caused by different *Mycobacteria*. In both diseases the symptoms are due to inflammation and tissue destruction in the infected body parts. The diagnosis, treatment and prevention of these disabling diseases are covered in detail, including the rapid diagnostic test for TB and assessments of disability and nerve damage in people with leprosy.

Part 3 (Study Sessions 20–31) is about the human immunodeficiency virus (HIV) and the spectrum of HIV diseases leading to acquired immune deficiency syndrome (AIDS). It includes opportunistic infections and other sexually-transmitted infections (STIs). The focus is on diagnosis, treatment options and regimens, and prevention of infection and HIV transmission, including from mother to child, and protection from accidental HIV infection in health workers. It also covers positive living for people with HIV and palliative care for those who are dying.

Part 4 (Study Sessions 32–42) completes the Module by discussing the diagnosis, treatment, prevention and control of other communicable diseases of public health importance, including

diarrhoeal diseases, intestinal parasites, acute respiratory infections and otitis media, relapsing fever, typhus, neglected tropical diseases, zoonoses, trachoma and scabies. The Module ends with three study sessions on integrated disease surveillance and response, and epidemic investigation and management.

Study Session 1 Basic Concepts in the Transmission of Communicable Diseases

Introduction

As you will recall from the Module on *Health Education, Advocacy and Community Mobilisation,* **health** is defined as a complete state of physical, mental and social well-being and not the mere absence of disease. The term **disease** refers to a disturbance in the normal functioning of the body and is used interchangeably with 'illness'. Diseases may be classified as communicable or non-communicable. **Communicable diseases** are caused by infectious agents that can be transmitted to other people from an infected person, animal or a source in the environment. Communicable diseases constitute the leading cause of health problems in Ethiopia.

Before we describe each communicable disease relevant to Ethiopia in detail in later study sessions, it is important that you first learn about the basic concepts underlying communicable diseases. Understanding these basic concepts will help you a lot, as they form the basis for this Module.

In this first study session, we introduce you to definitions of important terms used in communicable diseases, the types of infectious agents that cause these diseases, the main factors involved in their transmission, and the stages in their natural development. This will help you to understand how measures for the prevention and control of communicable diseases are put into place at several levels of the health system, including in homes and at your Health Post – which is the focus of Study Session 2.

Learning Outcomes for Study Session 1

When you have studied this session, you should be able to:

1.1 Define and use correctly all of the key terms printed in **bold**. (SAQs 1.1 and 1.5)

1.2 Identify the main types of infectious agents. (SAQs 1.2 and 1.3)

1.3 Describe the main reservoirs of infectious agents. (SAQ 1.3)

1.4 Describe the chain of transmission of communicable diseases and explain how infectious agents are transmitted by direct and indirect modes. (SAQs 1.3 and 1.5)

1.5 Describe the characteristics of susceptible hosts and the main risk factors for development of communicable diseases. (SAQ 1.4)

1.6 Describe the stages in the natural history of communicable diseases. (SAQ 1.5)

1.1 What are communicable diseases?

As described in the introduction, the organisms that cause communicable diseases are called **infectious agents**, and their transmission to new uninfected people is what causes communicable diseases; (note that **infectious diseases** is an interchangeable term). Familiar examples of communicable diseases are malaria and tuberculosis. Diseases such as heart disease, cancer and diabetes mellitus, which are not caused by infectious agents and are not transmitted between people, are called **non-communicable diseases**.

This curriculum includes a Module on *Non-Communicable Diseases, Emergency Care and Mental Health.*

■ Tuberculosis is caused by an organism called *Mycobacterium tuberculosis*, which can be transmitted from one person to another. Is TB a communicable or non-communicable disease?

□ It is a communicable disease because it is caused by an infectious agent and it develops as a result of transmission of the infectious agent.

1.1.1 The burden of communicable diseases in Ethiopia

Outpatient refers to someone who comes to a health facility seeking treatment, but does not stay overnight. An inpatient is someone admitted to a health facility, who has at least one overnight stay.

Communicable diseases are the main cause of health problems in Ethiopia. According to the Ethiopian Federal Ministry of Health, communicable diseases accounted for most of the top ten causes of illness and death in 2008/09. As you can see in Table 1.1, most causes of outpatient visits are due to communicable diseases.

■ Can you identify the communicable diseases in Table 1.1?

□ You may not recognise them all (you will learn about them in later study sessions), but you probably mentioned malaria, respiratory infections, parasitic diseases, pneumonia and diarrhoea.

Table 1.1 Top 10 leading causes of outpatient visits in most regions of Ethiopia, September 2008–August 2009. (From: Federal Ministry of Health (2010) *Health and Health Related Indicators*: *2008/9*, Addis Ababa, Ethiopia)

A **clinical diagnosis** is based on the typical signs and symptoms of the disease, without confirmation from diagnostic tests, e.g. in a laboratory.

Rank	Diagnosis	Percentage of all outpatient visits
1	Malaria (clinical diagnosis without laboratory confirmation)	8.3
2	Acute upper respiratory infections	8.1
3	Dyspepsia (indigestion)	5.9
4	Other or unspecified infectious and parasitic diseases	5.0
5	Pneumonia	4.8
6	Other or unspecified diseases of the respiratory system	4.0
7	Malaria (confirmed with species other than *Plasmodium falciparum*)	3.7
8	Diarrhoea with blood (dysentery)	3.7
9	Helminthiasis (caused by worms)	3.5
10	Diseases of the musculoskeletal system and connective tissue (muscles, bones and joints)	3.0
Total % of all causes of outpatient visits		**47.2**

The naming of infectious agents is discussed in Section 1.2.1.

Table 1.2 shows that most causes of inpatient deaths are due to communicable diseases, including pneumonia, tuberculosis, HIV/AIDS and malaria. These and other communicable diseases will be discussed in detail in later study sessions of this module.

Table 1.2 Top 10 leading causes of inpatient deaths in most regions of Ethiopia, September 2008–August 2009. (Source as Table 1.1)

Rank	Diagnosis	Percentage of all inpatient deaths
1	Pneumonia	12.4
2	Other or unspecified effects of external causes	7.1
3	Tuberculosis	7.0
4	Human immunodeficiency virus (HIV) disease	5.1
5	Anaemias	3.9
6	Other or unspecified diseases of the circulatory system (heart, blood vessels)	3.7
7	Hypertension (high blood pressure) and related diseases	3.5
8	Malaria (clinical diagnosis without laboratory confirmation)	3.1
9	Malaria (confirmed with *Plasmodium falciparum*)	2.5
10	Road traffic injuries	2.3
Total % of all causes of inpatient deaths		**50.8**

1.1.2 Endemic and epidemic diseases

Not all communicable diseases affect a particular group of people, such as a local community, a region, a country or indeed the whole world, in the same way over a period of time. Some communicable diseases persist in a community at a relatively constant level for a very long time and the number of individuals affected remains approximately the same. These communicable diseases are known as **endemic** to that particular group of people; for example, tuberculosis is endemic in the population of Ethiopia and many other African countries.

By contrast, the numbers affected by some communicable diseases can undergo a sudden increase over a few days or weeks, or the rise may continue for months or years. When a communicable disease affects a community in this way, it is referred to as an **epidemic**. Malaria is endemic in some areas of Ethiopia, and it also occurs as epidemics due to an increase in the number of cases suddenly at the beginning or end of the wet season.

A **case** refers to an individual who has a particular disease.

1.1.3 Prevention and control measures

The health problems due to communicable diseases can be tackled by the application of relatively easy measures at different levels of the health system. Here, we will use some examples at the individual and community levels, which are relevant to your work as a Health Extension Practitioner.

Some measures can be applied before the occurrence of a communicable disease to protect a community from getting it, and to reduce the number of cases locally in the future. These are called **prevention measures**. For example, vaccination of children with the measles vaccine is a prevention measure, because the vaccine will protect children from getting measles. **Vaccination** refers to administration of vaccines to increase resistance of a person against infectious diseases.

Once a communicable disease occurs and is identified in an individual, measures can be applied to reduce the severity of the disease in that person, and to prevent transmission of the infectious agent to other members of the community. These are called **control measures**. For example, once a child becomes infected with measles, treatment helps reduce the severity of the disease, and possibly prevents the child's death, but at the same time it decreases the risk of transmission to other children in the community. In this context, treatment of measles is considered a control measure.

- Later in this Module, you will learn that the widespread use of insecticide-treated mosquito nets (ITNs) is recommended as a prevention measure for malaria, which is transmitted to people by mosquitoes. If you promote the effective use of mosquito nets in your community, how would you expect the number of malaria cases to change over time?

- An *increase* in the effective use of mosquito nets should *reduce* the number of cases of malaria.

Next we look at the main ways in which infectious agents are transmitted.

1.2 Factors involved in the transmission of communicable diseases

Transmission is a process in which several events happen one after the other in the form of a chain. Hence, this process is known as a **chain of transmission** (Figure 1.1). Six major factors can be identified: the infectious agent, the reservoir, the route of exit, the mode of transmission, the route of entry and the susceptible host. We will now consider each of these factors in turn.

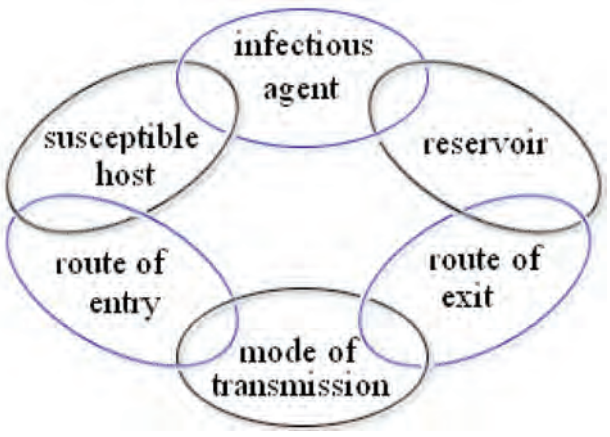


Figure 1.1 Factors involved in the chain of communicable disease transmission.

1.2.1 Infectious agents

Scientific names

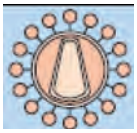
Tables 1.1 and 1.2 referred to *Plasmodium falciparum* as an infectious agent causing malaria. This is an example of how infectious agents are named scientifically, using a combination of two words, the 'genus' and the 'species' names. The genus name is written with its initial letter capitalised, followed by the species name which is not capitalised. In the example above, *Plasmodium* is the genus name and *falciparum* refers to one of the species of

this genus found in Ethiopia. There are other species in this genus, which also cause malaria, e.g. *Plasmodium vivax*.

Sizes and types of infectious agents

Infectious agents can have varying sizes. Some, such as *Plasmodium falciparum* and all bacteria and viruses, are tiny and are called **micro-organisms**, because they can only be seen with the aid of microscopes. Others, such as the ascaris worm (*Ascaris lumbricoides*), can be easily seen with the naked eye. The different types of infectious agents are illustrated in Table 1.3 according to their size, starting with the largest and ending with the smallest, and are then discussed below.

Table 1.3 Different types of infectious agents: their number of cells, visibility and examples. (Adapted from The Open University, 2007, *Water and Health in an Overcrowded World*, Chapter 2)

Type of infectious agent	**Number of cells**	**Visibility**	**Examples**	
Helminths	many	Visible with the naked eye	Ascaris worm causes ascariasisIts length reaches 15–30 cm	
Protozoa	1	Visible with a standard microscope	*Plasmodium falciparum* causes malaria	
Bacteria	1	Visible only with a special microscope; much smaller in size than protozoa	*Vibrio cholerae* causes cholera	
Viruses	0	Visible only with a special microscope; much smaller in size than bacteria	HIV causes AIDS	

Helminths are worms made up of many cells; for example, *Ascaris lumbricoides*.

Protozoa are micro-organisms made up of one cell; for example, *Plasmodium falciparum*.

Bacteria are also micro-organisms made up of one cell, but they are much smaller than protozoa and have a different structure; for example *Vibrio cholerae*, which causes cholera.

Viruses are infectious agents that do not have the structure of a cell. They are more like tiny boxes or particles and are much smaller than bacteria; for example, **HIV** (the Human Immunodeficiency Virus), which can lead to AIDS.

Though not as common as causes of communicable disease in humans, other types of infectious agents include *fungi* (e.g. ringworm is caused by a fungus infection), and *mites* (similar to insects), which cause scabies.

1.2.2 Reservoirs of infectious agents

Many infectious agents can survive in different organisms, or on non-living objects, or in the environment. Some can only persist and multiply inside human beings, whereas others can survive in other animals, or for example in soil or water. The place where the infectious agent is normally present *before* infecting a new human is called a **reservoir**. Without reservoirs, infectious agents could not survive and hence could not be transmitted to other people. Humans and animals which serve as reservoirs for infectious agents are known as **infected hosts**. Two examples are people infected with HIV and with the bacteria that cause tuberculosis; these infectious agents persist and multiply in the infected hosts and can be directly transmitted to new hosts.

Animals can also be reservoirs for the infectious agents of some communicable diseases. For example, dogs are a reservoir for the virus that causes rabies (Figure 1.3). Diseases such as rabies, where the infectious agents can be transmitted from animal hosts to susceptible humans, are called **zoonoses** (singular, zoonosis).

Figure 1.3 Rabies is a zoonosis, which can be transmitted from dogs to humans. (Photo: WHO at http://www.who.int/rabies/animal/en/)

Non-living things like water, food and soil can also be reservoirs for infectious agents, but they are called **vehicles** (not infected hosts) because they are not alive. You will learn more about them later in this study session.

- Bacteria called *Mycobacterium bovis* can be transmitted from cattle to humans in raw milk and cause a type of tuberculosis. In this example, what is the infectious agent and the infected host or hosts?

- The infectious agent is *Mycobacterium bovis* and the infected hosts are cattle and humans.

1.2.3 Route of exit

Before an infectious agent can be transmitted to other people, it must first get out of the infected host. The site on the infected host through which the infectious agent gets out is called the **route of exit**. Some common examples are described below.

Respiratory tract

The routes of exit from the respiratory tract are the nose and the mouth. Some infectious agents get out of the infected host in droplets expelled during coughing, sneezing, spitting or talking, and then get transmitted to others (Figure 1.4). For example, people with tuberculosis in their lungs usually have a persistent cough; *Mycobacterium tuberculosis* uses this as its route of exit.

Figure 1.4 Infectious agents in the respiratory tract can exit from infected hosts during coughing and be transmitted to others.

Gastrointestinal tract

The anus is the route of exit from the gastrointestinal tract (or gut). Some infectious agents leave the human body in the stool or faeces (Figure 1.5). For example, the infectious agents of shigellosis, a disease which can cause bloody diarrhoea, use this route of exit.

Figure 1.5 Infectious agents can get out of the body with faeces and get transmitted to others.

Skin

Some types of infectious agents can exit the body through breaks in the skin. For example, this route of exit is used by *Plasmodium* protozoa, which are present in the blood and get out of the human body when a mosquito bites through the skin to suck blood.

1.2.4 Modes of transmission

Once an infectious agent leaves a reservoir, it must get transmitted to a new host if it is to multiply and cause disease. The route by which an infectious agent is transmitted from a reservoir to another host is called the **mode of transmission**. It is important for you to identify different modes of transmission, because prevention and control measures differ depending on the type. Various *direct* and *indirect* modes of transmission are summarised in Table 1.3 and discussed below it.

Table 1.4 Summary of different modes of transmission.

Mode of transmission	Sub-types of transmission
Direct	Touching
	Sexual intercourse
	Biting
	Direct projection of droplets
	Across the placenta
Indirect	Airborne
	Vehicle-borne
	Vector-borne

Direct modes of transmission

Direct transmission refers to the transfer of an infectious agent from an infected host to a new host, without the need for intermediates such as air, food, water or other animals. Direct modes of transmission can occur in two main ways:

- **Person to person**: The infectious agent is spread by direct contact between people through touching, biting, kissing, sexual intercourse or direct projection of respiratory droplets into another person's nose or mouth during coughing, sneezing or talking. A familiar example is the transmission of HIV from an infected person to others through sexual intercourse.
- **Transplacental transmission**: This refers to the transmission of an infectious agent from a pregnant woman to her fetus through the placenta. An example is mother-to-child transmission (MTCT) of HIV.

Indirect modes of transmission

Indirect transmission is when infectious agents are transmitted to new hosts through intermediates such as air, food, water, objects or substances in the environment, or other animals. Indirect transmission has three subtypes:

- **Airborne transmission**: The infectious agent may be transmitted in dried secretions from the respiratory tract, which can remain suspended in the air for some time. For example, the infectious agent causing tuberculosis can enter a new host through airborne transmission.
- **Vehicle-borne transmission**: A **vehicle** is any non-living substance or object that can be contaminated by an infectious agent, which then transmits it to a new host. **Contamination** refers to the presence of an infectious agent in or on the vehicle.
- **Vector-borne transmission**: A **vector** is an organism, usually an *arthropod*, which transmits an infectious agent to a new host. Arthropods which act as vectors include houseflies, mosquitoes, lice and ticks.

Arthropods are invertebrates (animals without backbones), such as insects, which have segmented bodies and three pairs of jointed legs.

■ Can you suggest some examples of vehicles that could transmit specific infectious agents *indirectly* to new hosts?

□ You may have thought of some of the following:

- Contaminated food, water, milk, or eating and drinking utensils. For example, the infectious agent of cholera can be transmitted to a person who eats food or drinks water contaminated with faeces containing the organism.
- Contaminated objects such as towels, clothes, syringes, needles and other sharp instruments. For example, sharp instruments contaminated with HIV-infected blood can transmit HIV if they penetrate the skin of another person.
- Soil is a vehicle for some bacteria. For example, a person can be infected with bacteria that cause tetanus if contaminated soil gets in through broken skin.

■ Can you think of a vector-borne disease mentioned several times in this study session?

□ Malaria is transmitted by mosquito vectors.

1.2.5 Route of entry

Successful transmission of the infectious agent requires it to enter the host through a specific part of the body before it can cause disease. The site through which an infectious agent enters the host is called the **route of entry**.

■ We have already mentioned all the routes of entry in previous sections. Can you summarise what they are, and give an example of an infectious agent for each of them?

□ The routes of entry are:

- The respiratory tract: some infectious agents enter the body in air breathed into the lungs. Example: *Mycobacterium tuberculosis*.
- The gastrointestinal tract: some infectious agents enter through the mouth. Example: the infectious agents causing diarrhoeal diseases enter through the mouth in contaminated food, water or on unclean hands (Figure 1.6).

- The skin provides a natural barrier against entry of many infectious agents, but some can enter through breaks in the skin. Example: malaria parasites (*Plasmoduim* species) get into the body when an infected mosquito bites through the skin to suck blood.

Figure 1.6 Some infectious agents get into the body with contaminated food, water or on hands. (Photo: Basiro Davey)

■ Can you think of an infectious agent that enters and exits through the *same* body part? Can you think of one where the entry and exit routes are *different* parts of the body?

□ The route of entry and exit for *Mycobacterium tuberculosis* is through the respiratory system. The route of entry for infectious agents of diarrhoeal diseases is the mouth, but the route of exit is the anus with the faeces.

1.2.6 Susceptible hosts and risk factors

After an infectious agent gets inside the body it has to multiply in order to cause the disease. In some hosts, infection leads to the disease developing, but in others it does not. Individuals who are likely to develop a communicable disease after exposure to the infectious agents are called **susceptible hosts**. Different individuals are not equally susceptible to infection, for a variety of reasons.

Factors that increase the susceptibility of a host to the development of a communicable disease are called **risk factors**. Some risk factors arise from outside the individual – for example, poor personal hygiene, or poor control of reservoirs of infection in the environment. Factors such as these increase the *exposure* of susceptible hosts to infectious agents, which makes the disease more likely to develop.

Additionally, some people in a community are more likely to develop the disease than others, even though they all have the *same* exposure to infectious agents. This is due to a low level of immunity within the more susceptible individuals. **Immunity** refers to the resistance of an individual to communicable diseases, because their *white blood cells* and *antibodies* (defensive proteins) are able to fight the infectious agents successfully. Low levels of immunity could be due to:

- diseases like HIV/AIDS which suppress immunity
- poorly developed or immature immunity, as in very young children
- not being vaccinated
- poor nutritional status (e.g. malnourished children)
- pregnancy.

■ In general terms, in what two ways could the risk of developing a communicable disease be reduced?

Vaccination is discussed in detail in the *Immunization* Module in this curriculum.

□ By reducing exposure to infectious agents, or increasing the person's immunity, for example by vaccination or improving their diet.

Finally, look back at Figure 1.2. We can now summarize the chain of transmission as follows:

- the infectious agent gets out of the reservoir through a route of exit
- it gets transmitted to a susceptible host by a direct or indirect mode of transmission and it gets into the susceptible host through a route of entry
- if it multiplies sufficiently in the susceptible host it will cause a communicable disease.

1.3 Natural history of a communicable disease

The natural history of a disease is also referred to as the *course* of the disease, or its *development and progression*; these terms can be used interchangeably.

The **natural history** of a communicable disease refers to the sequence of events that happen one after another, over a period of time, in a person who is not receiving treatment. Recognizing these events helps you understand how particular interventions at different stages could prevent or control the disease. (You will learn about this in detail in Study Session 2.)

Events that occur in the natural history of a communicable disease are grouped into four stages: exposure, infection, infectious disease, and outcome (see Figure 1.6). We will briefly discuss each of them in turn.

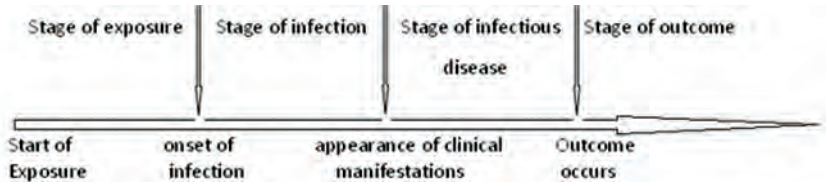


Figure 1.6 Stages in the natural history of communicable diseases.

1.3.1 Stage of exposure

Here a *contact* refers to an association between a susceptible host and a reservoir of infection, which creates an opportunity for the infectious agents to enter the host.

In the **stage of exposure**, the susceptible host has come into close contact with the infectious agent, but it has not yet entered the host's body cells. Examples of an exposed host include:

- a person who shakes hands with someone suffering from a common cold
- a child living in the same room as an adult with tuberculosis
- a person eating contaminated food or drinking contaminated water.

1.3.2 Stage of infection

At this stage the infectious agent has entered the host's body and has begun multiplying. The entry and multiplication of an infectious agent inside the host is known as the **stage of infection**. For instance, a person who has eaten food contaminated with *Salmonella typhii* (the bacteria that cause typhoid fever) is said to be *exposed*; if the bacteria enter the cells lining the intestines and start multiplying, the person is said to be *infected*.

At this stage there are no **clinical manifestations** of the disease, a term referring to the typical symptoms and signs of that illness. **Symptoms** are the

complaints the patient can tell you about (e.g. headache, vomiting, dizziness). **Signs** are the features that would only be detected by a trained health worker (e.g. high temperature, fast pulse rate, enlargement of organs in the abdomen).

1.3.3 Stage of infectious disease

At this stage the clinical manifestations of the disease are present in the infected host. For example, a person infected with *Plasmodium falciparum*, who has fever, vomiting and headache, is in the **stage of infectious disease** – in this case, malaria. The time interval between the onset (start) of infection and the first appearance of clinical manifestations of a disease is called the **incubation period**. For malaria caused by *Plasmodium falciparum* the incubation period ranges from 7 to 14 days.

Remember that not all infected hosts may develop the disease, and among those who do, the severity of the illness may differ, depending on the level of immunity of the host and the type of infectious agent. Infected hosts who have clinical manifestations of the disease are called **active cases**. Individuals who are infected, but who do not have clinical manifestations, are called **carriers**. Carriers and active cases can both transmit the infection to others.

■ To which stage in the natural history of a communicable disease do (a) active cases and (b) carriers belong?

□ (a) Carriers are in the *stage of infection*, as they do not have clinical manifestations of the disease. (b) Active cases are in the *stage of infectious disease*, as they have the manifestations.

Depending on the time course of a disease and how long the clinical manifestations persist, communicable diseases can be classified as acute or chronic. **Acute diseases** are characterized by rapid onset and short duration of illness. For instance, diarrhoea that starts suddenly and lasts less than 14 days is an *acute diarrhoeal disease*. **Chronic diseases** are characterized by prolonged duration of illness; for example, a *chronic diarrhoeal disease* lasts more than 14 days.

1.3.4 Stage of outcome

At this stage the disease may result in recovery, disability or death of the patient. For example, a child who fully recovers from a diarrhoeal disease, or is paralyzed from poliomyelitis, or dies from malaria, is in the **stage of outcome**.

In the next study session you will learn how communicable diseases are classified, and about the main types of prevention and control measures.

Summary of Study Session 1

In Study Session 1 you have learned that:

1 Communicable diseases are caused by infectious agents that can be transmitted to susceptible individuals from an infected person, or from other animals, objects or the environment.

2 Infectious agents include helminths, protozoa, bacteria, viruses and fungi.

3 Six factors are involved in the transmission of communicable diseases: the infectious agent, the reservoir, route of exit, mode of transmission, route of entry, and the susceptible host.

4 A reservoir is a human, another animal, or a non-living thing (such as soil), where the infectious agent normally lives.

5 Modes of transmission of an infectious agent can be *directly* through person-to-person contact, or across the placenta from mother to fetus. *Indirect* transmission can occur through air, vehicles such as water, food and contaminated objects, or via a vector such as a mosquito.

6 A susceptible host is a person or animal who can develop infection if exposed to the infectious agent. Susceptibility is increased if exposure is high, or the host's immunity is low.

7 The natural history of an untreated communicable disease has four stages: stage of exposure, stage of infection, stage of infectious disease, and stage of outcome.

Self-Assessment Questions (SAQs) for Study Session 1

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the questions below. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 1.1 (tests Learning Outcome 1.1)

Consider a disease known as diabetes mellitus, which is characterized by an increase in the blood sugar level. Infectious agents may contribute to the development of the disease in early childhood, but are not the main cause of the disease. Can it be classified as communicable? Explain your reasons.

SAQ 1.2 (tests Learning Outcome 1.2)

Giardiasis is an endemic communicable disease in Ethiopia. Its infectious agent (*Giardia intestinalis*) is a single-celled organism bigger than bacteria, but not visible with the naked eye. To which class of infectious agents listed below is it likely to belong? Explain your reasons.

A Helminths

B Viruses

C Protozoa.

SAQ 1.3 (tests Learning Outcomes 1.2, 1.3 and 1.4)

Hookworm infection is caused by parasites which are common in Ethiopia. The parasites live in the human intestine and lay eggs which are expelled from the body with the faeces into the soil. The eggs grow into worms in the soil, which penetrate the skin of people walking barefooted. Identify each of the following in this example:

A The infectious agent

B The reservoir

C The mode of transmission

D The route of exit and the route of entry.

SAQ 1.4 (tests Learning Outcome 1.4)

Based on the description in SAQ 1.3, what are the risk factors for hookworm infection?

SAQ 1.5 (tests Learning Outcomes 1.1, 1.2 and 1.6)

First read Abebe's story and then answer the questions that follow it.

Case study 1.1 Abebe's story

Typhoid fever is a disease that manifests clinically with high fever and headache. Suppose Abebe is infected with the infectious agent of typhoid fever, but he has no manifestations of the disease. He works in a cafe and among 20 people he served in one day, five got infected, but only three of these developed the disease. Among the three who developed typhoid fever, two recovered and one died.

From the given information:

(a) What are the likely modes of transmission?
(b) Which of the affected persons are active cases and which are carriers?
(c) Can you group the 20 people who were served in the cafe into the four stages of the natural history of a communicable disease?

Study Session 2 Prevention and Control of Communicable Diseases and Community Diagnosis

Introduction

In the first study session, you learned about the basic concepts in the transmission of communicable diseases. The knowledge you gained will help you to understand this study session because they are interlinked. In the first section, you will learn about the different ways of classifying communicable diseases. Following classification you will learn the approaches in prevention and control of communicable disease. This will help you in identifying appropriate measures for the prevention and control of communicable diseases that you, as a Health Extension Practitioner, and other health workers will put into place in your community. This study session forms the basis for study sessions later in this Module on specific diseases such as malaria, tuberculosis and HIV/AIDS. Finally, you will learn how to apply the methods of community diagnosis to assess and prioritise actions to prevent and control the main communicable diseases in your community.

Learning Outcomes for Study Session 2

When you have studied this session, you should be able to:

2.1 Define and use correctly all of the key words printed in **bold**. (SAQs 2.1, 2.2 and 2.4)

2.2 Identify the two main ways of classifying communicable diseases, and illustrate their usefulness. (SAQs 2.1 and 2.2)

2.3 Describe and give examples of prevention and control measures targeting the reservoir of infection. (SAQs 2.3 and 2.4)

2.4 Describe and give examples of prevention and control measures targeting the mode of transmission of communicable diseases. (SAQs 2.3 and 2.4)

2.5 Describe and give examples of prevention and control measures that protect the susceptible host from communicable diseases. (SAQs 2.3 and 2.4)

2.6 Describe the basic processes involved in community diagnosis and give examples of how you would apply these methods. (SAQ 2.5)

2.1 Classification of communicable diseases

Communicable diseases can be classified in different ways into groups with similar characteristics. Classification will help you to select and apply appropriate prevention and control measures that are common to a class of communicable diseases. In this section you will learn the basis for each way of classifying communicable diseases and its relevance to your practice. This will be clarified using examples of communicable diseases that you may already be familiar with.

In Study Session 1 you have learned the types of infectious agents which can be used for classification of communicable diseases. Apart from this, there are two main ways of classifying communicable diseases, which are important for you to know. The classification can be *clinical* or *epidemiologic,* as described in Box 2.1.

Box 2.1 Two ways of classifying communicable diseases

Clinical classification is based on the main clinical manifestations (symptoms and signs) of the disease.

Epidemiologic classification is based on the main mode of transmission of the disease.

Now, we will discuss the details of each type of classification with specific examples.

2.1.1 Clinical classification of communicable diseases

As stated in Box 2.1, this classification is based on the main clinical manifestations of the disease. This way of classification is important in helping you to treat the symptoms and signs that are common to (shared by) individuals who suffer from different diseases. Clinical classification is illustrated by the example given below.

Diarrhoeal diseases

Figure 2.1 Diseases whose main manifestation is diarrhoea are clinically classified as diarrhoeal diseases. The common treatment for this class of disease includes fluid replacement.

Some diseases are classified as **diarrhoeal diseases**. The main clinical symptom is **diarrhoea**, which means passage of loose stool (liquid faeces) three or more times per day. Two examples of diarrhoeal diseases are *shigellosis* and *cholera*. (Further details about these diseases are in Study Session 33 of this Module). People with watery diarrhoeal disease suffer from loss of fluid from their bodies. Therefore, even though the infectious agent might be different, as in the examples of shigellosis and cholera, the common management of patients with diarrhoeal disease includes fluid replacement (Figure 2.1).

Other clinical classifications

Another clinical classification refers to diseases characterised as **febrile illnesses**, because they all have the main symptom of fever, for example, malaria. **Respiratory diseases** are another clinical classification; their main symptoms include cough and shortness of breath, as in pneumonia.

Diseases have many symptoms and signs. As a Health Extension Practitioner, you will need to decide which symptom is the main one for classification. Using the method of clinical classification will help you decide to treat the main symptom. You will be able to identify the main symptoms more easily when you learn about specific diseases later on in this Module. Bear in mind that for most diseases, treatment of the main symptom is only supportive (that is it will not cure the disease). Therefore, you have to give treatment specific to the infectious agent. This will be discussed later in this Module under the specific diseases.

2.1.2 Epidemiologic classification

This classification is based on the main mode of transmission of the infectious agent. The importance of this classification for you is that it enables you to select prevention and control measures which are common to (shared by) communicable diseases in the same class, so as to interrupt the mode of transmission. To clarify the importance of epidemiologic classification, consider the following examples.

Cholera and *typhoid fever* are two different diseases which can be transmitted by drinking contaminated water. Therefore, they are classified as **waterborne diseases**, using the epidemiologic classification. The common prevention measures for the two diseases, despite having different infectious agents, include protecting water sources from contamination and treatment of unsafe water before drinking, for example by boiling (Figure 2.2) or adding chlorine.

The main types of epidemiologic classification are described in Box 2.2.

Figure 2.2 One method of treating unsafe water is boiling before drinking.
(Photo: Wikimedia Commons at http://commons.wikimedia.org/wiki/Category:Boiling_water)

Box 2.2 Epidemiologic classification of communicable diseases

Based on the mode of transmission of the infectious agent, communicable diseases can be classified as:

- **Waterborne diseases:** transmitted by ingestion of contaminated water.
- **Foodborne diseases:** transmitted by the ingestion of contaminated food.
- **Airborne diseases:** transmitted through the air.
- **Vector-borne diseases:** transmitted by vectors, such as mosquitoes and flies.

■ Suppose while you are working in your health facility, a 20 year-old man comes to you complaining of high fever accompanied by violent shivering (rigors), vomiting and headache. A blood examination for malaria found evidence of *Plasmodium falciparum*. Assume that he acquired the parasite after being bitten by infected mosquitoes. How would you classify this man's health problem, using two different classifications?

□ Clinically the disease is classed as a *febrile illness* because fever was the main clinical manifestation. Using epidemiologic classification, the disease is classed as *vector-borne* because it was transmitted by the mosquito.

You will learn how to carry out the rapid blood test for malaria in Study Session 7 of this Module.

When you have studied more about malaria in later study sessions, you will be able to see how the clinical classification as a *febrile illness* can help you in the management of the patient. As he has a high fever, in addition to treatment with anti-malarial drugs, you should take measures to lower the fever by giving him paracetamol. The epidemiologic classification of the disease as *vector-borne* helps you to select measures to prevent and control malaria in the community, for example by advocating protection from mosquito bites by using bed nets, and drainage of small collections of water where mosquitoes breed.

In the next section we will discuss the general approaches to prevention and control of communicable diseases at community level.

2.2 General approaches in the prevention and control of communicable diseases

You now have a working knowledge of factors involved in the *chain of disease transmission* (described in Study Session 1), and how to classify communicable diseases. This knowledge will help you to identify prevention and control measures that can be applied at each link in the chain. When we say **prevention** it refers to measures that are applied to prevent the occurrence of a disease. When we say **control** it refers to measures that are applied to prevent transmission *after* the disease has occurred. Most of the measures for prevention and control of communicable diseases are relatively easy and can be applied using the community's own resources. You have an important role in educating the public to apply these measures effectively.

■ You have learned that prevention and control of communicable diseases involves interventions to break the chain of transmission. Can you recall the six factors involved in the chain?

□ They are the infectious agent, the reservoir, the route of exit, the mode of transmission, the route of entry, and the susceptible host.

We can simplify the discussion of prevention and control measures acting on the chain of transmission by merging these six factors into three groups:

- Infectious agents in the reservoir of infection and the route of exit from the reservoir are discussed under the heading 'reservoir'.
- The 'mode of transmission' is the second category that we will discuss.
- The route of entry and the susceptible host are discussed under the heading 'susceptible host'.

2.2.1 Measures targeting the reservoir of infection

During your community practice, the prevention and control measures you will undertake depend on the type of reservoir. In this section we will discuss measures for tackling human and animal reservoirs. When you encounter an infected person, you should undertake the measures described below.

Diagnosis and treatment

First, you should be able to diagnose and treat cases of the disease, or refer the patient for treatment at a higher health facility. There are two ways to identify an infected individual: when a patient comes to you (Box 2.3, on the next page, describes how you should approach a patient in order to identify a case), and by screening (discussed below). Identifying and treating cases as early as possible, reduces the severity of the disease for the patient, avoiding progression to complications, disability and death; and it also reduces the risk of transmission to others.

Box 2.3 Approaches to the diagnosis of a case

- The first step is to ask about the main complaints of the patient.
- Then ask about the presence of other related symptoms and risk factors.
- Examine the patient physically to detect signs of any diseases you suspect.
- Finally, refer the patient for laboratory examinations if available (e.g. blood examination for malaria).

Screening

Screening refers to the detection of an infection in an individual who does not show any signs or symptoms of the disease. It is carried out using specific tests called *screening tests*. Screening will help you to detect an infection early and organise appropriate treatment so as to reduce complications and prevent transmission to others. An example of screening that may be familiar to you is screening the blood of pregnant women for HIV infection.

Issues related to HIV/AIDS will be further discussed in Study Sessions 20–30 later in this Module.

Isolation

Following detection of an infectious disease, you may need to separate patients from others to prevent transmission to healthy people. This is called **isolation**. It is not indicated for every infection, but it is important to isolate people with highly severe and easily transmitted diseases. For example, an adult case of active pulmonary tuberculosis ('pulmonary' means in the lungs) should be kept in isolation in the first two weeks of the intensive phase of treatment. The isolation period lasts until the risk of transmission from the infected person has reduced or stopped. The period and degree of isolation differs between different diseases, as you will learn in later study sessions.

You will learn further details about tuberculosis in Study Sessions 13–17 of this Module.

Reporting

Cases of communicable diseases should be reported to a nearby health centre or *woreda* Health Office periodically, using the national surveillance guidelines.

How to report communicable diseases will be discussed in Study Session 41 of this Module.

Animal reservoirs

When infected animals are the reservoir involved in the transmission of communicable diseases, different measures can be undertaken against them. The type of action depends on the animal reservoir, and ranges from treatment to destroying the infected animal, depending on the usefulness of the animal and the availability of treatment. For example to prevent and control a rabies outbreak, the measures to be taken are usually to destroy all stray dogs in the area, and vaccinate pet dogs if the owner can afford this protection and the vaccine is available.

2.2.2 Measures targeting the mode of transmission

The detailed discussion of interventions to prevent and control all these modes of transmission can be found in the *Hygiene and Environmental Health* Module.

The measures that can be applied to interrupt transmission of infectious agents in water, food, other vehicles and by vectors, are described below.

Water

Measures to prevent transmission of infection due to contaminated water include boiling the water, or adding chemicals like chlorine. **Disinfection** is the procedure of killing most, but not all, infectious agents outside the body by direct exposure to chemicals. Adding chlorine is one method of disinfecting water. Physical agents can also be used, for example filtering water through a box of sand, or pouring it through several layers of fine cloth. Faecal contamination of water should also be prevented by protecting water sources and through proper use of latrines (Figure 2.3).

Figure 2.3 Proper use of latrines can help prevent breeding of vectors, and contamination of hands, food and water.
(Photos: left, WaterAid, right, Pam Furniss)

Food

Measures to prevent transmission in contaminated food include washing raw vegetables and fruits, boiling milk, and cooking meat and other food items thoroughly before eating. Contamination with faeces can be prevented by hand washing and proper use of latrines.

Other vehicles

Measures to tackle transmission in or on vehicles other than water and food include:

- *Contaminated objects* like household utensils for cooking, eating and drinking should be washed with soap and water.
- *Contaminated medical instruments and clothing* can be sterilized, disinfected or properly disposed of.

Sterilisation involves destruction of all forms of micro-organisms by physical heat, irradiation, gas or chemical treatment. The difference between disinfection and sterilisation is that disinfection kills most, but not all, micro-organisms. Disinfection can be done using alcohol, chlorine, iodine or heating at the domestic level; whereas sterilisation has to use extreme heating, irradiation or strong chemicals like a high concentration of chlorine.

Vectors

Measures against vectors include preventing breeding of vectors, through proper disposal of faeces and other wastes, eradication of breeding sites, and disinfestation. **Disinfestation** is the procedure of destroying or removing small animal pests, particularly arthropods and rodents, present upon the person, the clothing, or in the environment of an individual, or on domestic animals. Disinfestation is usually achieved by using chemical or physical agents, e.g. spraying insecticides to destroy mosquitoes, and removing lice from the body and clothing.

2.2.3 Measures targeting the susceptible host

The measures described below help to protect the susceptible host either from becoming infected, or from developing the stage of infectious disease if they are exposed to the infectious agents.

Vaccination

As you already know from Study Session 1, **vaccination** refers to administration of vaccines to increase the resistance of the susceptible host against specific vaccine-preventable infections. For example, measles vaccination helps to protect the child from measles infection, and BCG vaccination gives some protection from tuberculosis (Figure 2.4).

You will learn more about vaccine-preventable diseases in Study Sessions 3 and 4 of this Module.

Figure 2.4 Vaccination can help to prevent transmission of communicable diseases by increasing the resistance of susceptible hosts. (Photo: AMREF, Ethiopia/ Demissew Bezuwork)

Chemoprophylaxis

Chemoprophylaxis refers to the drugs given to exposed and susceptible hosts to prevent them from developing an infection. For example, individuals from non-malarial areas who are going to a malaria endemic area can take a prophylactic drug to prevent them from developing the disease if they become infected with malaria parasites from a mosquito bite.

Chemoprophylaxis is pronounced 'keem-oh-proff-ill-axe-sis'; ('chemo' refers to medical drugs, and 'prophylaxis' means 'an action taken to prevent a disease').

Maintaining a healthy lifestyle

Proper nutrition and exercise improves a person's health status, supports the effective functioning of their immune system, and increases resistance to infection.

Limiting exposure to reservoirs of infection

Measures taken to decrease contact with reservoirs of infection include:

- Condom use to prevent transmission of HIV and other sexually transmitted infections (STIs).
- Use of insecticide treated nets (ITNs) over the bed at night, insect repellants and wearing protective clothing to prevent diseases transmitted by insect vectors.
- Wearing surgical or very clean gloves and clean protective clothing while examining patients, particularly if they have wounds, or the examination involves the genital area.
- Keeping personal hygiene, like taking a daily bath and washing your hands frequently. Hand washing with soap and water is the simplest and one of the most effective ways to prevent transmission of many communicable diseases (Figure 2.5). The times when hands must be washed are indicated in Box 2.4.

Figure 2.5 Hand washing with soap and water is the simplest and most effective way to prevent transmission of communicable diseases. (Photo: Basiro Davey)

Box 2.4 When to wash hands with soap and clean water?

- After using the toilet
- After handling animals or animal waste
- After changing a diaper (nappy) or cleaning a child's bottom
- Before and after preparing food
- Before eating
- After blowing the nose, coughing, or sneezing
- Before and after caring for a sick person
- After handling waste material.

Now you have many good ideas on what measures can be undertaken to prevent and control communicable diseases. However, you have to apply these methods effectively in order to prevent and control the most important communicable diseases in your community. But how do you identify these diseases? In the next section we will answer this question.

2.3 Community diagnosis

In order to select and apply effective prevention and control measures, you first have to determine which type of diseases are common in the community you are working with. How do you do that? The method is called **community diagnosis** and it involves the following four steps:

- Data collection
- Data analysis
- Prioritising problems
- Developing an action plan.

Data collection methods and data analysis are described in the Module on *Health Management, Ethics and Research*.

Let's start with data collection and proceed to the others step by step.

2.3.1 Data collection

Data collection refers to gathering data about the health problems present in the community. This is important as it will help you to have good ideas about the type of problems present in the area where you work. Where do you get useful data concerning the health problems in your community? The following sources of data can be used:

- Discussion with community members about their main health problems
- Reviewing records of the health services utilized by the community
- Undertaking a community survey or a small-scale project
- Observing the risks to health present in the community.

After collecting data it should be analysed to make meaning out of it.

2.3.2 Data analysis

Data analysis refers to categorising the whole of the data you collected into groups so as to make meaning out of it. For instance you can assess the magnitude of a disease by calculating its *prevalence* and its *incidence* from the numbers of cases you recorded and the number of people in the population in your community.

Prevalence refers to the total number of cases existing in the population at a point in time, or during a given period (e.g. a particular month or year). The number of cases can be more usefully analysed by calculating the **prevalence rate** in the community: to do this you divide the total number of cases you recorded in a given period into the total number of people in the population. The result is expressed 'per 1,000 population' in a community as small as a *kebele*. For example, suppose that in one year you record 100 cases of malaria in a *kebele* of 5,000 people: for every 1,000 people in the *kebele*, there were 20 malaria cases in that year. So the prevalence rate of malaria in that *kebele* is expressed as 20 cases per 1,000 people in that year.

Prevalence rates and incidence rates can also be expressed as 'per 10,000' or 'per 100,000' in much larger populations, e.g. of a region or a whole country.

Calculating the prevalence *rate* is more useful than just counting the number of cases, because the population size in your *kebele* can change over time. The prevalence rate takes account of changes in the number of people, so you

can compare the prevalence rates from different years, or compare the rate in your *kebele* with the rate in another one.

Incidence refers only to the number of *new* cases of a disease occurring in a given period. The **incidence rate** is calculated by dividing the total number of new cases of the disease in a certain period of time into the total number of people in the population, and is expressed as 'per 1,000 population'.

■ If there were 10 new cases of cholera in a *kebele* of 5,000 people in one month, what is the incidence rate of cholera per 1,000 population in that period?

□ The incidence rate in this example is two new cholera cases per 1,000 population.

As a health professional working in a community affected by several health problems at the same time it is difficult to address all the problems at once. Therefore, you should give priority to the most important ones first. But how do you prioritise? You are going to see how to do that next.

2.3.3 Prioritising health problems

Prioritising refers to putting health problems in order of their importance. The factors that you should consider in prioritising are:

- the *magnitude* of the problem: e.g. how many cases are occurring over what period of time?
- the *severity* of the problem: how high is the risk of serious illness, disability or death?
- the *feasibility* of addressing the problem: are the prevention and control measures effective, available and affordable by the community?
- the *level of concern* of the community and the government about the problem.

Health problems which have a high magnitude and severity, which can be easily solved, and are major concerns of the community and the government, are given the highest priority. After prioritising which disease (or diseases) you will give most urgent attention to, the next step is to develop an action plan.

2.3.4 Action plan

An **action plan** sets out the ways in which you will implement the interventions required to prevent and control the disease. It contains a list of the objectives and corresponding interventions to be carried out, and specifies the responsible bodies who will be involved. It also identifies the time and any equipment needed to implement the interventions. Once you have prepared an action plan you should submit it for discussion with your supervisor and other officials in the *woreda* Health Office to get their approval. Then implement the work according to your plan.

Now that you have learned the basic concepts and methods relating to communicable diseases in general, it is time for you to move on to consider the diagnosis, treatment, prevention and control of specific diseases. In the next two study sessions, you will learn about the bacterial and viral diseases that can be prevented by vaccination.

Summary of Study Session 2

In Study Session 2, you have learned that:

1 Communicable diseases can be classified based on their clinical or epidemiologic features.

2 Clinical classification is based on the main clinical manifestations of the disease (e.g. diseases characterised by diarrhoea are classified as diarrheal diseases; diseases characterised by fever are febrile diseases).

3 Epidemiologic classifications are based on the mode of transmission and include foodborne, waterborne, airborne and vector-borne diseases.

4 Prevention and control measures for communicable diseases may target the reservoir of infection, the mode of transmission, or the susceptible host.

5 Measures against a human reservoir include treatment and isolation. Measures against animal reservoirs can be treatment or destroying the animal.

6 Measures against transmitters like food, water, other vehicles, and vectors, include hand washing with soap, effective use of latrines, destruction of breeding sites, disinfection, sterilisation and disinfestation.

7 Measures to protect susceptible hosts include vaccination, keeping personal hygiene, use of bed nets and use of condoms.

8 Community diagnosis of health problems involves data collection; data analysis; prioritising interventions based on the magnitude and severity of the problem, the feasibility of addressing it, and the level of concern; and making and implementing an effective action plan.

Self-Assessment Questions (SAQs) for Study Session 2

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the questions below. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 2.1 (tests Learning Outcomes 2.1 and 2.2)

Tuberculosis (TB) is common in Ethiopia. Its main clinical manifestations include chronic cough and shortness of breath. Using this information, which classification of communicable diseases can you apply to TB and to which class does TB belong?

SAQ 2.2 (tests Learning Outcomes 2.1 and 2.2)

How would you classify pulmonary tuberculosis using the epidemiologic method? What is the main importance of such classification?

SAQ 2.3 (tests Learning Outcomes 2.3, 2.4 and 2.5)

Suppose in a certain rainy season you diagnosed malaria in several people who came to you seeking treatment. Then, you undertook the following measures:

(a) You treated each patient with the appropriate drug.
(b) You mobilised the community to eradicate breeding sites of mosquitoes.
(c) You gave health education on the proper use of bed nets.

Which factor in the chain of disease transmission are you targeting with each of the above measures?

SAQ 2.4 (tests Learning Outcomes 2.1, 2.3, 2.4 and 2.5)

Which of the following statements are *true* and which are *false*? In each case, explain your reasoning.

A Isolation of the susceptible host is advised for the duration of the incubation period of a severe and easily transmitted disease.
B Sterilisation refers to the destruction of all forms of micro-organisms by physical or chemical agents such as alcohol and chlorine.
C Vaccination and vector control target the infected host so as to prevent transmission of infection.

SAQ 2.5 (tests Learning Outcome 2.6)

Suppose among the diseases you have identified in your community, two are malaria and ascariasis (infection by ascaris worms). Let's say the prevalence rate of malaria is 90 per 1,000 population and the prevalence rate of ascariasis is 200 per 1,000 population.

(a) If you need to prioritise activities to control one of these diseases, what other criteria should you consider?
(b) Malaria is a more severe disease than ascariasis. Let's say that interventions for both diseases are equally feasible, but the community and government are more concerned about malaria. So, considering all the factors, to which disease do you give higher priority for prevention and control?

Study Session 3
Bacterial Vaccine-Preventable Diseases

Introduction

This study session and the next one focus on the communicable diseases that can be prevented by immunization with vaccines. Together they are known as **vaccine-preventable diseases**. In this study session you will learn about vaccine-preventable diseases caused by bacteria. In Study Session 4 we will describe those that are caused by viruses. Greater understanding of these diseases will help you to identify the ones that are common in your community, so that you can provide effective vaccination programmes, and identify and refer infected people for specialised treatment at a higher health facility.

In this study session, you will learn some basic facts about bacterial vaccine-preventable diseases, particularly how these diseases are transmitted, and how they can be treated and prevented. Our focus will be on tetanus and meningitis, because tuberculosis (TB), which is a bacterial vaccine-preventable disease, will be discussed in much more detail in Study Sessions 13–17 of this Module. Bacterial pneumonia (infection of the lungs), caused by bacteria called *Streptococcus pneumoniae* and *Haemophilus influenzae*, is also discussed in detail later, in Study Session 35. A vaccine against *Haemophilus influenzae* is already being given to children in Ethiopia. A new vaccine against *Streptococcus pneumoniae* is planned to be introduced in Ethiopia, probably in 2011/2012.

You will learn about vaccines in detail in the *Immunization* Module.

Learning Outcomes for Study Session 3

When you have studied this session, you should be able to:

3.1 Define and use correctly all of the key words printed in **bold**. (SAQs 3.1, 3.2 and 3.3)

3.2 Describe what causes common bacterial vaccine-preventable diseases, how the infectious agents are transmitted, and the characteristic symptoms of an affected person. (SAQs 3.1 and 3.4)

3.3 Describe how the bacterial vaccine-preventable diseases tetanus and meningococcal meningitis can be treated, controlled and prevented in rural communities. (SAQs 3.2, 3.3 and 3.4)

3.1 Vaccines, immunity and vaccination

Before we can tell you about the vaccine-preventable diseases, you need to understand what is meant by a vaccine. **Vaccines** are medical products prepared from whole or parts of bacteria, viruses, or the toxins (poisonous substances) that some bacteria produce. The contents of the vaccine have first been treated, weakened or killed to make them safe. If a vaccine is injected into a person, or given orally by drops into the mouth, it should not cause the disease it is meant to prevent, even though it contains material from the infectious agent. Vaccines are given to susceptible persons, particularly children, so that they can develop immunity against the infectious agent (Figure 3.1).

Figure 3.1 Vaccination may hurt for a moment but the BCG vaccine given to this baby will help to protect him against tuberculosis. (Photo: AMREF Ethiopia/Demissew Bizuwerk)

As you will recall from Study Session 1, **immunity** refers to the ability of an individual to resist a communicable disease. When a dead or weakened micro-organism is given in the form of a vaccine, this process is called **vaccination** or **immunization**. For simplicity, in this Module we will refer to 'vaccination', but you should be aware that these two terms are used interchangeably.

The vaccine circulates in the body and stimulates white blood cells called **lymphocytes** to begin producing special defensive proteins known as **antibodies**. Antibodies are also normally produced whenever a person is infected with active bacteria or viruses transmitted from a reservoir in the community. Antibodies and white blood cells are very important natural defences against the spread of infection in our bodies, because they can destroy infectious agents before the disease develops. What vaccination does is to stimulate this normal response, by introducing a weakened or killed form of infection, which the white blood cells and antibodies attack.

This defensive response against the harmless vaccine increases the person's level of immunity against the active infectious agents, if the same type that was in the vaccine gets into the body. The protective effect of vaccination lasts for months or years afterwards, and if several vaccinations are given with the same vaccine, the person may be protected from that infection for their lifetime. The Module on *Immunization* will teach you all about the vaccines available in Ethiopia in the Expanded Programme on Immunisation (EPI), and how they are stored and administered in vaccination programmes.

3.2 Overview of bacterial vaccine-preventable diseases

Vaccine-preventable diseases are important causes of death in children. The causes, infectious agents, modes of transmission, symptoms, and methods of prevention, treatment and control of the most important bacterial vaccine-preventable diseases are summarized in Table 3.1. Note that some of the diseases shown in Table 3.1, such as diphtheria and pertussis, are no longer common in Ethiopia, or in other countries where vaccination in childhood against their infectious agents is widespread. Tuberculosis and bacterial pneumonia are discussed in detail in later study sessions.

In this study session, we will describe *tetanus* and bacterial *meningitis*, so that you will be able to identify and refer cases of these diseases, and also know how you might help to prevent them in your community.

Table 3.1 Causes, transmission, symptoms, prevention and control methods for common bacterial vaccine-preventable diseases.

Disease	Bacterial cause *(scientific name)*	Mode of transmission	Symptoms	Prevention and control methods
Tuberculosis	*Mycobacterium tuberculosis*	Respiratory by coughing or sneezing	Chronic cough, weight loss, fever, decreased appetite (more details are given in Study Session 13)	BCG vaccine, chemoprophylaxis, early diagnosis and treatment
Diphtheria	*Corynebacterium diphtheriae* and its toxin	Respiratory by coughing or sneezing	Sore throat, loss of appetite, and slight fever	Diphtheria vaccine, combined with two or four other vaccines against pertussis, tetanus, BCG, etc.
Pertussis	*Bordetella pertussis*	Respiratory by coughing or sneezing	Runny nose, watery eyes, sneezing, fever, and continuous cough, followed by vomiting	Pertussis vaccine, combined with two or four other vaccines against diphtheria, tetanus, BCG, etc.
Tetanus	*Clostridium tetani*	From soil into a wound or broken skin, through direct contact	Stiffness in the jaw and neck, with stomach and muscle spasms	Tetanus vaccine for children, combined with other vaccines, or given alone for women of childbearing age
Meningitis (infection of the brain or spinal cord)	*Neisseria meningitidis*	Respiratory by coughing or sneezing	Fever, headache, neck stiffness, coma	Meningococcal vaccine and treatment by antibiotics
	Streptococcus pneumoniae	Respiratory by coughing or sneezing	Fever, headache, neck stiffness, coma	Treatment by antibiotics; a pneumococcal conjugate vaccine (PCV) will be introduced to Ethiopia soon
Pneumonia (infection of the lungs)	*Streptococcus pneumoniae*	Respiratory by coughing or sneezing	Cough, fast breathing/ difficult breathing (more details are given in Study Session 35)	Treatment by antibiotics; a pneumococcal conjugate vaccine (PCV) will be introduced to Ethiopia soon
	Haemophilus influenzae	Respiratory by coughing or sneezing	Cough, fast breathing/ difficult breathing (more details are given in Study Session 35)	Treatment by antibiotics; Hib is part of the pentavalent vaccine

3.3 Tetanus

In this section, you will learn about what tetanus is, how it is transmitted, what its clinical symptoms are, and how it can be treated and prevented. Having this information will help you to identify cases of tetanus and refer them to the nearby hospital or health centre for further treatment. All cases should be reported to the District Health Office. After reading this section, you should also be able to educate your community about the causes of tetanus, and how to prevent it. You will learn how to give the tetanus toxoid vaccine to children, and to women of reproductive age, in the Module on *Immunization*.

3.3.1 Definition, cause and occurrence of tetanus

Tetanus is a neurological disorder, that is, a disorder of the nervous system. Symptoms of tetanus are tight muscles that are difficult to relax, and muscle *spasms* (muscle contractions that occur without the person wanting them to). These problems with the muscles are caused by a toxin (poison) produced by the bacteria called *Clostridium tetani*.

Tetanus is among the top ten causes of illness and death in newborns in Ethiopia. Tetanus in newborns is called **neonatal tetanus**. Nine out of every 1,000 newborns in Ethiopia have neonatal tetanus. More than 72% of the newborns who have tetanus will die.

Tetanus is also common among older children and adults who are susceptible to the infection. Unvaccinated persons are at risk of the disease, and people who have a dirty wound which favours the growth of the bacteria that cause tetanus are especially vulnerable.

3.3.2 Mode of transmission of tetanus

People can get tetanus through exposure to tetanus bacteria (*Clostridium tetani*) which are always present in the soil. The bacteria can be transmitted directly from the soil, or through dirty nails, dirty knives and tools, which contaminate wounds or cuts. A newborn baby can become infected if the knife, razor, or other instrument used to cut its umbilical cord is dirty, if dirty material is used to dress the cord, or if the hands of the person delivering the baby are not clean. Unclean delivery is common when mothers give birth at home in poor communities, but it can be prevented by skilled birth attendants (Figure 3.2).

Figure 3.2 Skilled birth attendants can reduce the risk of tetanus infecting babies born at home in rural communities. (Photo: AMREF/Sven Torfinn)

The disease is caused by the action of a toxin produced by the bacteria, which damages the nerves of the infected host. This toxin is produced during the growth of the tetanus bacteria in dead tissues, in dirty wounds, or in the umbilicus following unclean delivery of the newborn.

3.3.3 Clinical manifestations of tetanus

The time between becoming infected with *Clostridium tetani* bacteria and the person showing symptoms of tetanus disease is usually between three and 10 days, but it may be as long as three weeks.

- What is the name given to the gap in time between infectious agents entering the body, and the first appearance of the disease they cause? (You learned this in Study Session 1.)

- It is called the **incubation period**.

In cases of tetanus, the shorter the incubation period, the higher the risk of death. In children and adults, muscular stiffness in the jaw, which makes it difficult or impossible to open the mouth (called 'locked jaw') is a common first sign of tetanus. This symptom is followed by neck stiffness (so the neck cannot be bent), difficulty in swallowing, sweating, fever, stiffness in the stomach muscles, and muscular spasms (involuntary contraction of the muscles).

Babies infected with tetanus during delivery appear normal at birth, but they become unable to feed by suckling from the breast at between three and 28 days of age. Their bodies become stiff, while severe muscle contractions and spasms occur (Figure 3.3). Death follows in most cases.

Figure 3.3 A baby who has rigidity and arching of the whole body due to tetanus. (Photo: WHO, 2000, at www.who.int/vaccines-documents/)

- A newborn baby (10 days old) who was born in a village with the assistance of traditional birth attendants, is brought to you with fever, stiffness in the stomach muscles and difficulty in opening his mouth, so he is unable to breastfeed. What is the possible cause of this baby's symptoms, and why do you make this diagnosis? What action will you take?

- The newborn may have tetanus since he was born at home without the care of a skilled birth attendant. The umbilical cord could be infected by tetanus. You should refer this child urgently to the nearest health centre or hospital.

3.3.4 Treatment, prevention and control of tetanus

Once a person has tetanus, he or she will be treated by an antibiotic drug. **Antibiotics** are medicines that destroy bacteria, or stop them from multiplying in the body. However, many people who have tetanus die despite the treatment. Hence, prevention is the best strategy, and vaccination is the best way to prevent tetanus.

Tetanus toxoid (TT) vaccination

The tetanus vaccine contains inactivated tetanus toxoid (poison), which is why it is often called TT vaccine. Tetanus toxoid vaccination is given routinely to newborns and infants as part of the threefold DPT vaccine (with diphtheria and pertussis vaccines), or the pentavalent (fivefold) vaccine, which includes vaccines for diphtheria, tetanus, pertussis, Hepatitis B (a virus), and a bacterium called *Haemophilus influenzae* type B (Hib). Neonatal tetanus can also be prevented by vaccinating women of childbearing age with tetanus toxoid vaccine, either during pregnancy or before pregnancy. This protects the mother and enables anti-tetanus antibodies to be transferred to the growing fetus in her uterus.

■ What is the name given to this mode of transmission? (You learned about it in Study Session 1 in reference to infectious agents being transferred from mother to baby).

□ The transmission from mother to fetus is called *transplacental transmission* because the mother's antibodies pass across the placenta and into the baby.

Cleanliness is also very important, especially when a mother is delivering a baby, even if she has been vaccinated with TT vaccine.

People who recover from tetanus do not have increased natural immunity and so they can be infected again. Therefore they will need to be vaccinated.

The World Health Organization (WHO) and UNICEF set a goal to eliminate neonatal tetanus by 2005. **Elimination** in this case would mean that the number of neonatal tetanus cases would have to be reduced to below one case per 1,000 live births per year in every district. Notice that elimination of a communicable disease does not mean there are *no* cases — just very few right across a country or region. **Eradication** means the total and sustained disappearance of the disease from the population.

■ Do you think that tetanus can ever be eradicated? Explain why, or why not.

□ Because tetanus bacteria survive in soil in the environment, eradication of the disease is not possible.

To achieve the elimination goal, countries like Ethiopia, with a high number of tetanus cases every year, need to implement a series of prevention strategies, which include those listed in Box 3.1.

Box 3.1 Strategies to prevent and control tetanus

- *Vaccinating* a higher percentage of pregnant women against tetanus with vaccines containing tetanus toxoid (TT).
- *Vaccinating* all females of childbearing age (approximately 15–45 years) with TT vaccine in high-risk areas where vaccination coverage is currently low.
- *Outreach vaccination campaigns* where health workers go to rural villages and give TT vaccine, usually three times at intervals (known as a 'three-round' vaccination campaign).
- *Promoting clean delivery and childcare practices*, through better hygiene and care of the newborn's umbilicus.
- *Improving surveillance and reporting* of cases of neonatal tetanus. The case finding and reporting will help us to give appropriate treatment and vaccination to children.

Clean delivery practices are described in the *Labour and Delivery Care* Module.

3.4 Meningococcal meningitis

In this section, we will describe what meningococcal meningitis is, how it is transmitted, what its clinical symptoms are, and also how it can be treated and prevented. With this information, we hope you will be able to identify a person with meningitis and refer him or her *urgently* to the nearest health centre or hospital for further diagnosis and treatment. You should also be able to detect meningococcal meningitis epidemics in the community.

Cases of meningitis must be referred *urgently* for medical treatment.

3.4.1 Definition and cause of meningococcal meningitis

Meningococcal meningitis is an infection of the brain and spinal cord by the bacterium *Neisseria meningitidis* (also known as the meningococcus bacterium). The disease is caused by several groups of meningococcus bacteria, which are given distinguishing codes such as type A, B, C, Y and W135.

The disease occurs globally, but in sub-Saharan Africa, meningitis epidemics occur every two to three years. An **epidemic** is a sudden and significant increase in the number of cases of a communicable disease, which may go on rising for weeks, months or years. Meningitis epidemics are common in many countries of Sub-Saharan Africa, including Ethiopia. In Ethiopia, these epidemics are usually caused by group A and C type meningococcus bacteria, and are more common in western Ethiopia. The disease is most common in young children, but it also can affect young adults living in crowded conditions, in institutions, schools and refugee camps.

In populations over 30,000 people, a meningitis epidemic is defined as 15 cases per 100,000 inhabitants per week; or in smaller populations, five cases in one week or an increase in the number compared to the same period in previous years.

3.4.2 Mode of transmission and clinical symptoms

Meningococcal meningitis is transmitted to a healthy person by airborne droplets from the nose and throat of infected people when they sneeze or cough. The disease is marked by the sudden onset of intense headache, fever, nausea, vomiting, sensitivity to light and stiffness of the neck. Other signs include lethargy (extreme lack of energy), coma (loss of consciousness), and convulsions (uncontrollable shaking, seizures). Box 3.2 summarises the *general* signs of meningitis, which may also be caused by some other serious conditions, and the more *specific* signs which are characteristic of meningitis.

Box 3.2 General and more specific signs of meningitis in infants

General signs of meningitis:

- Drowsy, lethargic or unconscious
- Reduced feeding
- Irritable
- High pitched cry.

More specific signs of meningitis:

- Convulsion (fits)
- Bulging fontanelle in infants.

A child with typical signs of meningitis such as neck stiffness, bulging fontanelle and convulsion, should be immediately referred to the nearest hospital or health centre.

During examination of a baby with meningitis, you will notice stiffness of the neck, or bulging of the **fontanelle** – the soft spot on top of the head of infants (see Figure 3.4). The fontanelle bulges because the infection causes fluid to build up around the brain, raising the pressure inside the skull. A bulging fontanelle due to meningitis is observed in infants since the bones of the skull are not yet fused together.

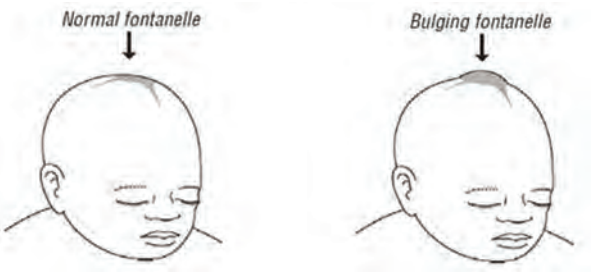


Figure 3.4 Bulging of the fontanelle in infants is a sign of meningitis. (Source: WHO, 2005, *Pocket Book of Hospital Care for Children*, p.50)

Children may also show rigid posture due to irritation of the covering part of the brain or spinal cord. To check the presence of neck stiffness, ask the parents to lay the child in his/her back in the bed and try to flex the neck of the child (Figure 3.5).

Figure 3.5 Neck stiffness is a danger sign of meningitis.

If meningitis is not treated, mortality is 50% in children. This means that half of all cases end in death. However, with early treatment, mortality is reduced to between 5 to 10%. But about 10 to 15% of those surviving meningococcal meningitis will suffer from serious complications afterwards, including mental disorders, deafness and seizures.

3.4.3 Diagnosis and treatment of meningitis

Meningitis is diagnosed by physical examination of the person, and by laboratory testing of the fluid from their spinal cord, where the meningococcal bacteria can be found. In the hospital or health centre, the meningitis is treated using antibiotics given intravenously (IV), that is, liquid antibiotics given directly into the bloodstream through a vein.

■ Tetanus and meningitis are both diseases in which fever and stiffness of the neck are important symptoms. How could you tell these diseases apart in babies by examining them yourself?

□ Tetanus and meningitis can both be manifested by fever and neck stiffness, but there are other specific signs of each disease which help in differentiation. For instance, people with tetanus may have tightness of the abdominal muscles and may be unable to open their mouths. By contrast, the bulging fontanelle is a typical sign of meningitis in young babies, which would not be found in cases of tetanus. However, these diseases are very difficult to distinguish on the basis of clinical examination alone.

3.4.4 Prevention and control of meningococcal meningitis

Next we describe how to prevent meningococcal meningitis from spreading in a community. The most important preventive and control methods are summarized in Box 3.3.

Box 3.3 Strategies to prevent and control meningitis

- *Early identification* and *prompt treatment* of cases in the health facility and in the community.
- *Education* of people in the community on the symptoms of meningitis, the mode of transmission and the treatment of the disease.
- *Reporting* any cases of meningitis to the District Health Office; and avoiding close contact with the sick persons. Your health education messages should tell everyone about this.
- *Vaccination* against meningococcus bacteria of types A, C, Y and W135, as described in the *Immunization* Module.

A mass immunization campaign that reaches at least 80% of the entire population with meningococcus vaccines can prevent an epidemic. However, these vaccines are not effective in young children and infants, and they only provide protection for a limited time, especially in children younger than two years old. A single case of meningitis could be a warning sign for the start of an epidemic. As a community Health Extension Practitioner, you will need to educate your community about the symptoms of meningitis and how it is transmitted. All cases should be reported to the District Health Office.

The next study session is also about vaccine-preventable diseases, but we turn your attention to those common diseases of this type that are caused by viruses.

Summary of Study Session 3

In Study Session 3, you have learned that:

1 Vaccine-preventable diseases are communicable diseases that can be prevented by immunization with vaccines containing weakened or killed infectious organisms or their toxins.

2 Vaccination increases the level of immunity in the body to the infectious agents that were used to make the harmless vaccine.

3 Tuberculosis, diphtheria, pertussis, tetanus, meningococcal meningitis and streptococcal pneumonia are the commonest and the most important bacterial vaccine-preventable diseases.

4 Tetanus and meningococcal meningitis are bacterial vaccine-preventable diseases that cause many deaths of children and adults in developing countries.

5 Tetanus bacteria (*Clostridium tetani*) live in the soil and enter the body through wounds, breaks in the skin and, in the newborn, in the umbilical cord after it has been cut.

6 The symptoms and signs of tetanus include rigid posture, stiffness in the jaw and neck, difficulty in swallowing, sweating, fever, stiffness in the stomach muscles and muscular spasms.

7 Clean delivery of babies by trained health professionals, and vaccination of children and women in the reproductive age groups with tetanus toxoid (TT) vaccine, are the most important strategies for preventing neonatal tetanus.

8 Meningococcal meningitis is caused by *Neisseria meningitidis* (or the meningococcus bacteria); they are passed from person to person in airborne droplets when the infected host coughs or sneezes, sometimes causing epidemics.

9 A person who has signs of meningitis, such as high fever, neck stiffness, lethargy and loss of consciousness, or bulging of the fontanelle in babies, should be referred immediately to the nearest hospital or health centre.

10 Cases of tetanus or meningococcal meningitis in the community should be reported to the District Health Office.

Self-Assessment Questions (SAQs) for Study Session 3

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the following questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 3.1 (tests Learning Outcomes 3.1 and 3.2)

Mention two or more bacterial vaccine-preventable diseases that have the same modes of transmission.

SAQ 3.2 (tests Learning Outcomes 3.1 and 3.3)

What are the methods for preventing bacterial meningitis?

SAQ 3.3 (tests Learning Outcomes 3.1 and 3.3)

If you observe a child who has a fever, neck stiffness and a rigid posture, as shown in Figure 3.6, what is the likely cause? What action will you take and why?

Figure 3.6 Rigid posture of a sick child. (Source: WHO, 2005, *Pocket Book of Hospital Care for Children* p.149)

SAQ 3.4 (tests Learning Outcomes 3.2 and 3.3)

Mention two major bacteria that commonly cause meningitis. Can you differentiate between the symptoms caused by these bacteria? What would you do if you encounter a person with these symptoms?

Study Session 4 Viral Vaccine-Preventable Diseases

Introduction

In Study Session 3 we gave an overview of vaccine-preventable diseases, and then focused on two of the main diseases in this category that are caused by bacteria. In this study session, you will learn about the major vaccine-preventable diseases that are caused by viruses, how they are transmitted, and how they can be prevented and controlled. Knowing the signs and symptoms of these viral diseases will help you to identify them in your community, so that you can refer infected people quickly for treatment at a nearby health centre. Greater understanding of viral vaccine-preventable diseases will also enable you to explain to parents why they should have their children vaccinated to prevent them from susceptibility to these viruses. How to give vaccines to children is described in the *Immunization* Module.

Learning Outcomes for Study Session 4

When you have studied this session, you should be able to:

4.1 Define and use correctly all of the key words printed in **bold**. (SAQs 4.1 and 4.3)

4.2 Describe what causes the common viral vaccine-preventable diseases, how the infectious agents are transmitted, and the characteristic signs and symptoms of an affected person. (SAQs 4.2 and 4.3)

4.3 Describe the treatment in the community of children who have measles. (SAQ 4.2)

4.4 Describe how measles, polio and hepatitis B can be controlled and prevented in rural communities. (SAQ 4.3)

4.1 Overview of viral vaccine-preventable diseases

As you know from Study Session 1 of this Module, **viruses** are microscopic infectious agents that do not have the structure of a cell; they are more like tiny boxes or particles. They are much smaller than bacteria and can only be seen with the most powerful microscopes. Some of the diseases caused by viruses can be prevented by vaccination, as you will learn in this study session.

■ Do you know of any human communicable diseases caused by a virus?

□ HIV disease and AIDS are caused by the human immunodeficiency virus (HIV). You may also have thought of measles, polio or hepatitis.

HIV cannot be prevented by vaccination at the present time, but the other three viral diseases mentioned above are part of the Expanded Programme of Immunization (EPI) in Ethiopia and many other countries around the world (see Table 4.1, on the next page). The composition of the vaccines, which contain dead or weakened viruses or fragments of their structure, and the routes of administration, are described in detail in the *Immunization* Module. In the following sections, we will look at each of these diseases in turn.

Table 4.1 Causes, transmission, symptoms, prevention and control methods for common viral vaccine-preventable diseases.

Disease	Cause	Mode of transmission	Symptoms	Prevention methods
Measles	measles virus	Respiratory by coughing or sneezing	Cough, rash and fever	measles vaccination
Poliomyelitis	polio virus	Ingesting (faeco-orally)	A few children have paralysis of the legs or hands; many will not show symptoms	oral polio vaccination (OPV)
Hepatitis	hepatitis B virus	Direct contact with body fluids or blood, or sexually transmitted	Fever, yellow colouring of the white part of the eye; many children will not show symptoms	hepatitis B vaccination

4.2 Measles

In this section, you will learn about what measles is, how it is transmitted, what its signs and symptoms are, and how it can be treated and prevented. Having this information will help you to identify a child with measles and give necessary treatment. After reading this section, you should also be able to identify an epidemic of measles in the community if it occurs, so you will be able to report it to the District Health Office.

4.2.1 Definition, cause and occurrence of measles

Note that (unlike bacteria, which have two-part *species* names) the names of most viruses are simply the disease it causes followed by the word 'virus', as in 'measles virus'.

Measles is a highly transmissible infectious disease caused by the measles virus. Globally, measles kills more children than any other vaccine-preventable disease. In 2008, there were around 165,000 deaths from measles worldwide – most of them in young children and almost all of them in low-income countries. Because the virus is so easily transmitted, you should be aware that it usually causes an epidemic and may cause many deaths, especially among malnourished children. In Ethiopia, measles occasionally causes epidemics. Almost 5,000 children suffered from measles in 2009 and 2,726 cases had already been confirmed in 2010 by early July of that year. However, it is estimated that deaths from measles can be reduced by more than 60% through effective vaccination programmes.

Figure 4.1 Transmission of measles by airborne droplets occurs easily in schools. (Photo: Ali Wyllie)

4.2.2 Mode of transmission of measles

Measles is spread through contact with the nose and throat secretions of infected people, and in *airborne droplets* released when an infected person sneezes or coughs. A person with measles can infect others for several days before and after he or she develops symptoms. The disease spreads easily in areas where infants and children gather, for example in health centres, homes and schools (Figure 4.1).

4.2.3 Clinical manifestations of measles

The first sign of infection with measles is a high fever, which begins approximately 10–12 days after exposure to the virus and lasts for several

days. During this period, the child may develop a runny nose, a cough, red and watery eyes (Figure 4.2), and small white spots inside his or her cheeks.

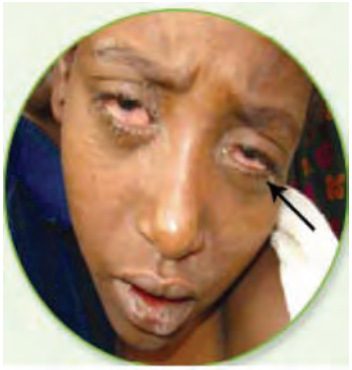


Figure 4.2 Red eyes (conjunctivitis) due to measles. (Source: WHO and Ethiopian Federal Ministry of Health, 2005, *Case Definition of Measles*)

Conjunctivitis is pronounced 'con-junk-tiv-eye-tiss'.

After several days, a slightly raised **rash** (appearance of small pigmentations or red spots on the skin, or '*shifta*' in Amharic), develops, usually on the face and upper neck. Over a period of about three days, the rash spreads to the body (Figure 4.3) and then to the hands and feet. It lasts for five or six days and then gradually fades. The incubation period from exposure to the onset of the rash averages 14 days.

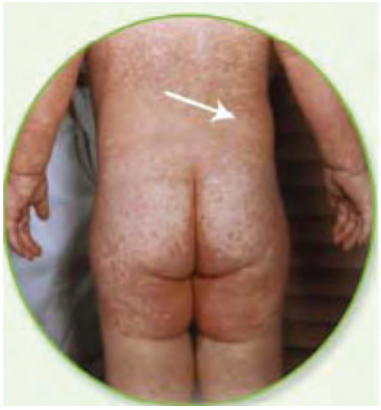


Figure 4.3 Measles rash covering the whole body of a child. (Source: WHO and Ethiopian Federal Ministry of Health, 2005, *Case Definition of Measles*)

To identify cases of measles, you need to confirm the presence of fever and rash, with cough or running nose, or conjunctivitis (red eyes).

Measles may be severe, causing several complications that can lead to permanent disability or death, including pneumonia (infection of the lower respiratory tract), encephalitis (infection in the brain), otitis media (infection of the middle ear), corneal clouding and blindness (Figure 4.4), and diarrhoea with dehydration. You will learn about pneumonia and acute otitis media in more detail in Study Session 35.

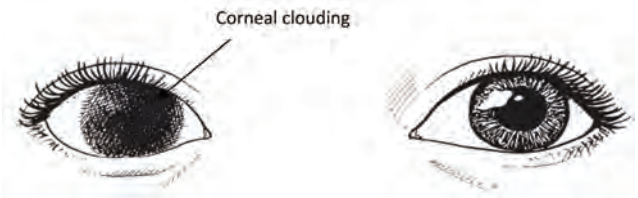


Figure 4.4 Corneal clouding in a child with measles and vitamin A deficiency. (Source: WHO, 2005, *Pocket Book of Hospital Care for Children*)

The structure of the eye and the main causes of blindness are covered in the Module on *Non-Communicable Diseases, Emergency Care and Mental Health.*

Severe measles, manifested by complications such as pneumonia, and clouding of the eyes or blindness, is particularly likely in poorly nourished children, especially those who do not receive sufficient vitamin A in their diet. Vitamin A, which is found in yellow vegetables like carrots and yellow fruits like mangoes, is essential for good eyesight and it also strengthens the immune system of children. If measles develops in a child with a shortage of vitamin A, this makes the disease more severe and damage to eyesight is more likely. Measles and vitamin A deficiency together are a major cause of blindness among children in Africa and in other areas of the world where measles is common. Children who live in crowded conditions and whose immune systems have been weakened by HIV/AIDS, or other diseases, are also more likely to develop severe measles.

■ Give a reason why malnourished children are more likely to develop severe measles.

□ Children with malnutrition, particularly those who lack vitamin A, have weak immunity and cannot fight the measles virus, which causes severe clinical symptoms and may even kill them.

4.2.4 Treatment, prevention and control of measles

Cases of severe measles with pneumonia or clouding of the cornea should be referred immediately to the nearest health facility.

It is very important to encourage children with measles to eat and drink. Advise the parents to help their child as much as possible with nutrition and intake of fluids; treat any dehydration with oral rehydration salts (ORS) as necessary. Antibiotics should only be prescribed for ear infections and pneumonia caused by bacteria, which are able to develop in the person weakened by measles. Remember that antibiotics only attack bacteria – they have no activity against any viruses, including the measles virus.

Vitamin A supplementation

As lack of vitamin A is such a problem associated with measles, all children in developing countries who are diagnosed with measles should receive *two doses of vitamin A supplements given 24 hours apart*, at a dosage appropriate to their age (see Table 4.2). For instance, a 7 month-old infant with measles should receive one dose of vitamin A, which contains 100,000 International Units (IU) on the day of diagnosis (day 1) and also on the next day (day 2). Giving Vitamin A can help prevent eye damage and blindness and reduce the number of deaths from measles by 50%, so this is a very important and effective part of the treatment.

IU stands for International Unit; this is the internationally agreed measurement of vitamin dosages

Table 4.2 Dosage of vitamin A for children with measles.

Age	Immediately on diagnosis	Next day	Follow-up
Infants less than 6 months old	50,000 IU	50,000 IU	Third dose 2–4 weeks later if there are signs of eye problems
Infants aged 6–11 months	100,000 IU	100,000 IU	
Children aged 12 months and over	200,000 IU	200,000 IU	

Measles vaccination

Measles is prevented by vaccination with measles vaccine. By the year 2008, successful vaccination campaigns all over the world had succeeded in reducing measles deaths by around 75% — a huge drop from the 750,000 deaths in the year 2000. The World Health Organization (WHO) estimated that in 2008 around 83% of the world's children were receiving one dose of measles vaccine by their first birthday.

How to administer the measles vaccine to children is described in the *Immunization* Module.

All infants at *nine months* of age or shortly thereafter should be vaccinated through routine immunization services. This is the foundation of the sustainable measles death-reduction strategy. It is also possible to reduce infections with measles by giving vaccination to vulnerable children. For example, to reduce the risk of measles infection in hospitals, all children between the ages of six and nine months, who have not received measles vaccine and who are admitted to a hospital, should be vaccinated against measles. If the children's parents do not remember or know whether they have received measles vaccine, the child should still be vaccinated. If a hospitalised child has received measles vaccine before nine months of age, a second dose should be administered at nine months, or as soon as possible after nine months.

All children should be provided with a second opportunity for measles vaccination. This is to make sure that children who did not receive a previous dose of measles vaccine, or children who were vaccinated earlier but did not develop immunity, have another chance to develop immunity. The second opportunity may be delivered either through routine immunization services or through periodic mass campaigns of vaccination.

Measles surveillance

Measles surveillance (looking for cases of measles in the community) should be strengthened at community level, so that there is early warning of any possible epidemics. Try to persuade parents that a child with measles should be kept isolated from other children who have not previously had measles or been vaccinated, to avoid the disease from spreading. As a health worker, you should report any cases of measles in your community to the District Health Office. As well as this, of course, you have the important task of vaccinating all children who are around nine months old against measles.

Next, we would like you to read Case Study 4.1 and then answer the questions that follow it.

Case Study 4.1 Alemu's parents want to cure his rash by prayer

During a house-to-house visit in a remote village, you see a one year-old boy called Alemu, who has a high fever, a cough and small rashes (the spots look like *teff*) on his forehead and neck. Alemu's parents call this illness *'ankelis'* or *'wotetie'* in the local language. The treatment they believe will cure their son is to prepare a coffee ceremony to the gods who they believe to have spiritual power. They informed you that their two older children were cured by the same treatment and they will continue acting the same way for Alemu.

- What should you advise Alemu's parents? What actions should you take to help the child? And what else should you do?

- Advise the parents that the child may have a disease called measles, which is caused by a virus. Measles is prevented by vaccination, and children who recover from measles naturally will never get it again (they develop lifelong immunity). If the disease is severe, children may die. Inform the parents that for a very sick child like Alemu, complications such as pneumonia and death can be prevented by giving vitamin A and fluids such as oral rehydration salts. Give vitamin A (200,000 IU) on the first and second day to Alemu. After convincing the parents, refer the child to the health centre and report the case to the District Health Office. Search for other similar cases in the village.

4.3 Poliomyelitis (polio)

In this section, we will describe what polio is and how it is transmitted, its clinical symptoms, how it is treated and how it can be prevented and controlled. This will help you to identify cases of polio and refer them for further diagnosis and treatment. It will also help you to give health education in your community about how to prevent polio in children through the administration of oral polio vaccine in drops into the mouth.

4.3.1 Definition, cause and occurrence of polio

Poliomyelitis (usually called **polio**) is a viral disease that causes **paralysis** (weakness or inability to use the muscles) of the legs, arms or hands. Polio is caused by three types of viruses, namely, poliovirus types 1, 2 or 3; (note that 'poliovirus' is all one word). Many countries agreed in 1988 to try to *eradicate* polio completely from the world. The Ethiopian government has a plan to eradicate the disease in the near future. As a result of a continuing vaccination programme, polio is fortunately becoming a rare disease in Ethiopia. However, there are sometimes cases among people who come to Ethiopia from neighbouring countries such as Sudan.

4.3.2 Mode of transmission and clinical manifestation of polio

Polioviruses are transmitted when people drink water or eat food contaminated by faeces (or stools) which carry the virus (faeco-oral transmission). However, most children infected by polioviruses never feel ill. Less than 5% of those infected may have general flu-like symptoms such as fever, loose stools, sore throat, headache, or stomach ache. Most children who get a poliovirus infection without symptoms develop immunity and have lifelong protection against polio. A few children may develop a kind of paralysis called **acute flaccid paralysis (AFP)**, which is characterized by acute (rapidly developing, severe) loss of movement or weakness of the legs, arms or hands.

Paralytic polio begins with mild symptoms and fever, followed by severe muscle pain and paralysis, which usually develops during the first week of illness. Patients may lose the use of one or both arms or legs. Some patients may not be able to breathe because of the paralysis of respiratory muscles in the chest, which can lead to death. Some patients who develop paralysis due to polio recover the ability to move the affected limbs to some degree over time, but the degree of recovery varies greatly from person to person. A diagnosis of polio is confirmed by laboratory testing of stool samples.

4.3.3 Treatment and prevention of polio

While the initial symptoms of acute polio such as muscle pain and fever can be relieved, there is no treatment that can cure the weakness and paralysis if AFP develops. Regular physical exercise can help paralysed children to resume some activity. Prevention of polio by vaccination is the best method to eradicate the disease. Three doses of oral polio vaccine (OPV) are given during routine vaccinations for other communicable diseases, and/or during campaigns for polio eradication. A detailed description of the vaccination procedure is given in the *Immunization* Module.

An initial dose of OPV can also be given at birth or before 2 weeks of age.

Polio surveillance and reporting

You should immediately report a case of AFP to the District Health Office and take stool samples from the patient. The stool sample should be sent to Addis Ababa to identify the virus. Stool specimens must be collected within 14 days of paralysis onset in order to have the greatest chance of isolating the virus. Try to collect the first specimen at the time of the case investigation. If the patient is not able to produce a stool, leave a cup, cold box and frozen ice packs with the family so that they can collect it from the patient later.

To collect faeces from the child, ask him or her to defaecate onto clean paper. Use a spatula or very clean spoon to put the stool specimen in a clean container and label it and write the date. After collection, the specimens must be placed immediately in a refrigerator for shipment, or in a cold box between frozen ice packs at 4–8°C. The specimens must reach the laboratory in Addis Ababa within 72 hours of collection.

- Gemechis is a two-year-old boy who has had weakness in his legs for the last two days. His mother has told you that he has mild fever and diarrhoea. What should you do?

- The boy may have AFP due to poliovirus infection. You should collect a stool sample from Gemechis and immediately report to the District Health Office and have the sample sent to Addis Ababa for laboratory analysis. For further evaluation and treatment, refer the child to the nearest health centre.

As a Health Extension Practitioner, if you identify a case of AFP you must report it immediately. You will also routinely need to give the oral polio vaccine (OPV) to all eligible children in your community.

4.4 Hepatitis B

In this section, we describe what hepatitis B is and how it is transmitted, its clinical symptoms, and how it can be treated and prevented. This will help you to identify cases of hepatitis and refer them for further investigation and treatment, and also to educate your community about what causes hepatitis B and how it can be prevented by vaccination and safer sexual practices.

4.4.1 Definition, cause and occurrence of hepatitis B

Hepatitis is a term referring to a serious inflammation of the liver. Several viruses can cause hepatitis, but the hepatitis B virus (or HBV) is the most important one. Hepatitis B disease is a major global health problem and the most serious type of viral hepatitis. The WHO estimates that an estimated two billion people have been infected with HBV worldwide, and more than 350 million have chronic (long-term) liver infections. About 600,000 people die

every year as a result either of acute liver infection, or of chronic liver damage or liver cancer, which develops slowly over decades and eventually leads to their death.

4.4.2 Mode of transmission and clinical manifestation of HBV

HBV is carried in the blood and other body fluids of people who are infected. It is usually spread by contact with infected blood or body fluids in the following ways:

- *Injury or injection*: with contaminated sharp unsterile objects or instruments.
- *From a pregnant mother to her baby*: During birth, the virus which exists in the blood or body fluid of the mother may be transmitted to the baby.
- *Unprotected sexual intercourse*: During sexual intercourse without a condom, the virus which exists in the blood of the infected person may be transmitted to the other partner through scratches or wounds, or through small breaks in the delicate membranes covering the sexual organs.

The incubation period of hepatitis B averages six weeks, but may be as long as six months. Young children who are infected (usually at birth) often show no symptoms. Also, a larger proportion of children become chronic carriers of HBV, compared with infected adults.

■ Do you remember what a 'chronic carrier' means?

□ It is a person who carries the infection for a long period of time and can transmit the infectious agent to others, but without showing any symptoms of the disease themselves.

People who show symptoms of hepatitis B disease may feel weak and experience stomach upsets and other flu-like symptoms, which may last several weeks or months. They may also have very dark urine or very pale stools. **Jaundice**, which presents with yellowing of the skin or a yellow colour in the whites of the eyes (Figure 4.5), is common. Jaundice results when the liver is unable to deal with a yellow substance called bilirubin, which is formed when old red blood cells are broken up and their constituents are recycled to make new red blood cells. If the liver is damaged, it can't deal with the bilirubin, which builds up in the body causing the yellow discoloration.

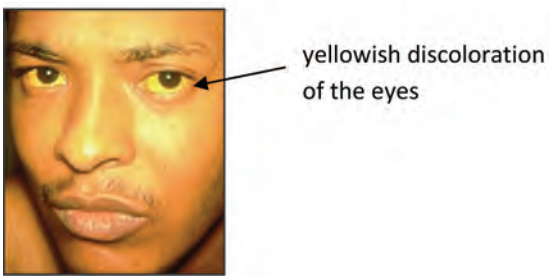


Figure 4.5 Yellowish colour in the white part of the eye due to hepatitis B. (Photo: CDC, accessed from **www.vaccineinformation.org/hepa/photos.asp**)

A laboratory blood test is required for confirmation of hepatitis B infection. Most HBV infections in adults are followed by complete recovery and 90% of adults will be completely rid of the virus within six months. Recovery also means that they are naturally protected from further infection with HBV for the rest of their lives. However, 30–90% of infants and children who become infected with HBV become chronic carriers of the virus, and they have a much increased risk of developing chronic, life-threatening liver damage or liver cancer much later in life.

4.4.3 Treatment, prevention and control of hepatitis B

You should be aware that there is no curative treatment for acute hepatitis B disease. Advise patients or the parents of affected children to try to keep eating and drinking; replacement of fluids lost through vomiting or diarrhoea is essential, and giving ORS is recommended if dehydration is a concern. In chronic hepatitis B infection, the disease can sometimes be halted with medication, but the drugs cost thousands of dollars and are rarely available in developing countries.

Prevention of hepatitis B disease is by vaccination, which is 95% effective. All infants should get three or four doses of hepatitis B vaccine during the first year of life, as part of routine vaccination schedules. In Ethiopia, it is usually given in the *pentavalent vaccine*, which protects against HBV and four bacterial diseases. Your role is to educate your community about how hepatitis B is transmitted and how transmission can be avoided, and you will need to give the pentavalent vaccine to infants.

The pentavalent vaccine and its administration is described in the *Immunization* Module.

■ Do you know another viral disease which has the same modes of transmission as hepatitis B? What health education messages can you give to people to protect themselves from both diseases?

□ HIV has the same modes of transmission as HBV. The advice on protection from acquiring both these viruses is to avoid contact with another person's blood or body fluids, particularly during sexual intercourse.

Ways to prevent transmission of HIV are described in detail in Study Session 26 of this Module; they also apply to prevention of HBV transmission.

In the rest of Part 1 of this *Communicable Diseases* Module (Study Sessions 5–12), you will be learning about a disease that cannot (at the present time) be prevented by vaccination, which is not caused by either bacteria or viruses. It is the vector-borne disease *malaria*, caused by a protozoan and transmitted by mosquitoes.

Summary of Study Session 4

In Study Session 4, you have learned that:

1 Measles, polio and hepatitis B are viral vaccine-preventable diseases; most infants and children are protected from these infections in Ethiopia and most other countries by routine vaccinations.

2 Measles virus is easily transmitted from person to person by the respiratory route. Typical symptoms include fever, cough, running nose, red eyes, diarrhoea and a widespread rash. Severe measles may lead to complications such as ear infections, loss of eyesight and pneumonia.

3 Vitamin A should be given to children with measles to prevent damage to the eyes, which may lead to blindness.

4 Poliomyelitis (caused by poliovirus) is transmitted from person to person through the faeco-oral route. Most children with polio infection do not show symptoms, but a few may develop acute flaccid paralysis (AFP).

5 Hepatitis B virus (HBV) has several routes of transmission, such as contact with infected blood or other body fluids, through wounds, from mother to child at birth, or during unprotected sexual intercourse.

6 People with hepatitis B present with fever, weakness and jaundice. Children infected with HBV may become chronic carriers; long-term complications such as permanent liver damage or liver cancer can develop in later life.

7 Cases of measles, AFP and hepatitis should be actively searched in the community and reported to the District Health Office. Diagnosis can only be confirmed by laboratory isolation of the viruses.

8 Patients with severe complications of measles, AFP or signs of hepatitis, should be referred to the nearest health centre.

9 There is no curative treatment for measles, polio or hepatitis B disease. Supportive treatment for reduction of symptoms of measles and hepatitis includes maintaining intake of nutrients and fluids. Exercise therapy may help to improve mobility in people with AFP.

Self-Assessment Questions (SAQs) for Study Session 4

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the following questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 4.1 (tests Learning Outcomes 4.1, 4.2 and 4.4)

Which of the following statements is *false*? In each case, explain what is incorrect.

A Pneumonia and clouding of the cornea are two of the common complications of severe measles.

B Measles is very rarely fatal.

C The transmission of poliovirus cannot be prevented at the present time.

D Acute flaccid paralysis (AFP) is a rare complication of polio; most children infected with poliovirus show no symptoms.

E Almost all adults infected with hepatitis B virus (HBV) become virus carriers for the rest of their lives.

F Jaundice is a common complication of hepatitis B disease.

SAQ 4.2 (tests Learning Outcomes 4.2 and 4.3)

You see a child in your village who has a rash all over his body, which developed three days ago; before that he was ill with fever and diarrhoea, his nose was running and his eyes were red. Now he has an ear infection, with pus coming out of his ear. What is the most likely cause of his illness? What do you do in response?

SAQ 4.3 (tests Learning Outcome 4.2)

In Table 4.2 below, write the mode of transmission and the method of prevention against each of the viral diseases in the first column.

Table 4.2 Modes of transmission and prevention of three common viral diseases.

Disease	Mode of transmission	Prevention
measles		
polio		
hepatitis B		

Study Session 5 Malaria Epidemiology and Transmission

Introduction

In this study session you will learn about the burden of malaria worldwide, in Africa and in Ethiopia. As malaria is a vector-borne disease you will learn about the vectors, which in the case of malaria are the mosquitoes that carry the malaria parasite from person to person. You will learn where mosquitoes lay their eggs and the stages of development leading up to a new flying adult. Information about the **breeding habitats** (water collections where mosquitoes lay eggs and develop), and the life cycle of mosquitoes, is essential for you to target anti-vector interventions in the right way. A clear understanding of the life cycle of the malaria parasite and of the mosquito, the vector which transmits it from person to person, will help you carry out your responsibility of protecting people in your community from getting malaria and of treating people who do get malaria.

Learning Outcomes for Study Session 5

When you have studied this session, you should be able to:

5.1 Define and use correctly all of the key words printed in **bold**. (SAQ 5.1)

5.2 Describe the burden of malaria globally, in Africa and Ethiopia. (SAQs 5.2 and 5.3)

5.3 Describe the life cycle of the malaria parasite. (SAQ 5.4)

5.4 Describe the life cycle of the mosquito vector. (SAQ 5.5)

5.5 Explain how to identify the potential vector of malaria and tell it from other mosquitoes. (SAQ 5.6)

5.6 Describe the behaviour of vector mosquitoes. (SAQ 5.7)

5.1 The burden of malaria

Malaria is one of the most serious diseases to affect people in developing countries with tropical and subtropical climates. It is particularly dangerous for young children and for pregnant women and their unborn babies, although others may also be seriously affected in some circumstances. Malaria is endemic in 109 countries and more than three billion of the world's population lives in malaria risk regions. Globally, 300–500 million episodes of malaria illness occur each year, resulting in over one million deaths. As Figure 5.1 (on the next page) shows, changes in socio-economic conditions and anti-malaria interventions have gradually reduced the areas of the world where malaria is endemic, but it is still widespread as a major global disease. A communicable disease is said to be **endemic** in a region or country if it is always present there. In areas where many cases occur throughout the year, the disease is said to be highly endemic, or (to say it another way) it has high endemicity.

Endemic is pronounced 'end-em-ik', and endemicity is pronounced 'end-em-iss-it-ee'.

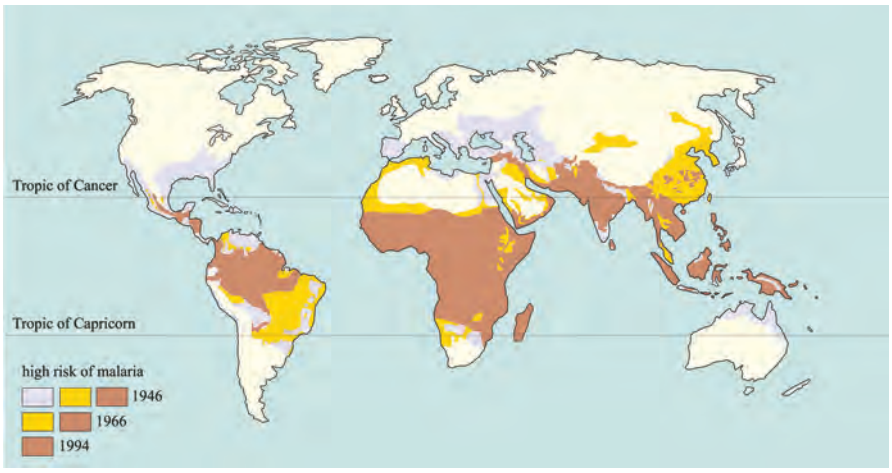


Figure 5.1 Changing geographical range of malaria. In 1946, the high risk range was all three coloured areas; by 1966, it was down to the yellow and brown areas; and by 1994 it was only the brown areas. (Source: The Open University, 2003, *Infectious Disease*, Book 5: *Evolving Infections*, Figure 3.1)

More than 90% of the worldwide deaths from malaria occur in sub-Saharan Africa and most of these deaths are in children. Malaria risk is highest in tropical Africa where conditions (which will be considered further below) are very favourable for malaria transmission (Figure 5.2).

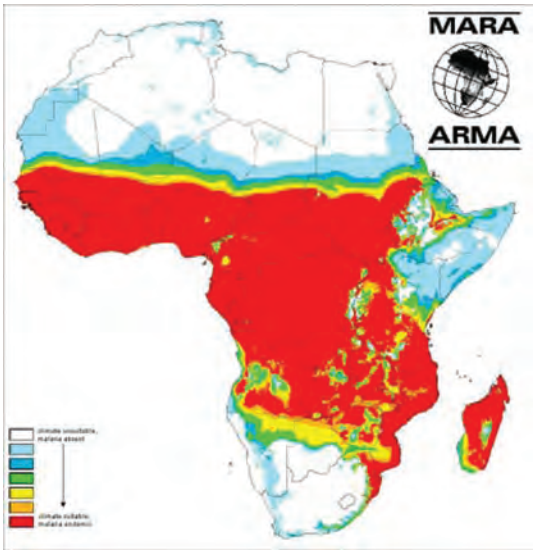


Figure 5.2 Distribution of malaria in Africa (WHO data).

- Look at Figure 5.2 and describe what it shows about the incidence of malaria in Africa.

- Figure 5.2 shows that the highest incidence of malaria (as shown in red) is around the equator and in the tropics. Malaria is much less common in the northern and southern part of the continent.

The intricate interactions between host, parasite, vector and the environment are the major factors in the distribution of malaria. Different areas can experience different levels of incidence rates.

Malaria can be viewed in terms of being *stable* or *unstable*. Malaria is said to be **stable** (and therefore endemic) when malaria infections occur for many months in a year, over many years. People living in highly endemic areas usually exhibit a high level of *immunity* and tolerate the infection well.

Immunity against malaria is the ability to fight the infection, which is developed by people with repeated episodes of malaria. Under endemic conditions, children under the age of five years, and pregnant mothers, are most likely to be infected as they have weaker immunity.

Unstable (epidemic) malaria refers to a seasonal type of transmission seen in areas of low endemicity, or to outbreaks in areas previously without malaria, or among non-immune persons. Epidemics can be due to changes in human behaviour, environmental and climate factors. For example, human migration and resettlement can introduce malaria into an area that did not have it previously, and this can expose a population to the disease that was not immune to malaria. Malaria epidemics generally occur when the population in an area has weak immunity to the disease, because so many people in the population will be vulnerable to malaria, not just children under five years of age and pregnant women.

However, it is important to remember that children and mothers are always more at risk, so they will need particular attention.

5.2 Epidemiology and distribution of malaria in Ethiopia

About 75% of the landmass of Ethiopia is malarious and 68% of the Ethiopian population, estimated at about 54 million in 2010, live in malaria risk areas. As you can see from Figure 5.3, malaria is a risk in the western and eastern lowlands and central midlands. However, it is absent or the risk is low in the central highlands, where the altitude (or elevation) is 2,000 metres or more above sea level, as Figure 5.3 shows. As you will see later, the reason is the effects of altitude on the habitat of the mosquito vector, and the development of the parasite inside the mosquito.

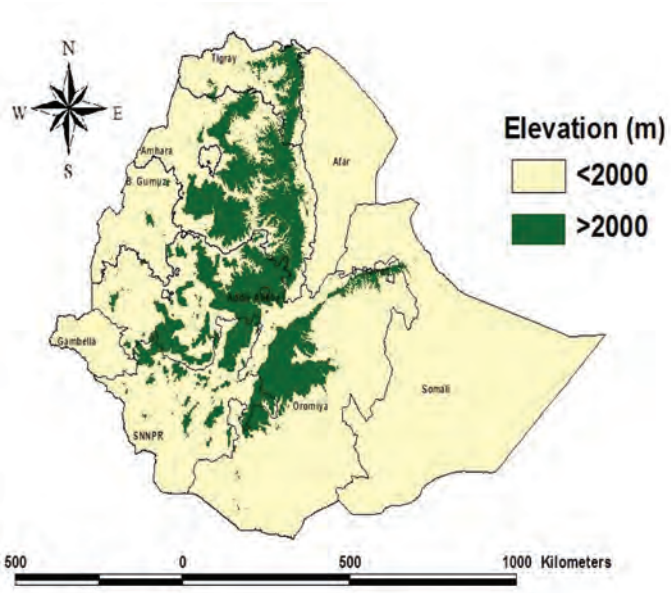


Figure 5.3 Malarious areas (below 2,000 metres elevation) and malaria-free areas (above 2,000 metres elevation) of Ethiopia. (Source: Ethiopian Federal Ministry of Health)

The exact number of people getting sick and dying of malaria every year in Ethiopia is not known. However, it is known that millions of people get sick and tens of thousands of people die due to malaria every year, and that rates of mortality (death) and morbidity (illness) dramatically increase during epidemics. The distribution of malaria in Ethiopia is not uniform. There are areas where the risk of malaria is high and there are areas where the risk is low. There are even areas, 25% of the country, that are malaria free.

You learned in Section 5.1 above that malaria transmission is classified as stable or unstable. The three most important factors that affect the distribution of malaria and its severity in Ethiopia are:

- Temperature
- **Humidity** (the amount of moisture in the air)
- The availability of water collections in which the mosquito vectors can breed.

Altitude, vegetation and rainfall have indirect effects because of their impact on temperature, humidity and availability of water collections for vector breeding.

The distribution of malaria in Ethiopia varies from place to place due to the above factors directly or indirectly affecting the pattern of malaria transmission. For example, the distribution of malaria in Ethiopia is largely determined by altitude. Altitude affects the pattern of malaria distribution in Ethiopia through its effect on temperature. Risk of malaria is highest in the western lowlands of Oromia, Amhara, Tigray and almost the entire regions of Gambella and Benishangul Gumuz. The midlands of Ethiopia between 1,000 and 2,200 metres altitude experience seasonal transmission of malaria with sporadic epidemics every few years. In the eastern lowlands of Ethiopia (primarily Afar and Somali), malaria is endemic only along the rivers, as this part of the country is largely dry away from rivers. Transmission is limited by the lack of water collections for mosquito breeding and low humidity due to low rainfall and sparse vegetation. The central highlands of Ethiopia are free of malaria mainly due to the low temperatures, which slows the development of the vector and the parasite.

5.3 Malaria parasites

Malaria is caused by *Plasmodium* parasites. *Plasmodium* parasites infect people and attack the red blood cells, which often leads to severe illness and death. The parasites are spread to people through the bites of infected *Anopheles* mosquitoes, which are the malaria vectors and which bite mainly between dusk and dawn.

The species names of malaria parasites are frequently abbreviated to *P. falciparum*, *P. vivax*, etc.

There are four types of human malaria, each due to one of the parasites with the following specific names:

- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium malariae*
- *Plasmodium ovale.*

Plasmodium falciparum and *Plasmodium vivax* are the most common malaria parasites in Ethiopia. 60% of malaria infections in Ethiopia are due to *P. falciparum* and 40% are due to *P. vivax*. *P. falciparum* is the most deadly and requires special attention.

Although both parasites are widely distributed, some communities will have more *falciparum* malaria while others will have more *vivax* malaria. Do you know which type of infection is more common in your community?

5.3.1 Life cycle of the malaria parasite

Human malaria (*Plasmodium* parasite) is transmitted from an infected person to another person by *Anopheles* mosquitoes, as shown in Figure 5.4. The parasite spreads by infecting two types of hosts: humans and female *Anopheles* mosquitoes. The mosquitoes then act as the vector for the parasite. Malaria is a human parasite that is transmitted only between people; malaria is not transmitted from animals to humans, or from humans to animals.

Figure 5.4 How malaria is transmitted from one person to another. (WHO, 1996, *Malaria: A Manual for Community Health Workers*)

Now you are going to learn about the life cycle of the parasite. Please study Figure 5.5 (on the next page) very carefully as it is going to help you understand about the pathology, signs, symptoms and treatment of malaria in the subsequent study sessions.

Malaria in humans develops via two stages: a liver and red blood cell stage. When an infected mosquito pierces a person's skin to take a blood meal, malaria parasites in the mosquito's saliva enter the bloodstream and migrate to the person's liver. Within 30 minutes of being introduced into the human body, they infect liver cells, multiplying in the liver cells for a period of 6–15 days. In the process they become thousands of parasites which,

following rupture of the liver cells, escape into the blood and infect red blood cells, thus beginning the red blood cell stage of its life cycle.

Within the red blood cells, the parasites multiply further, periodically breaking out of their host cells to invade fresh red blood cells. Several replication cycles occur. The pathology and clinical manifestations associated with malaria are almost exclusively due to the red blood cell stage parasites (Figure 5.5). The blood stage parasites are those that cause the symptoms of malaria.

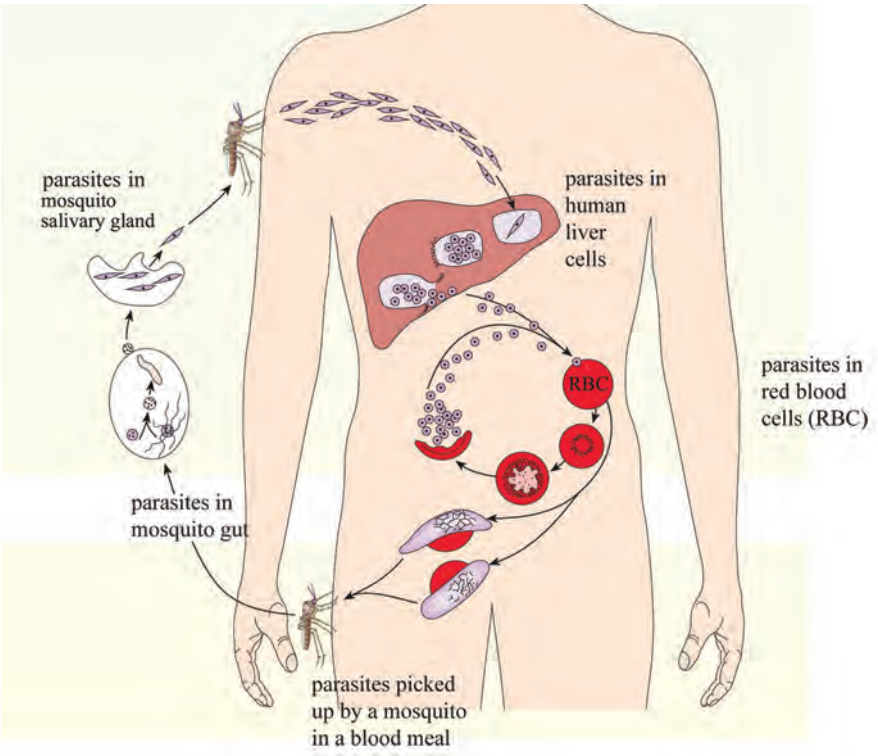


Figure 5.5 Life cycle of the malaria parasite. (Adapted from: The Open University, 2003, *Infectious Disease*, Book 5: *Evolving Infections*, Figure 3.4)

When certain forms of blood stage parasites, called *gametocytes*, are picked up by a female *Anopheles* mosquito during a blood meal, they start another, different cycle of growth and multiplication in the mosquito. After 10–18 days, the parasites are found in the mosquito's salivary glands. When the *Anopheles* mosquito takes a blood meal from another human, the parasites are injected with the mosquito's saliva and start another human infection when they enter the new person's liver cells. Thus the mosquito carries the disease from one human to another, acting as a vector. Unlike the infected human, the mosquito vector does not suffer from the presence of the parasites.

The most common way to be infected with malaria is through the natural transmission by mosquitoes, as already described. However, malaria can also be transmitted via blood transfusions or sharing syringes. Mother to child transmission during pregnancy has also been documented, but all the modes of transmission other than via the mosquito are believed to be very rare and unimportant.

5.3.2 Incubation period of malaria

When a person becomes infected with one of the *Plasmodium* parasites that cause malaria, he or she will not feel sick immediately. The period between infection with the parasites that cause the disease and the beginning of malaria symptoms is called the **malaria incubation period**. The infected person may feel normal from 7 to 21 days when infected with *Plasmodium* parasites. *P. falciparum* has a shorter incubation period (7 to 14 days) than *P. vivax* (12 to 18 days). *Plasmodium malariae* tends to have a much longer incubation period, as you can see from Table 5.1.

Table 5.1 Incubation period of malaria parasites.

Malaria parasites	Incubation period in days
P. falciparum	7–14
P. vivax	12–18
P. ovale	12–18
P. malariae	18–40

As you will learn in Study Session 7, *Plasmodium* infection causes fever in cycles or episodes which occur at either 48 or 72 hour intervals. Episodes of fever occur when the parasites are released into the blood and infect new red blood cells (see Figure 5.5).

5.3.3 Partial immunity to malaria

The severity of the attack depends on the *Plasmodium* species, as well as other circumstances, such as the state of immunity and the general health and nutritional status of the infected individual.

Following several attacks of malaria, people living in highly endemic regions can develop partial immunity that can protect them from severe attacks and death. But no-one develops complete immunity against malaria that can fully protect the person from infection. Pregnant women and children under five years of age are more susceptible to severe forms of the disease and death due to their weak immune system.

5.4 Life cycle of the mosquito vector

Now you will learn about the life cycle of the vector of the malaria parasite, the mosquito. Mosquitoes have four different stages in their life cycle: the egg, larva, pupa and adult (see Figure 5.6 on the next page). The first three stages are immature and are found in water collections. The adult is a flying insect. The time taken for the different stages to develop depends on temperature and nutritional factors in their environment. Development takes a shorter time at higher temperatures.

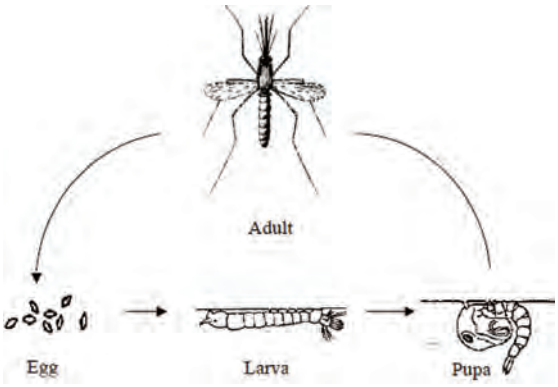


Figure 5.6 Life cycle of the malaria vector mosquitoes (*Anopheles* species). (WHO, 1997, *Vector Control Methods for Use by Individuals and Communities*)

5.4.1 Eggs

A female *Anopheles* mosquito normally mates only once in her lifetime. It usually requires a blood meal after mating before her eggs can develop. While the blood meal is not essential for the survival of female mosquitoes, it is crucial for successful egg production and egg laying. Blood meals are generally taken every two to three days, before the next batch of eggs is laid. About 100 to 150 eggs are laid on the water surface during oviposition (egg laying). Oviposition sites vary from small hoof prints and rain pools to streams, swamps, canals, river beds, ponds, lakes and crop fields. Each species of mosquito prefers different types of habitats to lay eggs. Under the best conditions in the tropics, the average lifespan of female *Anopheles* mosquitoes is about three to four weeks.

5.4.2 Larvae

Larvae (pronounced 'lah-vee') is the plural of larva ('lah-vah'); this stage of the life cycle is called the larval stage ('lah-val'). Pupae (pronounced 'pyoo-pee') is the plural of pupa ('pyoo-pah'); this stage of the life cycle is called the pupal stage ('pyoo-pal').

A larva hatches from the egg after one or two days and generally floats parallel under the water surface, since it needs to breathe air. It feeds by taking up food from the water. When disturbed, the larva quickly swims towards the bottom, but it soon needs to return to the surface to breathe. There are four larval stages or *instars*. The small larva emerging from the egg is called the first instar. After one or two days it sheds its skin and becomes the second instar, followed by the third and fourth instars at further intervals of about two days each. The larva remains in the fourth instar stage for three or four more days before changing into a pupa. The total time spent in the larval stage is generally eight to ten days at normal tropical water temperatures. At lower temperatures, the larval stages take longer to develop.

5.4.3 Pupae

The pupa is the stage during which a major transformation takes place, from living in water to becoming a flying adult mosquito. The pupa is shaped like a comma. It stays under the surface and swims down when disturbed, but it does not feed. The pupal stage lasts for two to three days, after which the skin of the pupa splits. Then the adult mosquito emerges and rests temporarily on the water's surface until it is able to fly.

5.4.4 Adult mosquitoes

Mating takes place soon after the adult emerges from the pupa. The female usually mates only once because it receives sufficient sperm from a single mating for all subsequent egg batches. Normally the female takes her first blood meal only after mating, but sometimes the first blood meal can be taken by young virgin females. The first batch of eggs develops after one or two blood meals (depending on the species); while successive batches usually require only one blood meal. The process of blood-feeding, egg maturation and egg laying is repeated several times throughout the life of the mosquito. The length of time between two feeding cycles depends on the external temperature. In *Anopheles arabiensis*, for example, the cycle takes 48 hours when the average day-night temperature is 23°C.

5.5 Malaria transmitting vectors in Ethiopia

You have now learned that malaria is transmitted from an infected person to another person by mosquitoes. However, not all mosquitoes carry malaria. There might be mosquitoes biting people in your village, but they may not be the ones that transmit the infection. The mosquitoes that transmit malaria belong to a group of mosquitoes called *Anopheles*. However, not all *Anopheles* mosquitoes are vectors of malaria. For example there are more than 40 species of *Anopheles* mosquitoes in Ethiopia, but only four species of *Anopheles* mosquitoes carry malaria. The scientific names of these mosquitoes are:

The scientific names of the mosquitoes that transmit malaria parasites are often abbreviated to *An. arabiensis, An. pharoensis,* etc.

- *Anopheles arabiensis*
- *Anopheles pharoensis*
- *Anopheles funestus*
- *Anopheles nili.*

An. arabiensis is the most important transmitter of malaria in Ethiopia and is responsible for more than 95% of transmissions. It is found everywhere in Ethiopia. The other three are secondary vectors of very minor importance.

Distinguishing the above four species of *Anopheles* from other *Anopheles* mosquitoes is not your responsibility and will not be part of this training. However, it is important for you to distinguish *Anopheles* mosquitoes in general from other mosquitoes at their larval stage. You will see the importance of this knowledge when you learn about vector control in Study Session 9.

5.6 Distinguishing *Anopheles* mosquitoes from other types

The terms ‘anophelines’ and ‘culicines’ refer to all species of these mosquito types.

There are two common types of mosquitoes that lay their eggs in water: anophelines, which can be vectors of malaria, and culicines, which do not carry malaria. It is very important that you know the difference in the morphology (structure and shape) of these mosquitoes to identify the exact breeding habitats that support the development of the potential vectors.

Now study the differences in the body structure and resting position in water collections of the anopheline and culicine larvae, as illustrated in Figure 5.7. You don't need magnifying or other equipment to distinguish anopheline and culicine larvae. You can tell the difference by looking at the larvae in the vector breeding waters. Your mentor will show you the difference between the two during your practical training. This will be a very important part of your task as a Health Extension Practitioner: identifying water collections that shelter anopheline larvae and taking action to eliminate such breeding grounds or kill the larvae. You will learn more about the action against mosquito larvae in Study Session 8.

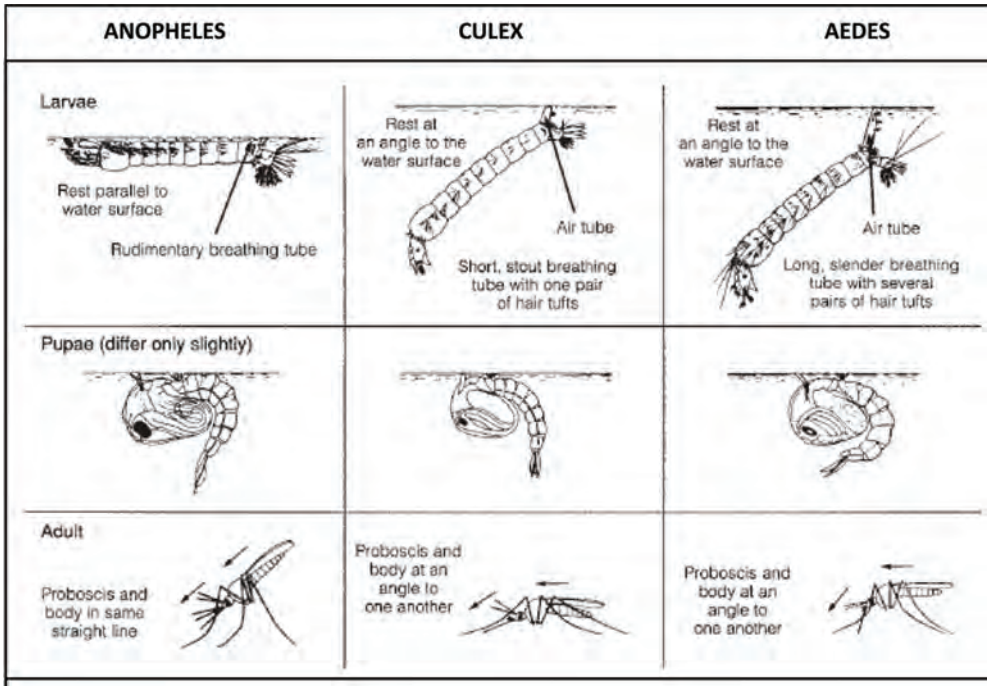


Figure 5.7 Distinguishing features of anopheline mosquitoes (potential malaria vectors) and culicine and aedes mosquitoes (which don't transmit malaria). (WHO, 1997; source as in Figure 9.2)

There are four stages in the mosquito life cycle, and three of them — eggs, larvae and pupae — are to be found in water.

5.6.1 Eggs

Mosquito eggs either clump together in a 'raft' (*Culex*) or float separately (*Aedes*); anopheline eggs float separately and each of them has 'floats'.

5.6.2 Larvae

The culicine larva has a breathing tube (siphon) which it also uses to hang down from the water surface, whereas the anopheline larva has no siphon and rests parallel to and immediately below the surface.

5.6.3 Pupae

Pupae of both anophelines and culicines are comma-shaped and hang just below the water surface. They swim when disturbed. The breathing trumpet of the anopheline pupa is short and has a wide opening, whereas that of the culicine pupa is long and slender with a narrow opening. However, it is difficult to distinguish anopheline from culicine pupae in the field.

5.6.4 Adults

With live mosquitoes, you can distinguish between adult anopheline and culicine mosquitoes by observing their resting postures. Anophelines rest at an angle between 50° and 90° to the surface, whereas culicines rest more or less parallel to the surface.

5.7 Behaviour of mosquitoes that transmit malaria

To help you work effectively to prevent malaria transmission, you need to learn about the most important behaviours of a malaria-transmitting mosquito.

Female mosquitoes can feed on animals and humans. Most species show a preference for certain animals or for humans. They are attracted by the body odours, carbon dioxide and heat emitted from the animal or person. Species of mosquitoes that prefer to feed on animals are usually not very effective in transmitting diseases from person to person. Those who prefer to take human blood are the most dangerous as they are more likely to transmit diseases between people. One of the reasons why *An. arabiensis* mosquitoes are better vectors of malaria than other mosquitoes is that they feed mostly on humans and very little on cattle.

Most anopheline mosquitoes bite at night. Some species bite just after sunset while others bite later, around midnight or in the early morning. Those that bite in the early evening may be more difficult to avoid than species that feed at night.

Some species prefer to feed in forests, some outside houses and others indoors. Mosquitoes that enter a house usually rest on a wall, under furniture or on clothes hanging in the house. Mosquitoes that bite outside usually rest on plants, in holes, in trees, or on the ground, or in other cool dark places. Mosquitoes that rest indoors are the easiest to control, as you will learn in Study Session 6.

Because digestion of the blood-meal and development of the eggs takes 2–3 days, a blood-fed mosquito looks for a safe resting place that is shaded and offers protection from drying out. Some species prefer to rest in houses or cattle sheds, while others prefer to rest outdoors, on vegetation or at other natural sites. After the mosquito takes a blood meal indoors, it usually rests inside the house, some for a short period and some for days. Mosquitoes do not usually bite while eggs are developing.

Adult females can normally live between 20 days and one month. The average survival is much shorter at 6–9 days. The average life-span of the female has direct relevance to its efficiency as a malaria vector, because it has to live long enough to transmit malaria (i.e. long enough for the parasite to complete its life cycle in the mosquito host, approximately 10 days).

On average, the flight range of adult *Anopheles* is between a few hundred metres and 2 kilometres. Therefore water collections very close to houses are more important sources of vectors than those located far away from houses. As you will see in Study Session 9, this is something that could be important when considering vector control measures to prevent vectors from breeding in water collections.

Summary of Study Session 5

In Study Session 5, you have learned that:

1 Malaria is a major public health problem in the world, Africa and Ethiopia, affecting millions of people each year.

2 The malaria parasite is transmitted from person to person by the bite of female mosquitoes.

3 The parasite is taken by the mosquito when feeding on an infected person.

4 The parasite develops and multiplies in the mosquito body and the cycle takes about 10 days, depending on the temperature.

5 The parasites are injected into humans when the mosquito bites.

6 Studying the life cycle of the malaria parasite that causes human malaria makes understanding the pathology, signs, symptoms and treatment of the disease easier.

7 Water collections are important for vector breeding.

8 Malaria is transmitted by *Anopheles* mosquitoes only; the larvae of *Anopheles* mosquitoes can be easily distinguished from other non-vector mosquitoes.

9 A female *Anopheles* mosquito needs to feed on blood to develop its eggs and reproduce.

10 The life cycle of the malaria vector from egg to adult takes 8 to 12 days, depending on temperature.

11 The vectors bite people from dusk to dawn.

12 The vectors can bite people indoors or outdoors.

13 The vectors feeding indoors are likely to spend some time resting inside houses after taking a blood meal.

14 Understanding the behaviour of the vector is important to plan preventive measures.

Self-Assessment Questions (SAQs) for Study Session 5

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 5.1 (tests Learning Outcome 5.1)

A person from a malaria-free place visiting a high malaria risk area shows signs and symptoms of malaria after 8 days of his stay in the area. Which of the following types of malaria parasites is the person most likely to be infected with: *P. falciparum, P. vivax, P. ovale* or *P. malariae*? Explain how you reached your answer.

SAQ 5.2 (tests Learning Outcome 5.2)

You have learned that the burden of malaria in Africa is higher than other parts of the world, and also that the malaria incidence varies in different regions of Africa. Where in Africa is the incidence of malaria highest? Where is malaria incidence low?

SAQ 5.3 (tests Learning Outcome 5.2)

The distribution of malaria in Ethiopia is not uniform. What are the possible explanations for the difference in malaria incidence in different areas of Ethiopia?

SAQ 5.4 (tests Learning Outcome 5.3)

Carefully study the life cycle of the parasite in the human body and the mosquito (see Figure 5.5). List the body parts of the mosquito and the body parts of humans that are directly associated with parasite development and reproduction.

SAQ 5.5 (tests Learning Outcome 5.4)

The following are statements about the life cycle of the malaria vector mosquito. Which of these statements is *false*? In each case, explain what is incorrect.

A The malaria vector mosquito lays its eggs on grass.
B The malaria vector mosquito life cycle has four stages.
C The malaria vector mosquito needs to feed on blood to develop its eggs.
D The adult female mosquito lays eggs only once in its life time.
E The stage that hatches from the eggs is the *pupae.*

SAQ 5.6 (tests Learning Outcome 5.5)

List two characteristics that illustrate how the *Anopheles* larvae are different from other mosquito larvae.

SAQ 5.7 (tests Learning Outcome 5.6)

You know that the parasite needs 10 days to develop inside the mosquito body. Therefore the mosquito needs to live at least 10 days to be able to transmit the infection. 10% of the mosquitoes live more than 10 days in February and more than 20% of them live more than 10 days in September.

(a) Do you expect malaria transmission to occur during these two periods?
(b) During which period will the incidence of malaria be higher?

Study Session 6 Factors that Affect Malaria Transmission

Introduction

As you learned in Study Session 5, the incidence of malaria varies from place to place and at different times. Such variations are very common in Ethiopia. There are areas where the incidence of malaria is high and other areas where the incidence is low, and some areas are malaria free. In some communities, malaria transmission lasts for several months or happens throughout the year, and in other areas it is very brief.

In this study session you will learn about the factors that affect the transmission and incidence of malaria. Climate affects the natural distribution of malaria in Ethiopia and elsewhere in the world. The three main climatic factors that directly affect malaria transmission are *temperature, rainfall* and *relative humidity* (the amount of moisture in the air). Several non-climatic factors, including differences between human hosts, human migration, and development projects, can also affect the pattern of malaria transmission and the severity of the problem.

Climatic means 'relating to the climate'.

Understanding the climatic and non-climatic factors that affect malaria transmission will help you to understand the risk of malaria in your village better. This kind of understanding will also be useful to you in monitoring, preventing, or controlling local malaria epidemics (Study Session 12).

Learning Outcomes for Study Session 6

When you have studied this session, you should be able to:

6.1 Define and use correctly all of the key words printed in **bold**. (SAQ 6.1)

6.2 Describe how temperature affects the development of the parasite and the vector, and explain the association between temperature and the distribution of malaria in Ethiopia. (SAQs 6.2 and 6.3)

6.3 Explain how humidity influences malaria transmission. (SAQs 6.1 and 6.3)

6.4 Explain the relationship between rainfall and malaria transmission. (SAQ 6.4)

6.5 Describe how important non-climatic factors influence the pattern and severity of malaria transmission. (SAQs 6.5 and 6.6)

6.1 Climatic factors

Climatic factors greatly influence the pattern and level of malaria transmission in Ethiopia, in Africa and the world. The most important **climatic factors** that directly affect malaria transmission are temperature, rainfall and humidity. We will consider these in turn. You may find it useful first to look back at Figure 5.5 to remind yourself of the lifecycle of the malaria parasite.

6.1.1 Temperature

The ranges of minimum and maximum temperature greatly affect the development of the malaria parasite and its mosquito vector, which determines malaria transmission.

Temperature and parasite development

Temperature affects the life cycle of the malaria parasite. The time required for the parasite to complete its development in the gut of the mosquito is about 10 days, but it can be shorter or longer than that depending on the temperature. As the temperature *decreases*, the number of days necessary to complete the development *increases* for a given *Plasmodium* species. *P. vivax* and *P. falciparum* have the shortest development cycles and are therefore more common than *P. ovale* and *P. malariae*.

The time needed for the parasite to complete its development in the mosquito, decreases to less than 10 days as temperature increases from 21°C to 27°C, with 27°C being the optimum. The maximum temperature for parasite development is 40°C. Below 18°C, the life cycle of *P. falciparum* in the mosquito body is limited. The minimum temperatures are between 14–19°C, with *P. vivax* surviving at lower temperatures than *P. falciparum*. Malaria transmission in areas colder than 18°C can sometimes occur because the *Anopheles* often live in houses, which tend to be warmer than the outside temperature.

Temperature and mosquito development

Development of the mosquito larva also depends on temperature – it develops more quickly at higher temperatures. Higher temperatures also increase the number of blood meals taken and the number of eggs laid by the mosquitoes, which increases the number of mosquitoes in a given area.

The minimum temperature for mosquito development is between 8–10°C; the optimum temperature is 25–27°C, and the maximum temperature for is 40°C.

Altitude and temperature

As you saw in Figure 5.3 in the previous study session, **altitude** (elevation above sea level) is one of the most important factors that determines the pattern of malaria transmission in Ethiopia. Altitude in Ethiopia varies from 100 metres below sea level to more than 4,000 metres above sea level. Altitude influences the distribution and transmission of malaria indirectly, through its effect on temperature. As altitude increases, temperature decreases, so highlands are colder and lowlands are warmer.

In the Ethiopian highlands, with altitudes between 2,000 and 2,400 metres, malaria transmission occurs for short periods only when temperatures rise unusually high.

- Can you explain why transmission occurs during these periods?

- The increased temperature allows the development of parasites to occur in the mosquitoes, and the mosquito population also increases as the temperature rises.

Beyond 2,400 metres, the temperature does not go high enough to support malaria transmission and these areas are free of malaria.

Addis Ababa is free of malaria, and most of the Ethiopian highlands above 2,000 metres have little or no locally transmitted malaria (Figure 6.1). The most important reason for this is that it is generally too cold in the highlands for mosquitoes to develop in large numbers, or for the malaria parasite to develop inside the vector.

Figure 6.1 The temperature above 2,400 metres in the Ethiopian highlands is too low for malaria transmission to occur. (Photo: Basiro Davey)

Equatorial Africa

Now look back at the map showing the distribution of malaria in Africa (Figure 5.2 in the previous study session). From your school geography education, you may remember that temperatures are higher around the equator and do not vary much through the year. Temperatures decrease progressively as you move north or south of the equator. The red part of the map shows a very high level of transmission around the equator and the light blue colour represents lower malaria transmission further north and south of the equator. One of the reasons for high levels of transmission near the equator is the warm and relatively constant temperature in tropical Africa.

6.1.2 Rainfall

As you learned in Study Session 5, anopheline mosquitoes breed in water. So the right amount of rainfall is often important for them to breed. Different anopheline mosquitoes prefer different types of water bodies in which to breed. In Ethiopia, water collections that support vector breeding appear mainly after the rains, and therefore malaria transmission is highest following the rainy season.

Of course, too much rainfall can flush away breeding habitats temporarily, but mosquitoes start breeding as soon as the rain stops. In most cases, flushing has a bigger impact on vector breeding habitats in the highlands and hilly areas than in the lowland plains. Not all water collections are suitable for the mosquito life cycle. In Ethiopia, rain water collections are the most important breeding ground, as the anopheline mosquitoes prefer to breed in fresh water collections created after the rainy season. Such water bodies may be clear or muddy (Figure 6.2 on the next page) but they are not polluted.

Note that the anopheline mosquitoes that transmit malaria do not breed in foul-smelling polluted water.

Figure 6.2 A muddy rainwater collection can support mosquito breeding if it is not polluted. (Photo: Dr Daddi Jima)

There are also places where *less* rainfall and drought can favour mosquito breeding and malaria transmission. Such places are usually covered by vegetation throughout the year and streams and rivers often flow rapidly. When the rains fail or are delayed, the flow of streams is interrupted and pooling occurs along the stream. Pooling creates a favourable environment for mosquito breeding. Malaria vectors mainly breed in stagnant water collections, rarely in slightly moving waters and never in rapidly flowing rivers and streams.

In drier areas, rainfall can also affect malaria transmission indirectly through its effect on humidity. Vegetation cover increases after rainfall, which in turn increases the relative humidity of the environment. The effect of humidity on malaria transmission is considered below.

6.1.3 Relative humidity

Relative humidity refers to the amount of moisture in the air, expressed as a percentage; (0% humidity would mean the air is completely free of moisture and 100% humidity would mean the air is completely saturated with moisture). Relative humidity affects malaria transmission through its effect on the activity and survival of mosquitoes. You may recall that mosquitoes need to live at least 8–10 days to be able to transmit malaria.

- Why is it important that mosquitoes should live this long, for the transmission of malaria?

- This is the length of time required for the parasite to develop inside the mosquito host. If the mosquito dies before the parasite has developed, then transmission of the parasite cannot occur.

Mosquitoes survive better under conditions of high humidity. They also become more active when humidity rises. This is why they are more active and prefer feeding during the night – the relative humidity of the environment is higher at night. If the average monthly relative humidity is below 60%, it is believed that the life of the mosquito is so short that very little or no malaria transmission is possible.

6.1.4 Combining the effects of climatic factors

Now think of your village in terms of its suitability for malaria transmission. How many (if any) malaria cases occur each month? Does the number vary between months? When do you see the highest number? Write down the

reasons you think are responsible for the variation in the number of malaria cases in your community. Then answer the following questions.

- What factors do you think are responsible for the high malaria incidence in some months? Consider the following factors and decide which of them would apply to your village

  (a) Immediately following the rains; if so, why?
  (b) When the temperature is hot; if so, why?
  (c) When the rains fail and there is drought; if so, why?
  (d) When the fields are covered with vegetation; if so, why?

- Of course, we don't know the climatic pattern in your village, but malaria transmission could be high:

  (a) *Immediately following the rains,* because there will be plenty of water collections for vector breeding after the rainy season.
  (b) W*hen the temperature is hot,* because temperature speeds up vector and parasite development.
  (c) *When the rains fail and there is drought,* because rivers and small streams slow down into pools, creating stagnant water collections for vector breeding.
  (d) *When the fields are covered with vegetation,* because when the vegetation cover is high the humidity increases; higher humidity helps the mosquito to live longer and transmit malaria.

6.2 Non-climatic factors

Factors that affect malaria transmission, but which are not related to the climate, are called **non-climatic factors**. The type of vector, the type of parasite, environmental development and urbanisation, population movement and migration, the level of immunity to malaria in the human hosts, insecticide resistance in mosquitoes, and drug resistance in parasites, all have a role in affecting the severity and incidence of malaria. We will look at each of these in turn.

6.2.1 Malaria vectors

As you learned in the Study Session 5, not all mosquitoes transmit malaria – only *Anopheles* mosquitoes (Figure 6.3) can carry the malaria parasite. In Ethiopia there are about 40 different species of *Anopheles* mosquitoes, but only four of them are known to transmit malaria parasites, and just one of them, *Anopheles arabiensis*, is responsible for more than 95% of malaria transmissions.

Figure 6.3 The *Anopheles* mosquito – the malaria vector.

Different species of *Anopheles* mosquitoes differ in their capacity to transmit malaria. This depends on the biology and behaviour of the mosquitoes. Mosquitoes in the *Anopheles gambiae* group (which includes *A. arabiensis)*, are the most efficient malaria vectors in the world. These mosquitoes are found only in Africa. In fact, the higher incidence of malaria in Africa compared to other parts of the world is mainly due the efficiency of these mosquitoes in transmitting the parasites.

Mosquitoes need a blood meal to develop and reproduce. They can take their blood meal either from humans or animals. Mosquitoes that mainly feed on humans are more efficient carriers of malaria than those that feed on animals.

One reason why mosquitoes in the *A. gambiae* group are very good vectors of malaria is that they prefer to bite humans more than animals. Mosquitoes that feed on humans and animals equally are much weaker vectors of malaria. Others feed exclusively on animals and are not malaria vectors. Therefore, the type of *Anopheles* mosquitoes and their feeding behaviour influence the intensity of transmission in an area.

Your knowledge and practical skills in identification of important breeding habitats in your village will be very helpful in your malaria prevention activities.

Mosquitoes adapted to breeding close to human settlements, and able to breed in a wide range of environments, are also better vectors of malaria than mosquitoes that breed away from human habitation. Some mosquitoes breed in small pools that are partially or completely exposed to the sun, while others prefer to breed in shaded stagnant pools. *A. gambiae* mosquitoes breed in a wide range of habitats, including small water collections such as hoof-prints, water-filled holes in rocks and trees, as well as dams, river beds and lake shores. Because *A. gambiae* vectors can breed in so many different habitats, they are responsible for much of the malaria transmission in Africa.

The main vector of malaria in Ethiopia, *A. arabiensis*, can be found in a variety of water collections, mainly closer to human habitations. However, stagnant water collections in borrow pits, ponds, micro-dams, pools in small rivers, and streams created immediately after the rainy season, are the most important breeding habitats for this vector.

6.2.2 Malaria parasites

You learned in Study Session 5 that there are four types of malaria parasite that can infect people. They are single-celled protozoa that can only be seen if viewed under a microscope (Figure 6.4).

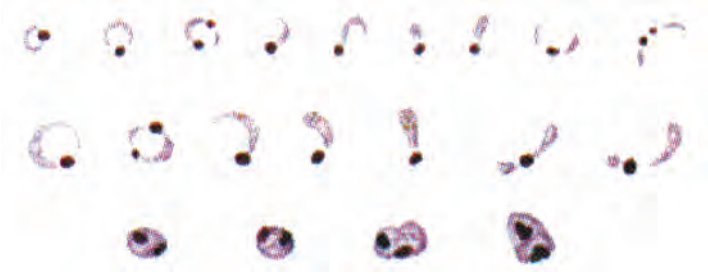


Figure 6.4 Developmental stages of malaria parasites (*Plasmodium* species) in the blood, stained to make them visible when magnified by a microscope. (Source: WHO, 1991, *Basic Malaria Microscopy, Part 1: Learner's Guide*, 2nd edition)

■ Can you recall the two forms of malaria that are most common in Ethiopia, and which one of them is more dangerous?

□ *P. vivax* is responsible for around 40% of cases and *P. falciparum* is responsible for around 60% of cases of malaria in Ethiopia. *P. falciparum* causes the most dangerous type of malaria and often kills untreated patients. *P. vivax* (and the other two rare forms) can make people very sick, but are not usually killers.

In some areas of Ethiopia *falciparum* malaria is more common, while in other areas *vivax* malaria is more common. *Falciparum* malaria is more common in Africa than in other parts of the world, and this is one reason why there are more deaths from malaria in Africa than elsewhere.

6.2.3 Water development projects

Big and small water-related development projects, such as irrigation channels, dams and ponds, can increase the incidence of malaria in villages that are located near such projects.

■ How can water development projects affect malaria transmission?

□ They create more vector breeding habitats; more vectors mean more malaria transmission.

Agricultural development, particularly with the use of irrigation, creates breeding sites for malaria mosquitoes, leading to increased malaria transmission. For instance, the use of irrigation to flood agricultural land during rice cultivation has long been associated with an increase in the number of vectors and a corresponding increase in the burden of malaria. Irrigated farming and rice agriculture is becoming more common in the lowlands of Ethiopia.

You will learn about environmental management to reduce the breeding sites for mosquitoes in Study Session 9 of this Module.

6.2.4 Urbanisation

The incidence of malaria is generally lower in urban areas than in rural areas. There are a number of reasons for this:

- While there is plenty of space for vector breeding in rural villages, mosquito breeding sites in urban areas are limited because more space is covered by houses.
- The main vectors of malaria in Ethiopia and elsewhere in Africa, are mosquitoes in the *A. gambiae* group, which breed in clean water; most water collections in urban settlements are polluted and unfavourable for mosquito breeding.
- People in urban areas may have more access to health care and malaria prevention strategies than people in rural villages.

However, rapid urbanisation of areas within or on the outskirts of urban centres is commonly done in an uncontrolled fashion without thought or planning (Figure 6.5). The settlers are mainly migrant workers from rural villages. Conditions are crowded; housing is often of poor quality or is of temporary construction; and the provision of health care and sanitation is often inadequate.

Figure 6.5 Rapid unplanned urban development can create many new breeding grounds for malaria vectors. (Photo: Basiro Davey)

Settlers tend to dig several pits to extract stone and soil for house construction, creating numerous breeding grounds for mosquitoes. This can lead to explosive growth of mosquito vectors, increased exposure of the population to vectors due to poor housing, and amplification of disease to epidemic proportions through lack of effective treatment.

Your main responsibility as a rural Health Extension Practitioner is mainly to provide care and set up preventive measures in rural communities. However, some semi-urban settlements at the periphery of urban centres could fall under the rural classification and be part of your catchment area. Remember that people living in such semi-urban centres can be at a higher risk of malaria than typical rural communities.

6.2.5 Population movement and migration

Population movements have significant implications for malaria transmission. The majority of the population movements in Ethiopia involve people moving from the highlands to the malaria-endemic lowlands as seasonal labourers. These people are often employed as daily labourers in the crop fields during the planting and harvesting seasons (Figure 6.6), when malaria transmission is at its peak. The poor living conditions and inadequate health care in such agricultural projects often worsen the problem of malaria. Migrants from malaria-free highlands lack immunity against the disease, as well as the appropriate knowledge of the transmission process and how to avoid being bitten by mosquitoes.

Figure 6.6 Migrant labourers from malaria-free areas are at increased risk of malaria during harvesting in lowland malaria-endemic areas.
(Photo: Basiro Davey)

Migration for the purpose of permanent settlement in a new area is also common in Ethiopia and is a major factor associated with malaria transmission. Migration is often from densely populated highlands to malaria-endemic lowlands, where the population density is low and the soil is more fertile. Major environmental transformations like deforestation, and new construction etc, take place during resettlement, enhancing the proliferation of mosquito breeding sites, and resulting in major malaria outbreaks.

Population movements and migration also make the malaria problem worse in the areas from which the migrants came. Temporary migrant workers often bring the parasites back to the malaria-free highlands and local transmission can be readily established as many of these communities could support vector breeding. Such sporadic epidemics could affect a large number of people, as the population in malaria-free areas is generally non-immune.

Large population displacements can also occur rapidly due to causes like war and civil unrest, or natural causes like drought and famine, flooding and earthquakes, etc. Displaced people from areas with malaria can introduce or reintroduce malaria into areas that are malaria free, and in some cases spread drug-resistant malaria. Displaced populations can in some cases be at a higher risk of getting sick or dying from malaria because:

- Displaced people may not have proper housing.
- They often camp near water bodies that serve as mosquito breeding sites.
- They could be non-immune, if moving from malaria-free to malaria-endemic areas.
- Malnutrition can worsen the malaria problem.
- The health care system can be overburdened, so there may be very limited malaria care and preventive measures.

You will learn about drug-resistance when we describe malaria case management in Study Session 8.

Though the chance of large scale population displacement due to social and natural disasters is rare in Ethiopia, it is important for you to keep in mind that displacement can worsen the problem of malaria.

6.2.6 Human host factors

Differences in human hosts also affect the pattern of malaria transmission and the severity of the disease. When it comes to malaria, people are either immune, or non-immune. Immune people often have a better chance of tolerating the effects of malaria and surviving the disease than non-immune people. In highly endemic areas, children under five years of age and pregnant women are the most at risk (Figure 6.7), because they have weak immunity to malaria infection. Immunity to malaria develops slowly after several infections and children need at least five years to develop their immunity. Pregnant women have less immunity to malaria due to their pregnancy.

Figure 6.7 Pregnant women and children under five years of age are most at risk of malaria due to their weakened immunity.
(Photo: UNICEF Ethiopia/Indrias Getachew)

Certain population groups can be infected by some types of malaria parasites, but not by others. For example most Africans south of the Sahara can get infected by *falciparum* malaria, but not by *vivax* malaria. This is another reason why most of the disease and deaths due to malaria occur in Africa, because *falciparum* malaria is the deadliest form of malaria and is highly prevalent in the continent.

6.2.7 Insecticide resistance in vectors

In Study Sessions 9, 10 and 11, you will learn how some insect-killing chemicals (**insecticides**) are used to kill mosquitoes and protect communities from mosquito bites. No (or low numbers of) mosquito bites mean no or less risk of malaria. However, after repeated application of these chemicals, the mosquitoes develop **insecticide resistance**, which means that they are no longer killed by the insecticides. This means a large number of mosquitoes will survive in the community, and the risk of malaria infections rises and many people can be affected.

6.2.8 Drug resistance in malaria parasites

You will learn about the medicines used to treat malaria in Study Session 8. These drugs kill the malaria parasite inside the human body. However, similar to the insecticide resistance mentioned above, after repeated use of an anti-malaria medicine, the parasite can develop resistance to that particular drug or to similar medicines. As a result, the parasites inside the human body can no longer be killed and patients cannot be cured unless new drugs are developed for treatments. If **drug-resistant malaria parasites** are not cleared by treatment from infected individuals, they are easily picked up by vector mosquitoes, and transmitted to new susceptible individuals who then develop drug-resistant malaria. Moreover, more people who are not getting cured by drug treatment means that more will die of malaria.

6.2.9 Interruption of control and prevention measures

Malaria is a curable disease if the parasites remain susceptible to available treatments, and it can be prevented by using several methods. However, long-term and sustained implementation of prevention and control measures is necessary to significantly reduce or eliminate the problem from a country or a specific geographic area. As a result of long-term successful interventions, a local population can lose their immunity to malaria in an area where it has been reduced to a low level for some time. Remember that repeated infections are necessary to develop immunity to malaria. Immunity gets lower or is lost if a person moves out of a malaria endemic area, or is protected from infection for several years. Therefore, if control and preventive measures are stopped before the disease is eliminated, malaria can surge back and affect more people, and affect them more severely than before.

Summary of Study Session 6

In Study Session 6, you have learned that:

1 Malaria transmission is directly affected by different climatic factors.

2 There is an optimal range of temperature that is best for the development of the vector and the parasite.

3 Temperature greatly influences the distribution of malaria in Ethiopia; most highlands in Ethiopia have very little or no malaria due to low temperature.

4 Altitude is the most important factor that determines the distribution of malaria. Altitude and temperature are closely related in Ethiopia. Lowlands are warm (good for malaria transmission), highlands are too cold for malaria parasites and vectors to develop.

5 Higher humidity makes the vector live longer; malaria is transmitted by vectors that live 8–10 days so the parasites have time to develop.

6 The main malaria transmission in Ethiopia is after the rainy season because rainfall creates many vector breeding grounds.

7 Several non-climatic factors affect the severity and incidence of malaria transmission, including the type of vectors and parasites, environmental developments and urbanisation, population movement and migration, the level of immunity in the human hosts, insecticide resistance in mosquitoes, and drug resistance in parasites.

Self-Assessment Questions (SAQs) for Study Session 6

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 6.1 (tests Learning Outcomes 6.1 and 6.3)

Imagine that the relative humidity of your village is 40% in February and 80% in September. Describe how this could affect malaria transmission in your village. Start by explaining the effect of humidity on the vector.

SAQ 6.2 (tests Learning Outcome 6.2)

Imagine that the average daily temperature in your village is 12°C and you rarely see malaria cases. Describe the reason why there is no malaria transmission in your village.

SAQ 6.3 (tests Learning Outcomes 6.2 and 6.3)

Imagine that your village is located at 1,000 metres above sea level and is covered with vegetation throughout the year. Several new malaria cases are occurring every month. What could be the factors causing the high malaria rate in your village?

SAQ 6.4 (tests Learning Outcome 6.4)

Most of the malaria cases in your village come in the two months following the rainy season. Very few cases occur in the dry season. Explain the reason why so many cases occur after the rainy season.

SAQ 6.5 (tests Learning Outcome 6.5)

Anopheles arabiensis prefers to bite humans more than animals. Another *Anopheles* mosquito, *An. pharoensis*, feeds more on animals than humans. Which one of them will be a better vector of malaria and why?

SAQ 6.6 (tests Learning Outcome 6.5)

In village A, most of the malaria cases are due to *falciparum* malaria. In village B, *vivax* malaria is more common than *falciparum* malaria. Which village will have more deaths due to malaria and why?

Study Session 7 Diagnosis of Malaria

Introduction

In this study session you will learn about two different methods used to identify malaria parasites in patients (parasite-based tests). But first you will need to make a clinical or 'presumptive' diagnosis of malaria, based on recognising the most common signs and symptoms of the disease, including severe malaria.

The most important malaria diagnostic method used at the community level is the **rapid diagnostic test (RDT)** for malaria. RDTs provide a quick way to tell whether a person with malaria-like symptoms actually has malaria, as the test takes only 15–20 minutes. The RDT detects certain chemicals in the blood that are produced by malaria parasites if they are present. In this study session you will learn how to use the RDT kit for malaria, including the precautions you must take when performing an RDT, and how to interpret the results.

Finally, we will briefly describe how malaria can be diagnosed using microscopic techniques to detect the presence of parasites in blood smears. You are not expected to use a microscope for diagnosis, but it is useful for you to know what is involved in microscopic diagnosis, which is done at health centres and hospitals.

Learning Outcomes for Study Session 7

When you have studied this session, you should be able to:

7.1 Define and use correctly all of the key words printed in **bold**. (SAQ 7.1)

7.2 Describe how to diagnose malaria and assess the severity of cases, based on clinical signs and symptoms. (SAQs 7.2 and 7.3)

7.3 List the advantages and limitations of rapid diagnostic tests (RDTs) for malaria. (SAQ 7.4)

7.4 Explain how to perform RDTs for malaria safely and effectively, and record the results accurately. (SAQs 7.5 and 7.6)

7.5 Explain how microscopic examination is used to diagnose malaria and state its advantages over RDTs. (SAQ 7.7)

7.1 Clinical diagnosis

In Study Session 2, you learned how to classify and diagnose communicable diseases according to their clinical symptoms. In this section, you will be able to apply those principles to the clinical diagnosis of malaria. In Study Session 5 you learned that some members of the population, such as children under the age of five years and pregnant women, are at a higher risk of getting malaria due to their weaker immunity. By learning how to identify malaria with clinical diagnosis (and confirm it with RDTs) you will be able to provide effective and prompt treatment of malaria to patients at the community level. By identifying signs and symptoms of severe malaria, you will also be able to refer patients that need higher medical care to the health centre or hospital. In this way your knowledge and actions could save many lives, as poorly diagnosed and managed malaria could kill many people in your community.

7.1.1 The symptoms and signs of malaria

The clinical symptoms of malaria vary from very mild to very severe, depending on several factors. In areas where malaria is very common, adults with the disease may show just a slight increase in body temperature. However, pregnant women, and in particular, young children, often have a severe illness with many symptoms. The most important symptom of malaria is fever (or a history of fever within the last two to three days). An attack often begins with shivering (body shaking). This is followed by a period of fever, and finally there is profuse sweating. During an attack the patient often complains of headache and pains in the back, joints, and all over the body (Figure 7.1).

Figure 7.1 An adult with malaria, Ethiopia.

There may also be loss of appetite, vomiting, and diarrhoea. The patient may feel better the next day, but may have another attack the day after that, and so on. If untreated (or inadequately treated), malaria can cause several weeks or months of poor health because of repeated attacks of fever, **anaemia** (see Box 7.1) and general weakness. Some patients rapidly become very ill and may die within a few days.

Box 7.1 Anaemia

Anaemia means not enough haemoglobin in the blood. Haemoglobin is the red substance in the red blood cells which carries oxygen. Malaria parasites destroy the red blood cells and so malaria may cause anaemia. Anaemia may also have other causes (for example, not enough iron in the food). You can recognise anaemia by looking at the patient's hands: the palms of a person with anaemia do not have the redness of a healthy person's palms. If the red colour of the inner eyelid or mouth is paler than in a healthy person, the patient has anaemia. Breathlessness and a fast pulse may also be present, because the person's blood cannot carry enough oxygen for their needs.

A critical feature that may help you to recognise if a fever is due to malaria or not is that **malarial fever** occurs in *cycles* – periods of fever alternate with periods in which the patient shows normal body temperature (below 37.5°C) and no symptoms. The stages of malarial fever attacks are shown in Table 7.1. (You will learn more about how to identify malaria cases in Section 7.2.3).

Table 7.1 Clinical symptoms of a typical malarial fever attack.

Stage of malarial fever attack			
Stage name	**Cold stage**	**Hot stage**	**Sweating stage**
Main clinical symptoms	• Feeling very cold • Vigorous shivering	• Feeling very hot – higher than normal temperature • Dry burning skin • Headache	• A lot of sweating • Fall in temperature • Feeling exhausted and weak • Tendency to fall asleep
How long symptoms last	15–60 minutes	2–6 hours	2–4 hours

■ A four-year-old patient is presented to you with fever of 38°C. The child also has poor appetite, is weak and has yellowish eyes. What other questions should you ask his mother or guardian to try and find out if the child is suffering from malaria? Give reasons for your answer.

□ You should try to find out how long the child has had fever. You should also find out whether the fever has alternated with a stage of sweating, followed by a cold, shivering stage. A child with a fever could have malaria, but fever can also be a symptom of other diseases. However, a child who has gone through stages of fever, sweating and shivering is much more likely to be suffering from malaria, as this is the typical pattern of malarial fever attacks.

Malarial fever attacks usually repeat every 48 hours, for patients infected with the two most common species of plasmodium in Ethiopia, *P. vivax* and *P. falciparum*.

7.1.2 Course of malarial disease

Symptoms of malaria usually start to appear 7 to 21 days after the bite of an infected mosquito. However, the normal *incubation period* is different for different species of *Plasmodium,* as described in Study Session 5. Remember that the **incubation period** is the time between the parasite getting into the blood of a person and the onset of symptoms.

■ Can you recall, from what you learned in Study Session 5, which of the following malaria parasites has the shortest incubation period? Which has the longest?

- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium malariae*
- *Plasmodium ovale.*

□ *P. falciparum* has the shortest and *P. malariae* has the longest incubation period.

A patient who is not treated may develop severe complications and may die, or may continue to have cycles of fever alternating with symptom-free periods. In general, the more *Plasmodium* parasites there are in the blood, the more severe the disease will be.

Disease progression varies with the parasite species

Disease progression varies according to the species of *Plasmodium* that has infected the patient. Patients infected with *P. vivax*, especially for the first time, can be quite ill. However, *P. vivax* rarely causes complications or results in death. **Relapses** (return of malaria symptoms due to activation of an old infection) due to *P. vivax* can occur for several years.

Patients with serious complications are generally referred to a health centre; you will learn how to refer such patients in Study Session 8.

By contrast, *P. falciparum* is the most lethal form of malaria infection. It causes the most serious complications, which are anaemia (Box 7.1 above) and **cerebral malaria**. In cerebral malaria, red blood cells infected by the parasite stick to small blood vessels in the brain. This reduces the flow of blood and the supply of oxygen and nutrients to the brain. If untreated, cerebral malaria can kill the patient in 24–48 hours. It most commonly affects young children (Figure 7.2).

Figure 7.2 A mother with a child suffering a malaria attack. (Photo: UNICEF Ethiopia)

7.1.3 How you can identify cases of malaria

The most important element in the clinical diagnosis of malaria is for you to be alert and to suspect malaria in all patients with fever, whether your catchment area is located in a malarious area or not. Because the distribution of malaria in Ethiopia is patchy, it is also very important for you to find out the geographical and travel history of a patient who shows signs and symptoms of malaria, most importantly fever.

In non-malarious areas, you should suspect malaria in a patient who has high fever, or has had fever in the last 48 hours, if the person has travelled to a malarious area or country in the previous two weeks. In malarious areas, fever, or a history of fever in the last 48 hours, should be enough for you to suspect malaria in a patient. You should pay particular attention to children under the age of five years and pregnant mothers, as these groups are at a higher risk than others.

■ Why do you think children are at higher risk of getting severely ill or dying of malaria than adults?

□ Children have a much weaker immunity against malaria. Immunity develops after repeated exposures to the malaria parasite and this takes time.

You can recognise malaria by *asking the right questions* and *looking for the important signs* (see Box 7.2):

Box 7.2 How to approach a clinical diagnosis of malaria

- *Ask:* Ask questions and listen to what the patient has to say (if the patient is a young child, listen to the parent or guardian). If the patient (or parent) does not mention fever, ask whether there has been a fever at any time during the past 2–3 days. *Patients who have had fever during the last 2–3 days may have malaria.*
- *Look:* Examine the patient for symptoms of malaria. Measure the temperature with a thermometer. If the temperature is more than 37°C, the patient has a fever. (If you do not have a thermometer with you, feel the forehead with the back of your hand. If the forehead feels hot, the patient probably has a fever).
- *Check:* In addition to fever, malaria patients can show the following signs and symptoms: loss of appetite, refusal to breastfeed (child), weakness, nausea, vomiting, headache, joint pains, muscle aches. If you see any of these features you should think about malaria and act immediately. If there is no fever and no history of fever during the past 2–3 days, the patient does *not* have malaria.

7.1.4 Danger signs of severe malaria

If the patient has had fever during the past 2–3 days, first *ask* about and then *look* for danger signs:

Ask:

- Is the patient unable to drink?
- Has the patient had convulsions (fits)?
- Does the patient vomit repeatedly?
- How much urine does the patient pass? Very little? None at all? Is it dark?
- Is the patient breathing fast, or having difficulty breathing?
- Does the patient have yellowish eyes, mouth or palms?

Look:

- Is the patient abnormally sleepy, difficult to wake, or confused?
- Does the patient have anaemia?
- Does the patient have severe dehydration? (Look for sudden weight loss, loose skin, sunken eyes, dry mouth)
- Is the patient unable to stand or sit?
- Is the patient breathing fast, or having difficulty breathing?
- Does the patient have yellowish eyes, mouth or palms?

If the answer to any of these questions is *yes*, the patient has severe malaria. The patient's life is in danger. Urgent treatment is needed to save the patient's life so refer immediately to the nearest health centre.

7.2 Parasitological diagnosis of malaria

If you suspect that a patient may have malaria, you will need to confirm the clinical diagnosis using specific tests to identify the presence of the malaria parasite or its products in the blood. This process is called **parasitological** or **parasite-based diagnosis**. In areas with a risk of malaria, or in patients who have travelled back from malaria-endemic areas, fever should be enough to make you suspect malaria and do a confirmatory test. The parasitological diagnosis of malaria can be divided into microscopic and non-microscopic tests. Microscopic tests involve the use of a microscope to see the parasite in the blood of a patient. At health post level you will not be able to carry out microscope tests, but they will be discussed briefly in Section 7.2.3. First we describe the non-microscopic tests, also known as rapid diagnostic tests (RDTs).

7.2.1 Introduction to rapid diagnostic tests (RDTs) for malaria

The national malaria diagnosis policy in Ethiopia is that Health Extension Workers and Practitioners must test anyone suspected of having malaria by using the RDT for malaria. RDTs are now available in all health posts in areas where malaria is a risk and you will receive some practical training in how to use them.

The Ethiopian national guidelines state that malaria treatment at health post level, or referral from the health post to the health centre, should be based on RDT test results, so knowing how to use the RDT properly is a very important part of your job. In this section you will learn how to use the RDTs more effectively. You will also learn about the precautions you have to take to protect yourself and other patients when working with blood.

How RDTs work

RDTs test whether a person with malaria-like symptoms actually has malaria by testing the blood of the patient for chemical substances produced by malaria parasites. Malaria parasites produce proteins called *antigens.* RDTs detect *malaria antigens*, so if they are present, the person will test positive. If malaria antigens are not present, the person will test negative.

The reason for using RDTs

RDTs enable you to find out if a fever is really caused by malaria rather than by other illnesses. You can also get information about which malaria parasites may be causing the infection. The information provided by RDTs is important for three main reasons:

- First, being able to tell quickly whether a patient with fever has malaria or not ensures that the patient can receive the correct treatment.
- Second, if a patient does have malaria, knowing which parasite may be involved is important, as some malaria parasites are more dangerous than others and require more urgent treatment.

■ Can you remember which malaria parasite causes the most serious malaria in Ethiopia?

□ *P. falciparum* can kill a person in 24–48 hours, for example by causing cerebral malaria. *P. vivax* is less likely to cause complications and is rarely fatal.

- Third, *falciparum* malaria treatment in Ethiopia is based on **artemisinin combination therapy** (**ACT**), which is more expensive than older anti-malarial drugs such as chloroquine (CQ) and sulfadoxine-pyrimethamine (SP). *Vivax* malaria accounts for 40% of the malaria cases in Ethiopia, but it does not need treatment with ACT. By identifying which patients have *falciparum* malaria, RDTs can save money, as ACTs will then only be given to patients with *falciparum* malaria.

You will learn about malaria case management with these drugs in Study Session 8.

By using the RDT you will be able to test for malaria parasites in a patient's blood, and in this way to provide a more accurate diagnosis than a clinical or presumptive diagnosis. RDTs give results in about 15–20 minutes, so a patient with malaria can begin treatment right away. RDTs do not require any expensive or complicated equipment and can be used by you in the patient's home. You should be able to learn to use RDTs in just a few hours in your practical training programme.

Limitations of RDTs

RDTs are very effective for diagnosing malaria, but there are some things they cannot do.

First, RDTs cannot test how *many* malaria parasites there are in the blood – they can only test whether parasites are present or absent. In fact, RDTs do not detect actual parasites; they detect parasite *antigens*, as mentioned above. Some parasite *antigens* can remain in the blood for at least two weeks after the parasites have been killed by drugs.

■ What will be the result if an RDT is used on a person within two weeks of taking anti-malarial drugs, and should you trust the result? Explain your answer.

□ An RDT used within two weeks of drug treatment may still detect parasite antigens and so give a positive result for malaria infection, even if the person no longer has parasites, because the parasites have been killed by the drugs. This is why this positive result cannot be trusted.

Second, RDTs can be damaged by heat and humidity, so the RDT should not be removed from its sealed package before you are ready to use it. If a package has been open for some time before the RDT is used, the RDT may be damaged and can give an invalid (false) result. You should discard this package and use another, unopened, package.

Actions following positive and negative results from RDTs

The national malaria treatment guidelines now recommend the use of parasite-based diagnosis using RDTs for malaria by community health workers for all age groups, except when the RDT is not available due to logistics problems.

- Before using the RDT, ask the patient if he or she has recently taken anti-malaria medication. If the patient has taken a complete course of anti-malaria medication in the last 5–14 days, a positive RDT result may be

misleading (see above). It may be necessary to refer the patient to a health centre with a laboratory for further testing using a microscope.

- If fever persists a few days after a negative RDT result and other appropriate management has been applied, you should re-test the patient with another RDT, as RDTs can sometimes miss early malaria infections.

Otherwise:

- If the patient has not recently taken anti-malarial medication and the test result is *positive,* treat the person for malaria according to national guidelines (see Study Session 8).
- If a patient has fever and the second test result is still *negative,* refer them to a higher level health centre.

We now explain how to use an RDT, and how to interpret the results.

7.2.2 How to use an RDT to get a malaria test result

Here is the checklist that you must follow when you are using an RDT for malaria diagnosis.

(i) *Check the expiry date on the package.* Do not use RDTs that have expired.

(ii) *Put on gloves before beginning* (Figure 7.3). Use a new pair of gloves for each patient. Do not re-use gloves.

Figures 7.3 to 7.10 are from WHO, 2006, *How to Use a Malaria Rapid Diagnostic Test (RDT): A Guide for Training CHWs and Other Health Workers.*

Figure 7.3 Put on new gloves before starting each RDT. (Source: WHO, 2006, see marginal note)

(iii) *Open the RDT package and remove the contents.* The blood-transfer device — it could be a capillary tube, straw, loop, pipette or other device — is used to collect blood and transfer it to the test cassette. (Once the packet is opened, the 'desiccant' sachet which absorbs moisture from the atmosphere in the package should be discarded.) The test cassette (shown later, in Figure 7.8) is used to conduct the test. The square hole labeled 'A' is where you add the blood. The round hole labeled 'B' is where you add the buffer.

(iv) *Write the patient's name on the cassette* (Figure 7.4).

Figure 7.4 Write the patient's name on the cassette.

(v) *Open the alcohol swab and clean the patient's third or fourth finger with alcohol* (Figure 7.5). This is to prevent infection. Other fingers may be used if necessary. Ask the patient: 'Are you right-handed or left-handed?' If the patient is right-handed, choose a finger on their left hand. If the patient is left-handed, choose a finger on their right hand.

Figure 7.5 Clean the patient's finger with alcohol.

(vi) After cleaning the finger with the alcohol swab, the finger must be allowed to *air dry.* After using the alcohol swab, place it on its wrapper and set it aside on the table. You will use it again to stop the bleeding after you collect the patient's blood.

(vii) *Once the patient's finger is dry, open the lancet.* Prick the patient's finger, preferably towards the side of the pulp (ball) of the finger. Discard the lancet in a sharps-only container immediately after using it (Figure 7.6).

Figure 7.6 The lancet used in the RDT must be put in a 'sharps only' safety box.

(viii) Turn the 'patient's' arm so their palm is facing downward. *Squeeze the pricked finger and allow a drop to well up below the finger tip* as in Figure 7.7. Use the loop or capillary tube or straw or the pipette to collect the drop from underneath. Once you have collected a sufficient amount of blood, you may hand the alcohol swab back to the patient and show him or her how to use it to stop the bleeding.

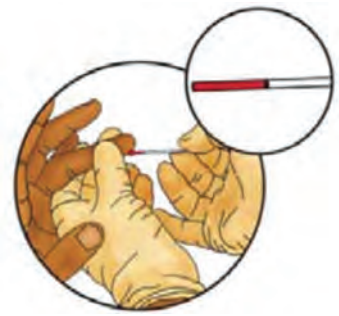


Figure 7.7 Drawing blood with a capillary tube.

Never put the lancet down before discarding it. Never discard the lancet in a non-sharps container. Never use a lancet on more than one person.

(ix) *Use the device (capillary tube, straw, loop, pipette or other) to add the drop of blood to the sample window* (square hole labeled with the letter A, see Figure 7.8). The blood needs to reach and be absorbed by the pad at the base of the square hole. If the blood is mostly deposited on the plastic edges of the well, but does not reach the pad, the test will not work correctly. Deposit the blood in the correct place using the capillary tube, straw, loop, pipette or other. Adding too much or too little blood can cause the test to give an invalid result or be difficult to read.

Figure 7.8 Adding blood to the RDT cassette.

(x) *Add the buffer solution to the round hole labeled B.* Hold the bottle vertically when adding the buffer solution, as in Figure 7.9. This ensures the correct drop size.

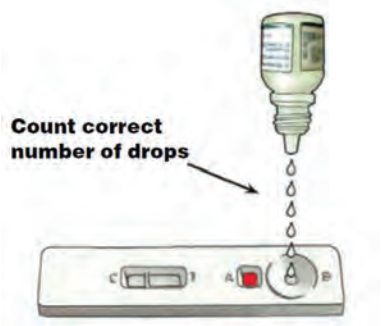


Figure 7.9 Adding the buffer solution.

(xi) *Wait for the correct duration of time (15 or 20 minutes) after adding buffer before reading the test results.*

(xii) *Discard the blood-collection device (e.g. capillary tube) safely after use.*

(xiii) *Remove and discard your gloves at this time.* To avoid possible contamination, the used gloves should be discarded in the non-sharps container before you do anything else.

7.2.3 How to read and interpret an RDT test result

The different possible results and what they mean are illustrated in Figure 7.10 and summarised in Table 7.2 (on the next page).

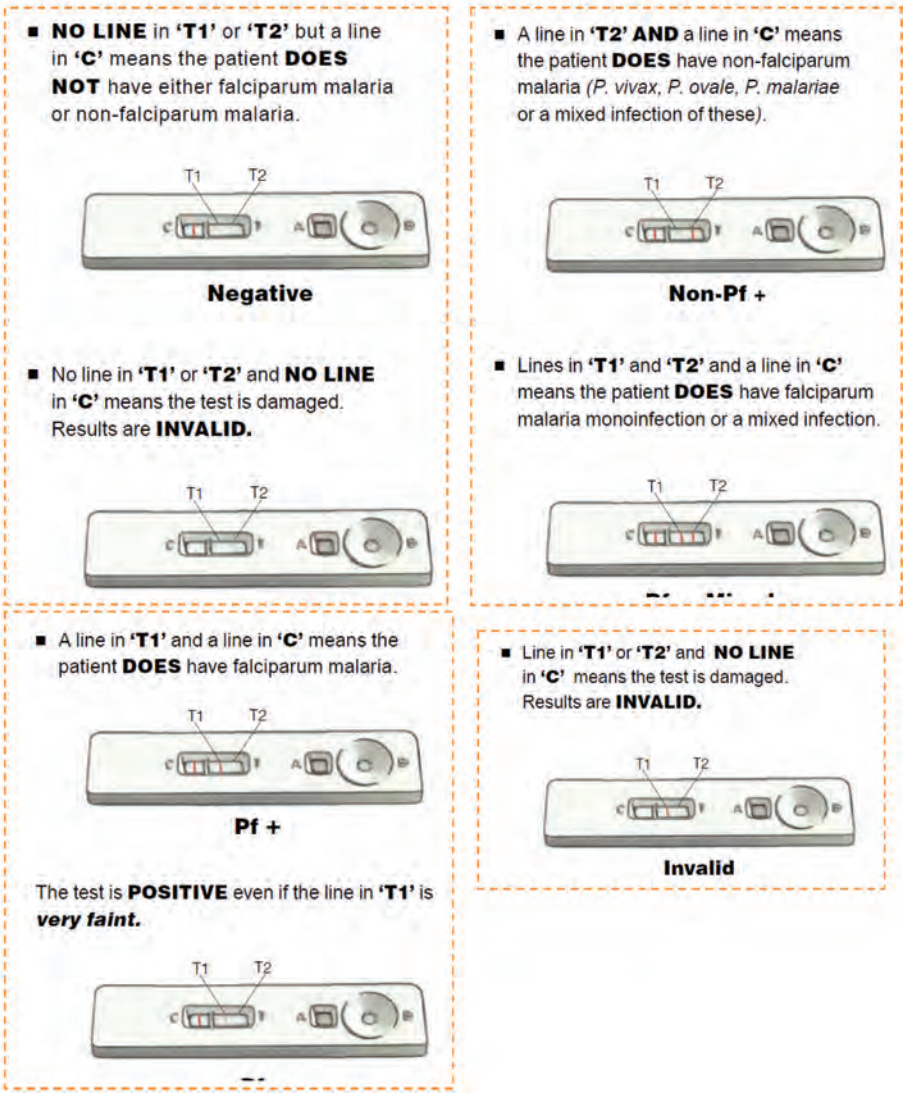


Figure 7.10 The different possible test results of a malaria RDT. 'C' is the control line; 'T1' and 'T2' are the test lines.

Table 7.2 Malaria RDT interpretation chart.

Results	Control Line C	Test lines T1	Test lines T2
		P. falciparum	*P. vivax*
Negative			
Positive: *P. falciparum* only			
Positive: *P. falciparum* only or mixed with other species			
Positive : non-*P. falciparum* (*P. vivax*)			
Invalid			
Invalid			
Invalid			

As you can see from Figure 7.10 and Table 7.2, sometimes the result can be *invalid*, that is, it could be incorrect.

- What should you do if the test result is invalid?
- Discard the RDT cassette. Open a new cassette and repeat the test using the new cassette.

7.2.4 Microscopic test for malaria

Figure 7.11 Malaria parasites being viewed under a microscope. (Photo: I-TECH/ Julia Sherburne)

Microscopic diagnosis of malaria is done by a trained laboratory technician at health centre or hospital level. It is not your responsibility to do a microscope test, but this section will briefly explain it so you understand the technique.

Microscopic diagnosis involves taking a small amount of blood from the patient, staining it and looking at it under a microscope to check for malaria parasites. In most cases of malaria, microscopic examination of thick and thin films of finger-prick blood will reveal malaria parasites. Thick films are 20–40 times more sensitive than thin films for detecting *Plasmodium* parasites, and are particularly useful if the number of parasites is low. Thin smears are also useful as they can allow identification of particular *Plasmodium* species (Figure 7.11). The diagnostic accuracy relies on the quality of the blood smear and the experience of laboratory personnel.

Summary of Study Session 7

In Study Session 7, you have learned that:

1 Knowledge of the signs and symptoms of malaria is important for its clinical diagnosis.

2 Different species of the malaria parasite can cause malaria of different severity. Of the two species present in Ethiopia, *P. falciparum* is more likely to cause a severe and fatal disease. Young children and pregnant women are more at risk of serious infection as they have weaker immunity.

3 The most important clinical symptom of malaria is fever (or a history of fever within the last 2–3 days), typically with regular attacks every 2–3 days lasting several hours. Attacks often begin with shivering, followed by fever, then profuse sweating.

4 In areas where malaria incidence is low, always ask those who have a fever about their travel history to malaria endemic areas in the last two weeks.

5 Carefully observe all suspected or confirmed malaria cases for any signs of severe malaria, which include convulsions, anaemia, repeated vomiting, high fever (above 39°C), severe dehydration, drowsiness or confusion, and reduced urine output.

6 Refer severe cases immediately.

7 Whenever possible malaria treatment should be based on parasitological diagnosis of malaria rather than on a clinical diagnosis based on symptoms.

8 Rapid diagnostic tests (RDTs) for malaria are available at health post level and are effective in diagnosing malaria if correctly used. RDTs cannot distinguish between species of malaria parasites or estimate the number present in the patient's blood sample.

9 In the absence of RDTs, you will need to use clinical symptoms to diagnose malaria. In some cases you may need to refer patients to the health centre or hospital, so a microscopic diagnosis of malaria can be carried out to confirm malarial infection.

Self-Assessment Questions (SAQs) for Study Session 7

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 7.1 (tests Learning Outcome 7.1)

What method is available to you at health post level to allow you to make a parasite-based diagnosis of malaria?

SAQ 7.2 (tests Learning Outcome 7.2)

Malaria is rare in your village. However, a 25 year-old male comes to your health post complaining of loss of appetite and muscle aches. You suspect malaria, but you don't have an RDT kit to confirm your diagnosis. What questions should you ask him to either *exclude* malaria as a possible diagnosis, or decide that you should *treat* him for malaria?

SAQ 7.3 (tests Learning Outcome 7.2)

A five-year-old child comes to your health post with fever. He was tested with an RDT and the result was positive for *falciparum* malaria. Before treating and sending him home, you have to check for signs of severe malaria in case he needs a referral. What are the signs and symptoms you would look for?

SAQ 7.4 (tests Learning Outcome 7.3)

You have learned that RDT and microscopy are two simple and useful methods to diagnose malaria. List two important advantages of RDT over microscopy.

SAQ 7.5 (tests Learning Outcome 7.4)

You are confronted with more than 20 fever cases in the community around your health post at the same time. You will test all patients with RDTs for malaria. What do you do to avoid any mix-up of results?

SAQ 7.6 (tests Learning Outcome 7.4)

List the precautions you need to take to avoid contaminating yourself and your patients with another person's blood, when performing an RDT for malaria.

SAQ 7.7 (tests Learning Outcome 7.5)

You treated the five-year-old child positive for *falciparum* malaria in SAQ 7.3, according to the national guideline. The child comes back after three days with fever and you again test him with an RDT. The patient was again positive for *falciparum* malaria.

(a) What will be your next action?
(b) What are the advantages of microscopy over RDTs?

Study Session 8
Malaria Case Management

Introduction

You have now learned how the malaria parasite is transmitted, the life cycle of the parasite, the symptoms and signs of the disease and the diagnosis of malaria. The objective of this study session is to give you the required knowledge and skills to provide effective and prompt treatment for malaria cases. You are going to learn:

- How to treat uncomplicated (non-severe) malaria in adults, in children and pregnant mothers.
- The pre-referral treatment of severe malaria cases.
- How to educate people about the benefits of early treatment of cases and adherence to the treatment course.

This study session will describe the procedures of malaria treatment, the anti-malaria medicines used under different situations, and the procedure of providing pre-referral care to patients that cannot be managed at your Health Post level. Providing early and effective treatment is one of the most important interventions of any malaria control programme. In fact, the most important indicator used to measure the success of malaria interventions is the proportion of people with malaria getting anti-malaria treatment within 24 hours after the onset of fever.

Unlike many communicable diseases, malaria is an *acute* infection that requires immediate attention after the onset of symptoms. The disease can quickly progress to a severe form, and death can occur within 48 hours of the onset of signs and symptoms. As a Health Extension Practitioner deployed within a village, you are the most important person, and probably the *only* person, who can provide early and effective treatment for malaria cases, within 24 hours. This is probably one of the most satisfying parts of your job because it is directly linked to saving lives.

Learning Outcomes for Study Session 8

When you have studied this session, you should be able to:

8.1 Define and use correctly all of the key words printed in **bold**. (SAQs 8.1 to 8.6)

8.2 List the different anti-malaria drugs and the dosage given to uncomplicated and severe cases of malaria. (SAQs 8.2, 8.4 and 8.6)

8.3 Describe the procedure for treating uncomplicated malaria and giving supportive treatment in different age groups and in pregnant mothers. (SAQs 8.1, 8.2 and 8.6)

8.4 Describe the procedure for the pre-referral treatment of cases of severe malaria and when to refer them to the health centre. (SAQs 8.3, 8.4 and 8.6)

8.5 Explain how you would identify and address the challenges in malaria case management. (SAQs 8.5 and 8.6)

8.1 Treatment of uncomplicated malaria

In Study Session 7 you learned the different methods for diagnosing malaria and how the clinical diagnosis and Rapid Diagnostic Test (RDT) methods are applied at the Health Post level. In this section you will learn about the treatment of uncomplicated (non-severe) malaria cases.

In order to prescribe an anti-malaria treatment for malaria-suspected fever cases, you should make a confirmed diagnosis using a **multi-species RDT**. This is an RDT that can test for different species of the malaria parasite. However, if you do not have this RDT at your Health Post, you can still make a malaria diagnosis based on the patient's history and based on findings of physical examination. The summary of the steps you follow to make a diagnosis and prescribe treatment for malaria is indicated in Box 8.1 below.

Box 8.1 Steps to follow to treat malaria cases

- Take history of the patient, including history of travel to malarious areas. Take enough time to pay proper attention to what the patient has to say.
- Do a physical examination, measure temperature, blood pressure and count the pulse rate.
- Consider if there is another obvious cause of fever other than malaria.
- Test for malaria parasites using multi-species RDTs (if you have the test kits and have been trained to use them).
- Treat the patient based on the result of the RDT.
- If you do not have RDTs in your Health Post, diagnose malaria based on the clinical findings from the patient's history and the physical examination.

In the next section you will learn the course of action to take when you use either an RDT, *or* clinical diagnosis, to determine the treatment of malaria. Carefully note the slight differences between the two approaches.

8.1.1 Treatment of uncomplicated malaria based on RDT confirmation

Scenario 1

If RDT indicates *P. falciparum* infection then treat the patient with appropriate doses of Coartem (one of the artemisinin-based combination drugs), or artemisinin combination therapy with chemical ingredients of artemether-lumefantrine. Before you give the patient Coartem, make sure that the patient is able to swallow the medication, and is not vomiting. (See the treatment doses of Coartem in Table 8.1 on the next page.) Coartem tablets are given according to the body weight or age of the patient, in six doses to be taken over three days. Give the first dose to the patient in front of you. Advise your patient to take fatty foods if available. If fatty food is not available, advise the patient to take any foods or fluids after swallowing Coartem. Explain that a fatty meal or milk improves absorption of Coartem, hence the patient can recover faster.

One tablet of Coartem contains 120 mg artemether, plus 20 mg lumefantrine, in a fixed dose.

Table 8.1 Coartem treatment doses and schedules by body weight and age.

Weight (kg)	Age	Day 1		Day 2		Day 3	
		Morning	Evening	Morning	Evening	Morning	Evening
5–14	4 months–2 years	1 tablet	1 tablet	1 tablet	1 tablet	1 tablet	1 tablet
15–24	3–7 years	2 tablets	2 tablets	2 tablets	2 tablets	2 tablets	2 tablets
25–34	8–10 years	3 tablets	3 tablets	3 tablets	3 tablets	3 tablets	3 tablets
35+	10 + years	4 tablets	4 tablets	4 tablets	4 tablets	4 tablets	4 tablets

Scenario 2

If the RDT indicates mixed infection of *P. falciparum* and *P. vivax*, then treat the patient with appropriate doses of Coartem, as in Table 8.1.

Scenario 3

If the RDT reveals *P. vivax* only, then treat the patient with Chloroquine (see the treatment doses in Table 8.2). Chloroquine is prepared in tablet or in syrup form. Chloroquine dose is 10 mg/kg of the patient's body weight, taken orally immediately (day 1), followed by 10 mg/kg at 24 hours (day 2), and 5mg/kg at 48 hours (day 3).

Chloroquine tablets are 150 mg base, and the syrup is 50 mg base per 5 ml dose.

- How many tablets of Chloroquine to take home do you give to a woman aged 36 years who is diagnosed with *P.vivax* malaria? *Note that you give her the first dose, i.e. 4 tablets, while she is in front of you.*
- You give her the remaining 6 tablets to take home. She will swallow 4 tablets on the second day and 2 tablets on the third day.

Table 8.2 Chloroquine treatment doses (tablets or syrup) and schedules by body weight and age.

Weight (kg)	Age	Day 1	Day 2	Day 3
5–6	less than 4 months	½ tablet *OR* 5 ml syrup	¼ tablet *OR* 5 ml syrup	¼ tablet *OR* 2.5 ml syrup
7–10	4–11 months	½ tablet *OR* 7.5 ml syrup	½ tablet *OR* 7.5 ml syrup	½ tablet *OR* 5 ml syrup
11–14	1–2 years	1 tablet *OR* 12.5 ml syrup	1 tablet *OR* 12.5 ml syrup	½ tablet *OR* 7.5 ml syrup
15–18	3–4 years	1 tablet *OR* 15 ml syrup	1 tablet *OR* 15 ml syrup	1 tablet *OR* 15 ml syrup
19–24	5–7 years	1½ tablets *OR* 20 ml syrup	1½ tablets *OR* 20 ml syrup	1 tablet *OR* 15 ml syrup
25–35	8–11 years	2 tablets	2 tablets	1 tablet
36–50	12–14 years	3 tablets	3 tablets	2 tablets
51+	15 + years	4 tablets	4 tablets	2 tablets

Scenario 4

If the RDT is positive for *P. falciparum* in:

- women who are less than 3 months pregnant,
- children whose weight is less than 5 kg or whose age is less than 4 months,

give quinine oral treatment. (See the treatment doses of quinine tablets in Table 8.3 below).

Quinine tablets may contain 200 mg or 300 mg. Check carefully when you calculate the dose.

Table 8.3 Quinine treatment doses by body weight and age.

Weight (kg)	Age	Dosage to be given daily	
		200 mg tablets	300 mg tablets
4–6	2–4 months	¼	-
6–10	4–12 months	⅓	¼
10–12	1–2 years	½	⅓
12–14	2–3 years	¾	½
14–19	3–5 years	¾	½
20–24	5–7 years	1	¾
25–35	8–10 years	1½	1
36–50	11–13 years	2	1½
50+	14 years and above	3	2

For all of Scenarios 1 to 4, if the patient vomits within 30 minutes after swallowing the drug, the medicine will not work. So give the patient the same dose again from your own stock (not from the tablets you give to the patient or the mother/caregiver to take home) and let the patient swallow it.

If a child vomits within 30 minutes of taking drugs at home, advise the patient/caregiver to take another dose, and to come back to the Health Post to collect another replacement dose from you so that the patient still takes the complete course of treatment.

To ensure appropriate intake of prescribed drugs, patients/ caregivers should be well informed on the treatment schedule to ensure intake of the complete dose.

Advise the patient/caregiver to come back if the patient does not show any improvement after three days of treatment with anti-malaria drugs, or if the signs and symptoms get worse at any time.

Whenever you encounter a suspected malaria case, use Figure 8.1 to guide you on the details of the procedures and steps that you need to follow to identify uncomplicated and severe malaria cases using RDTs, and manage them appropriately.

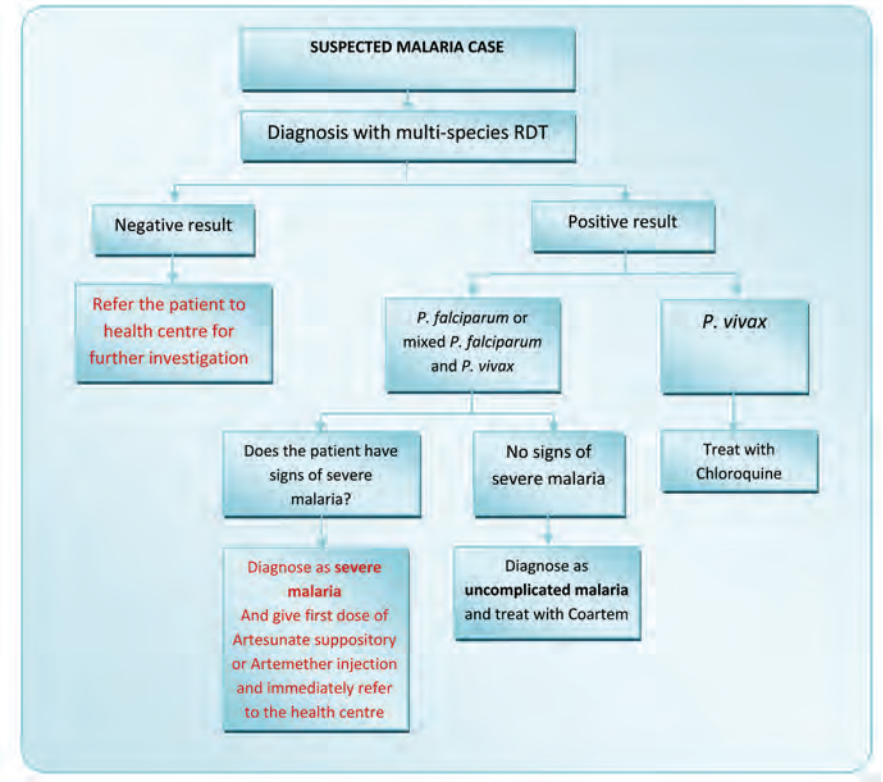


Figure 8.1 Flow chart for RDT diagnosis and treatment of malaria at Health Post level. (Adapted from Ethiopian Federal Ministry of Health, *Malaria Diagnosis and Treatment Guideline for Health Workers in Ethiopia*, 3rd edition, 2010).

- If the RDT result of Bekele, who is a 7-year-old child, shows *P. falciparum* infection, what anti-malaria drug would you give him? How many tablets will be a complete course of treatment? If Bekele vomited 25 minutes after swallowing the first dose you gave him, what should you do next?

- The appropriate anti-malaria drug to give Bekele is Coartem.

  The total number of tablets you give a 7-year-old child is 12 (go back to see the doses in Table 8.1 above). The Coartem strip that contains 12 tablets is shown in Figure 8.2. Bekele should be given 2 tablets in the morning and 2 tablets in the evening for 3 days.

  To replace the vomited dose, which is 2 tablets, give the child another 2 tablets to swallow again from your own stock — not from the tablets you gave to the mother/caregiver. The mother/caregiver must have 10 tablets to take home to continue the treatment.

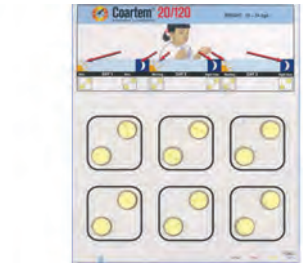


Figure 8.2 Coartem strip for patients who are 3 to 7 years old, or body weight of 15 to 24 kg.

Note that if the strip in Figure 8.2 (which is appropriate for Bekele) is not available, you can still cut out 12 tablets from the strip of adult doses as shown in Figure 8.3. While cutting the strips be careful not to cut the plastic or the blisters that contain individual tablets.

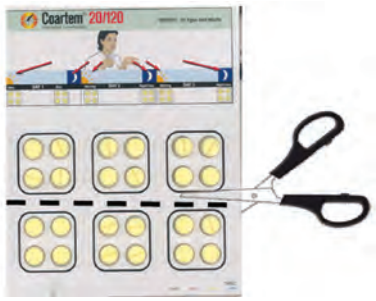


Figure 8.3 Cutting an adult Coartem strip with scissors into two to give to children.

Coartem shelf life and contraindications

Coartem has a short shelf life of two years only. So use those packages which are closer to the expiry date first. Do not expose Coartem to moisture and high temperature. Store it at temperatures of below 30°C in dry and cool places.

Coartem absorbs moisture from the surrounding environment very fast. To protect the drug from absorbing the moisture it is covered by plastic blisters. Therefore, do not remove the tablet from the blister if it is not going to be used immediately.

Coartem is **contraindicated** (not given) for some people. Box 8.2 gives you specific warnings on the groups who should not get Coartem.

Box 8.2 Contraindications of Coartem

Do not give Coartem for the following groups of people:

- For use as **prophylaxis**, that is for a healthy person who wants to swallow the drug in order to protect himself or herself from getting malaria
- Pregnant women in the first trimester (three months of pregnancy) and infants less than 5 kg or less than 4 months old
- Persons with a previous history of reaction after using the drug.

Previously, Coartem was contraindicated for breastfeeding mothers of infants less than 5 kg or under 4 months old. *WHO Malaria Treatment Guidelines*, 2010, now state that Coartem should be given to these patients.

8.1.2 Treatment of uncomplicated malaria based on clinical diagnosis

If you do not have the RDT in your Health Post, then use clinical methods (as described in Study Session 7) to diagnose suspected malaria in people seeking your help. If the diagnosis is clinical rather than parasite-based, treat uncomplicated malaria cases as follows:

- If the person does not have signs of severe malaria, then treat the patient with Coartem. After three days, check the patient again. If fever is still present refer the patient to the health centre.
- If the person has signs of *severe* malaria (as described in Section 8.2) then diagnose him/her as having severe malaria. Give first dose of Artesunate suppository or Artemether injection and immediately refer the patient to the nearest health centre.
- Advise the patient/caregiver to come back if the patient does not show any improvement after three days of treatment with anti-malaria drugs, or if the signs and symptoms get worse at any time.

Whenever you encounter a suspected malaria case and you do not have RDTs, Figure 8.4 will guide you in the details of the procedures and steps that you need to follow for the treatment and referral of patients diagnosed clinically.

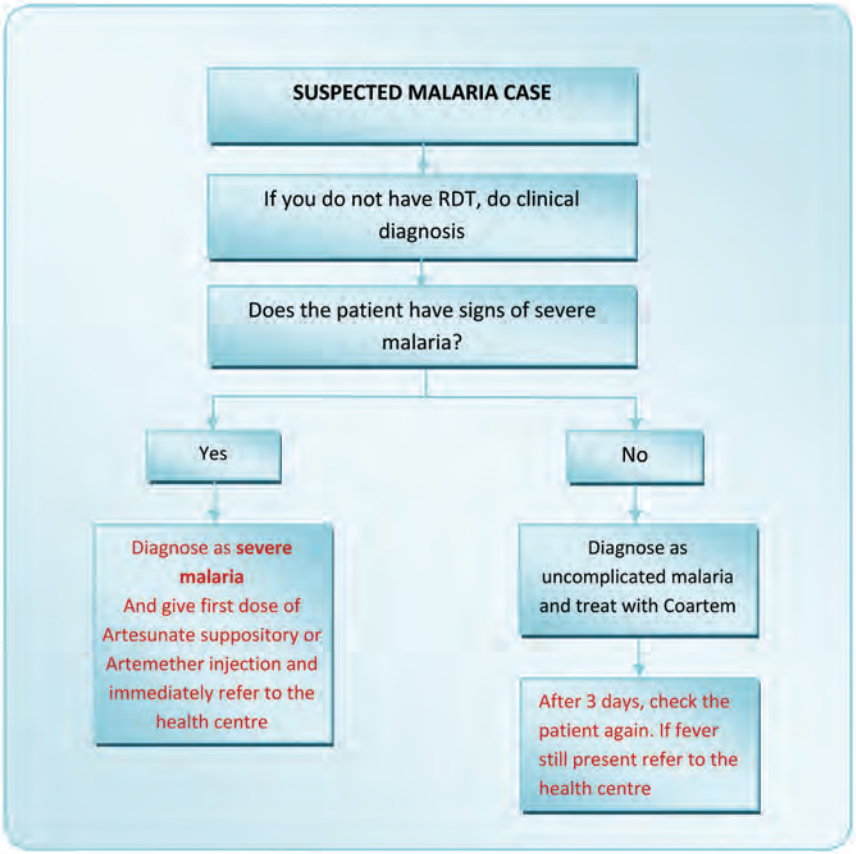


Figure 8.4 Flow chart for clinical diagnosis and treatment of malaria at Health Post level. (Adapted from Ethiopian Federal Ministry of Health, *Malaria Diagnosis and Treatment Guidelines for Health Workers in Ethiopia*, 3rd edition, 2010).

8.1.3 Supportive treatment of uncomplicated malaria cases

Many malaria patients have other clinical problems associated with malaria infection. While most of these problems get resolved when the patients are treated for malaria, some conditions need treatment at the same time as the malaria, that is, **supportive treatment**. Some of the supportive treatments that you should give the patient are as follows:

- If high fever is present, give the patient paracetamol tablets. Also advise the patient or caregivers to cool the fever by wetting the body of the patient with clean pieces of cloth dipped in slightly warm water, or by fanning.
- For patients with moderate dehydration, give oral rehydration salts (ORS) and advise them to drink more clean water or other fluids. In the case of breastfed infants, encourage mothers to provide extra breastfeeding.
- If you suspect mild or moderate anaemia is present, give ferrous sulphate (iron tablets), 200 mg once daily for two months, and advise the patient to return for a recheck in two months.

In addition to the diagnosis and treatment services you give to the patient with uncomplicated malaria, advise or educate the patient or the caregiver on the following issues and tell him or her that:

- He or she has a malaria infection.
- Early treatment within 24 hours of fever onset is important to prevent severe illness and death.

Figure 8.5 Give food and fluids prior to malaria treatment.

- To take/give the patient enough food, if possible a fatty meal, prior to taking the drug (Figure 8.5).
- To complete the full dose of treatment of the drug given, for example six doses of treatment for three days for Coartem.
- To return to the Health Post if the fever does not stop or if the patient does not get well after three days. The patient should also return to the Health Post if at any time before three days the condition gets worse — for example if the patient is unable to avoid vomiting up the drug, or there is persistent vomiting, dehydration, confusion, or excessive sleepiness.

8.2 Pre-referral treatment of severe malaria at the Health Post level

It is important that all patients are assessed for the danger signs of severe malaria that you learned about in Study Session 7 (Section 7.2.2). If a patient comes to the Health Post with danger signs, or is found to have any of them, he or she will require urgent medical attention and should be referred to a health centre as soon as possible.

Always remember that a delay in referral could cause death of the patient. The risk of death for severe malaria is greatest in the first 24 hours.

Before referring the patient, give pre-referral treatment for all patients presenting with any of the danger signs of severe malaria, regardless of whether the RDT result is negative or positive. The pre-referral treatments that you should give the patient include:

- The first dose of rectal Artesunate (see Table 8.4 below for the dosages), or if available, an intramuscular injection of Artemether in a dose of 3.2 mg/kg body weight.
- If an Artesunate suppository is expelled from the rectum within 30 minutes of insertion, insert a second suppository.
- In young children, hold the buttocks together for 10 minutes to ensure retention of the rectal dose of Artesunate.

Table 8.4 Rectal Artesunate dosage for pre-referral treatment by body weight and age.

Weight (kg)	Age	Artesunate dose (mg)	Formulation of the regimen (given all at the same time)
5–8.9	0–12 months	50	One 50 mg suppository
9–19	13–42 months	100	One 100 mg suppository
20–29	42–60 months	200	Two 100 mg suppositories
30–39	6–13 years	300	Three 100 mg suppositories
40–59	>13 years	400	One 400 mg suppository
60–80	Adults	800	Two 400 mg suppositories
80+	Adults	1,200	Three 400 mg suppositories

- Remember to give supportive treatment as indicated in Section 8.1.3 of this session if the patient has high fever, or dehydration, and in case of breastfed infants, encourage mothers to provide extra breastfeeding.
- If the patient is unconscious, in addition to the above mentioned pre-referral treatments, perform the activities indicated in Box 8.3.

Box 8.3 Steps in managing an unconscious patient

Ensure ABC of life support, as follows:

- *A = Airway:* in the unconscious or convulsing patient it is imperative that the airway is free of obstructions. In the convulsing child you may thrust the jaw forward to ensure a clear airway. Show family members how to position the patient (on his or her side) to ensure a clear airway is maintained.
- *B = Breathing:* check that the patient is breathing by looking for chest movements and listening for breath sounds.
- *C = Circulation:* feel or observe that hands and fingers are not cold, and colour is normal. Also check that the capillaries are refilling with blood by applying pressure for few seconds to a fingernail bed, then release the pressure to see if the blood returns fast, which is normal. Monitor and record vital signs (blood pressure, pulse, respiration rate).

For all the patients you are referring, ensure that the referral form is completed with detailed information, including:

- Clinical presentation/patient's medical history.
- Suspected diagnosis.
- RDT tests performed and results.
- List of all drugs/medication given, route, dose and time of administration.
- Reason for transfer to health centre.

8.3 Management of malaria in special groups

Special population groups such as infants below the age of four months or below 5 kg weight, and pregnant mothers in the first trimester, need different treatment and special attention.

■ What is the drug you give to treat malaria for an infant less than 5 kg body weight?

□ You give quinine oral tablets three times a day for 7 days, with the dose as indicated in Table 8.3 earlier in this study session.

Pregnant women

Now we will tell you about pregnant women. Pregnant women are at high risk of developing severe malaria. In addition, malaria during pregnancy can cause premature labour, stillbirth or abortion, as well as severe anaemia in the mother. The baby that is born may have low birth weight.

Therefore, you must give effective anti-malaria treatment to pregnant women with malaria immediately.

Pregnant women in the first trimester (the first three months) of pregnancy should NOT take Coartem. During the first trimester give oral quinine three times a day for 7 days (for dosage see Table 8.3 above). However, you can give Coartem if there is no quinine, or if you strongly believe that the mother

may not comply with the seven days of quinine treatment. The first dose should be given under your direct supervision.

If vomiting occurs within 30 minutes after swallowing the drug, the dose should be repeated with a replacement dose to ensure completion of treatment.

Advise the patient to take food while taking the drug, as quinine might cause low blood sugar (hypoglycaemia). Also assure her that symptoms like dizziness, ringing in the ears, blurred vision and tremors might occur, but these are not severe enough to stop treatment, and they will end when the drug treatment is finished. Explain to her the importance of completing her malaria treatment for the health of her unborn baby.

8.4 Adherence to malaria treatment

Adherence to malaria treatment, that is taking all the doses that are given, is very important for successful malaria treatment outcome. If patients do not adhere to the treatment they will not get cured completely and the disease will come back. Not adhering to the treatment can also lead to the parasites becoming *resistant* to the drug, so in future the drug will be less effective against the parasites.

Critical to patients' adherence is good communication between you and your patients. Adherence to malarial medication in patients has been linked to knowledge of malaria, access to information on medication for malaria, perceived benefit from the medication, and perceived barriers to treatment.

To ensure adherence, identify *high risk patients* that might not adhere to the treatment that is given to them. Do this identification during history-taking and clinical assessment. If the patient has one of the risk factors in Box 8.4, then he or she may not adhere to the full course of the drug treatment they received.

Box 8.4 Patients at high risk of low adherence to treatment

- Patients with chronic medical illness.
- Lack of transportation to come back or to send a sick family member.
- History of psychiatric conditions.
- Lack of economic support.
- Pregnant mothers.
- History of poor drug adherence for anti-malaria treatment.

Therefore, arrange a follow-up visit or link the patient to volunteer community health promoters or family members, if he or she is at risk of non-adherence.

During the first contact, if the patient is identified as a malaria case and has the high-risk features shown in Box 8.4, the following are the actions and key messages that you should tell to the patient:

- Ensure the first dose of the malaria treatment is taken under your observation and is well tolerated and not immediately vomited.
- Advise the patient to complete the treatment and educate him or her on the risk of not completing. If the full course is not taken the malaria will occur again.

- Advise patients not to share the drug with other sick members of the family. Advise them to send the sick ones to the Health Post.
- Visit the patient on the second day of the treatment and ensure that he or she takes the drugs properly (this can be aligned with your routine home visit).
- Link the patient to volunteer community health promoters or family members, who will ensure the patient takes the drugs properly.

8.5 The role of the Health Extension Practitioner in malaria treatment

Malaria is a curable and preventable disease, but it still kills many people. The main reasons for this unsatisfactory situation are:

- Some people do not come for treatment until they are very ill because:
  - They do not realise they might have malaria (people often think they have a common cold or other simple common infection).
  - They do not realise that malaria is a very dangerous disease.
- Many people do not know what causes malaria or how it is spread, so they are not able to protect themselves from the disease. (Prevention is covered in Study Sessions 9, 10 and 11.)

As a Health Extension Practitioner you can improve the situation by:

- Educating people to seek treatment immediately if they have a fever. This is especially important in young children and pregnant women, who should receive treatment against malaria within 24 hours of becoming ill.
- Recognising and treating malaria to prevent severe illness and death.
- Explaining how to take the treatment correctly, so that people can avoid repeated attacks of malaria.
- Advising patients who do not improve within 48 hours after starting treatment, or whose condition is serious, to go immediately to the nearest health centre that is capable of managing severe malarial disease.

8.5.1 Key messages and instructions

The problem of poor adherence may be overcome with simple health messages even when the majority of individuals are illiterate and lack formal education. Explain to people in your community that:

- Malaria is a killer disease if the treatment is not taken properly.
- Make sure that the patient has clearly understood drug labels and instructions.
- Clearly explain how to complete the treatment for malaria.
- Tell them not to interrupt taking medication. To take all (full course) of the anti-malaria drugs, prescribed to them.
- Do not share anti-malaria drugs with others.
- Whenever a family member has a fever, take them to the Health Post immediately.

Summary of Study Session 8

In Study Session 8, you have learned that:

1 Treatment of uncomplicated malaria should be based on diagnosis of malaria parasites using RDTs, but in the absence of RDTs, treatment can be given based on clinical diagnosis of malaria.

2 Different anti-malarial drugs that are used to treat malaria are based on the type of the malaria parasite species. All uncomplicated *falciparum* malaria patients and patients with mixed infections, *except* pregnant mothers in the first trimester, and infants less than four months old, are treated with Coartem. *Plasmodium vivax* cases are treated with Chloroquine.

3 It is equally important to treat other symptoms like high fever, dehydration and anaemia in uncomplicated malaria cases with the appropriate supportive treatment methods.

4 Severe malaria should be referred to the nearest health centre very fast. Before referring the patient it is important to give pre-referral treatment; this will help to prevent the patient's condition from getting worse.

5 The key messages you have to give to your community should focus on seeking early treatment and adherence to treatment.

Self-Assessment Questions (SAQs) for Study Session 8

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 8.1 (tests Learning Outcomes 8.1 and 8.3)

Which of the following statements about supportive treatment is *false*? In each case, state why it is incorrect.

A Supportive treatment is given to kill the malaria parasites in the blood circulation of the patient.

B Malaria patients with high grade fever should be given supportive treatment.

C Patients with moderate dehydration have to be immediately referred to a health centre without giving any supportive treatment.

D No supportive treatment is required for women with malaria, with normal temperature, who can breastfeed very well and with no anaemia.

E If the malaria patient has moderate anaemia, then treat with ferrous sulphate (iron tablets).

SAQ 8.2 (tests Learning Outcomes 8.2 and 8.3)

What anti-malaria drug would you give a patient with a clinical diagnosis of uncomplicated malaria, if you cannot do an RDT? How many times a day does the patient take this drug?

SAQ 8.3 (tests Learning Outcome 8.4)

Molamo is a 15 year-old boy who came to your Health Post. You diagnosed him with malaria and gave him Coartem. He took the medicine correctly as you ordered. Three days after his first visit he came back to your Health Post with no improvement of the fever. Describe the actions that you have to take.

SAQ 8.4 (tests Learning Outcomes 8.2 and 8.4)

Describe what you would do if you found that a patient who came to your Health Post is a suspected severe malaria case?

SAQ 8.5 (tests Learning Outcome 8.5)

What could happen if a malaria patient does not take the full course of treatment or does not adhere to the treatment?

SAQ 8.6 (tests Learning Outcomes 8.2, 8.3, 8.4 and 8.5)

Read Case Study 8.1 about Beka and answer the questions that follow it.

Case Study 8.1 Is Beka sick with malaria?

Beka is a five-year-old boy. His mother brought him to you to seek treatment. Beka and his family are living in your catchment area, which is malarious. The mother says he was well until this morning when he woke up and said he was feeling tired and refused his breakfast. When the mother touched him, he felt hot and she gave him ½ a tablet of paracetamol.

When you examined Beka, you found a well-nourished 15-kg child, not pale, alert and with temperature of 38.5°C measured with the thermometer under his armpit. You could not do a RDT because you used the last kit two days ago. In the rest of the examination, Beka is normal.

(a) What is your diagnosis?
(b) What treatment will you give Beka? And what dose?
(c) What will you tell his mother?

Study Session 9 Malaria Prevention: Environmental Management and Larviciding for Vector Control

Introduction

In this study session you are going to learn how you can make the environment unfavourable for mosquito breeding and how to kill the mosquito larvae in water collections. Using your knowledge from Study Session 5 about the distinguishing characteristics of anopheline larvae, we will teach you how to identify areas that are vector breeding habitats in the community, and how to organise and coordinate community participation in larval control measures. By cleaning and modifying the environment you can make it hard for the mosquitoes to complete their life cycle and be able to transmit malaria.

Larval control is one of the most important malaria prevention measures that can be planned and implemented at the community level. Larval control is any method that helps prevent vector breeding or kills the mosquito at its larval stage. There are other malaria prevention or vector control measures that are also very important and you will learn about them in Study Sessions 10 and 11.

Learning Outcomes for Study Session 9

When you have studied this session, you should be able to:

9.1 Define and use correctly all of the key words printed in **bold**. (SAQs 9.1, 9.4 and 9.5)

9.2 Describe how you would identify mosquito breeding habitats. (SAQs 9.2 and 9.3)

9.3 Describe environmental manipulation techniques for mosquito control. (SAQ 9.4)

9.4 Explain environmental modification measures that are useful for vector control. (SAQ 9.5)

9.5 Describe the principles of larviciding for malaria control. (SAQs 9.1 and 9.6)

9.6 Explain how the community can be mobilised to participate in larval control measures. (SAQ 9.7)

9.1 Why are mosquito larval control strategies so important?

Remember the following key points about malaria transmission from previous study sessions:

- Malaria is transmitted by a mosquito vector.
- Not all mosquito types transmit malaria.
- The mosquito lays its eggs in water collections and the life cycle in water takes about 10 days to complete.

The implications of these facts are that:

- No mosquitoes means no malaria transmission.
- Making water collections unfavourable for mosquito breeding means few or no mosquitoes in the community.
- Killing the mosquito larvae in the water collections before they become adults and fly away, means fewer or no mosquitoes in the community.
- Achieving the above goals means very small or no malaria transmission.

Measures that rely on using insect-killing **insecticides** against the adult (flying) mosquitoes inside houses (spraying and using insecticide-treated bed nets (ITNs), as described in Study Sessions 10 and 11), mean that the mosquitoes must be susceptible to the chemicals if the controls are to be successful. Moreover, they kill only the mosquitoes that enter houses to bite people. However, you learned in Study Session 5 that some mosquitoes can bite people outside houses and transmit malaria. So we are starting the three sessions on malaria prevention with larval control for the following reasons:

1 Larval control is the first line of defense in malaria prevention and presents your first chance of breaking the malaria transmission cycle.

2 The mosquito larvae are not flying insects; it is easy to find the water collections where they are developing to become the adult mosquitoes that will start biting people and transmitting malaria.

3 If people in your village get sick and die of malaria, you have to implement more expensive and complicated mosquito prevention and curative measures to protect the community.

4 Many of the larval control measures are inexpensive; they can be implemented by educating, mobilising and coordinating community members to clean their environment.

5 Compared to other measures, the chemical methods of larval control are also not very expensive and are simple enough to be applied by you or volunteer community health workers.

9.2 Larval control for malaria prevention

Mosquito species differ in their preferences for **breeding habitats**. The species that mainly transmit malaria in Ethiopia (*Anopheles arabiensis*) breed in clean and muddy water collections that are either man-made or naturally-occurring near houses; they do not breed in polluted water like in sanitation systems. Once the breeding sites are known, appropriate control measures may be simple and inexpensive. Most breeding sites in and near houses are easy to identify and simple methods are available to eliminate them. Community members can and should take action against any breeding by mosquitoes observed on or near their premises.

Larval control may be the only effective approach when mosquitoes bite outdoors and do not enter houses to feed or rest, or when the mosquitoes are not susceptible to the available insecticides. Insecticide resistance of malaria vectors is particularly important in the Ethiopian situation. An important additional advantage of larval control is that some of the measures provide long-lasting protection.

9.2.1 Environmental management for vector control

Environmental management for vector control refers to the planning, organisation, carrying out and monitoring of activities for the modification and/or manipulation of environmental factors, with the aim of preventing or minimising vector breeding and reducing human-vector-parasite contacts. If such measures result in long-lasting or permanent changes in land, water or vegetation, they are often referred to as **environmental modification**. When such measures have a temporary effect and need to be repeated, they are known as **environmental manipulation**.

In this study session, we will focus mainly on simple and effective environmental *manipulation* tools, which can be planned and implemented at the village level by mobilising the community and under your direct supervision. Some environmental *modification* methods could involve very complicated engineering designs of natural and man-made water systems to make them unfavourable for vector breeding, but these ambitious activities are beyond the objectives of the Health Extension Service.

The first step in planning environmental management activities is to identify the water collections where the potential vectors of malaria are breeding. You might plan to remove or destroy all potential breeding sites, whether they are sheltering mosquito larvae or not. However, this could be unrealistic if there are too many sites and your human and material resources are limited. Then you have to be selective and prioritise water collections according to the following criteria:

- First, water collections with anopheline mosquitoes only, and/or anopheline and other mosquito larvae should be removed.
- Second, all temporary rain water collections should be destroyed.
- Third, all water collections with other mosquito larvae have to be addressed.
- Fourth, any standing water that is not used by people or their animals should be removed.

■ Why give priority to elimination of anopheline breeding sites?

□ Because anophelines are vectors of malaria; other types of mosquitoes are not.

9.2.2 Environmental modification

Environmental modification includes drainage, filling, land levelling and transformation of impoundment margins (e.g. ditches to restrain livestock). Although these modification works are usually of a permanent nature, proper operation and adequate maintenance are essential for their effective functioning. The following are some of the environmental modification activities useful for mosquito control:

Removal or destruction of breeding sites

Mosquitoes do not need big swamps, ponds and big water bodies to lay their eggs and complete their life cycle. Very small water collections such as in hoof-prints, abandoned cans, jars and tyres can serve as mosquito breeding grounds. Therefore, small containers serving as breeding sites can be removed, destroyed or covered to deny access to mosquitoes.

Filling breeding sites

Filling of mosquito breeding sites with soil, stones, rubble, ash or rubbish is the most permanent control measure available. It is most suitable for reducing breeding sites that do not require much filling material, such as small depressions, water holes, **borrow-pits** (a hole that has been excavated by people as a source of soil, stones or dirt), and abandoned ditches or pools. On a small scale, no special expertise is needed and communities can carry out the work with shovels, picks, carts and other simple equipment. The filling material should be obtained without creating new breeding sites. Waste materials can be used for most of the filling. If refuse is used, it should be compacted (pressed down hard) and covered with earth to prevent breeding by flies. Very large areas can sometimes be filled at little cost by making use of waste soil and stones left over from a construction project.

Drainage

Proper drainage reduces mosquito breeding. The drainage of water can be accomplished by constructing open waterways and dykes with tidal gates, subsoil drainage and pumping. Leakages, obstructions and small pools or puddles of residual water in drainage ditches often afford suitable breeding sites for mosquitoes. The planning and construction of some drainage systems are complicated and require the expertise of engineers. However, some small-scale drainage works intended to control mosquitoes can be carried out by community members using simple equipment (Figure 9.1).

Figure 9.1 Community members digging a ditch to drain mosquito breeding pools. (Photo: Dr Daddi Jima)

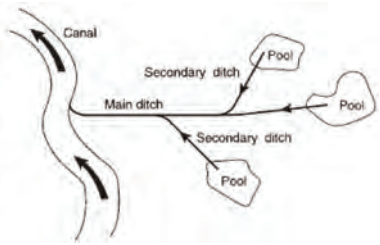


Figure 9.2 Open earth drains for larval control. (Source: WHO, 1997, *Vector Control Methods for Use by Individuals and Communities*)

Open ditches

Open earth drainage ditches like those in Figure 9.2 are the simplest to construct. They are used to prevent the accumulation of excess rainwater in depressions in the ground and to dry out marshy areas, borrow-pits, ground pools and other accumulations of surface water. The ditches carry the water away to an appropriate, lower-lying outlet, such as a river, stream, pond, soak away pit or main drainage ditch. They should follow the natural flow of water along the surface.

As shown in Figure 9.2, a main ditch may have several lateral or secondary ditches to collect water that does not readily drain into the main ditch.

Planting eucalyptus trees

As shown in Figure 9.3, eucalyptus trees can be used for drying marshy areas and other plots of land with a high water table. Species that grow rapidly and use a lot of water are particularly suitable. The trees dry the land by allowing water to evaporate through their leaves. For optimum evaporation they should be planted with adequate spaces between them. An additional advantage of the trees is their commercial value.

Figure 9.3 Planting eucalyptus trees helps to drain marshy land where mosquitoes could breed. (Photo: Dr Yemane Ye-ebiyo Yihdego)

9.2.3 Environmental manipulation

Increasing the flow of streams, regulation of the water level in reservoirs, vegetation removal and shading are examples of **environmental manipulation** activities. The following are some of the environmental manipulation activities which are useful for mosquito control:

Closing, screening or covering breeding sites

Potential breeding sites in relatively small enclosed habitats, such as drinking water storage containers, tyres and wells, should be made inaccessible to adult mosquitoes by covering them (e.g. as in Figure 9.4). Removable covers, such as mosquito-proof lids or wire mesh screening, can be fitted in some cases. Wells can be made mosquito-proof by closing them with slabs, an iron sheet or grass, and installing hand pumps.

Figure 9.4 Potential mosquito breeding sites in small containers can be covered. (Source: WHO, 1997: as in Figure 9.2)

Flushing

Flushing (increasing water flow in streams) is employed in small streams where there is a continuous and abundant supply of water flowing slowly enough to permit mosquitoes to breed in quiet places along the margins. A periodic discharge of a large volume of water washes away the eggs, larvae and pupae from the edges, or strands them on the banks.

In order to collect the water needed for flushing, a small dam is constructed upstream of the area where breeding occurs. The dam site should be at a point where the stream or channel is narrow and the banks are high. The dam could have a hand-operated gate, to release the water at least once a week. The method requires some initial investment, but is long-lasting and requires little maintenance. Health Extension Practitioners can mobilise the community to construct a small dam and water release system wherever such a measure is feasible to control mosquito breeding in the village.

Shading of ponds and stream banks

Where mosquitoes prefer breeding sites that are partly or fully exposed to sunlight, they can be controlled by planting shrubs and trees along the banks of streams and covering ponds with iron sheets or local materials (Figure 9.5). The main vector of malaria in Ethiopia, *An. arabiensis*, prefers to breed in sunlit water, so this intervention could be helpful.

Figure 9.5 Shading a pond with local materials. (Photo: Dr Yemane Ye-ebiyo Yihdego)

Removal of water plants

Figure 9.6 Removing water plants. (Source: WHO, 1997: as in Figure 9.2)

Mosquitoes can be controlled by removing vegetation from water collections. The plants provide the developing larvae with a safe hiding place from predators (e.g. fish), as well as protection from wave movement and currents. In small breeding sites, such as borrow-pits and ponds, the vegetation can be removed manually, for example by the members of communities, using rakes and other simple equipment (Figure 9.6). This method may also be effective in removing resting places for adult mosquitoes. In addition, it promotes evaporation and the drying up of small accumulations of water and makes breeding sites more visible for control purposes.

Straightening and steepening shorelines

Shorelines of streams, ditches and ponds can be made steeper to reduce the availability of shallow places suitable for breeding of mosquitoes, and to increase the speed of the flowing water.

9.2.4 Common vector breeding grounds in Ethiopia

In this section, we summarise the environmental control measures that will be most useful and appropriate in dealing with common mosquito breeding sites in Ethiopia.

Accumulations of water near roads

The construction of roads often leads to the creation of water collections that serve as vector breeding grounds. It often prevents natural drainage of the land and may result in the formation of large ponds alongside the roads.

Control measures include:

- Construction of underground channels allowing streams to continue on their natural courses.
- Use of larvicides (see Section 9.3).

Borrow-pits

Borrow-pits used to extract soil and stones for construction are very common in rural Ethiopia inside and outside villages. Older pits containing vegetation and freshly dug pits collecting rain water (Figure 9.7) can serve as very important vector breeding sites.

Figure 9.7 Ideal breeding ground for the mosquito vectors of malaria. (Photo: Dr Yemane Ye-ebiyo Yihdego)

Control measures include:

- Filling with mud and stones, or the disposal of household rubbish or waste. Filling the pits with rubbish or waste would also pollute the water, making it unfavorable for breeding of the malaria vectors, which normally prefer clean water.
- The removal of water plants and other mosquito shelters can make ponds temporarily unsuitable for breeding by mosquitoes.

Micro-ponds

Micro-ponds are the most common man-made structures in Ethiopia, and are used to harvest rain water for horticulture and small scale irrigation. There are several types of micro-ponds in use. Some are lined with plastic sheet to prevent seepage and some are covered to avoid evaporation. The plastic lining prevents vegetation growth, making it unfavourable for mosquito breeding; covering the ponds denies access to egg-laying mosquitoes. However, many micro-ponds are neither lined nor roofed and serve as very important vector breeding grounds. Moreover, the location of these ponds very close to houses makes them extremely dangerous sites in terms of malaria transmission.

Control measures include:

- Removal of vegetation along margins and steepening shorelines (Figure 9.8) reduces the breeding of vector mosquito species temporarily by taking away protective cover and removing shallows.
- Apply chemical larvicides (see Section 9.3).

Figure 9.8 Steepening shorelines can help to prevent mosquitoes from breeding. (Photo: Dr Yemane Ye-ebiyo Yihdego)

Rivers and creeks

Mosquitoes breed in quiet places close to the banks of rivers and creeks where there is protection from currents by obstacles, protruding roots, plants and so on. Effective control of larvae is generally difficult because of the large areas to be covered. Careful study is required to find out the exact location of the breeding sites. During the dry season mosquitoes may breed in stagnant pools in river beds.

Control measures include:

- Breeding sites may be reduced in some cases by removing obstructions in streams, removing vegetation from river edges, and smoothing and increasing the steepness of the banks to increase the speed of the flowing water.
- In the dry season, pools may form in river beds. If breeding occurs in such pools, they can be drained into the main stream. Some smaller pools may be filled up.
- Pools in river beds may be treated with larvicides (see Section 9.3).

Irrigation

Many development-linked activities (e.g. irrigation) lead to environmental changes and often inadvertently increase the risk of malaria transmission. Appropriate safeguards and actions to reduce the risk are required in the planning, construction, and maintenance phases of development projects. Irrigation canals should be lined and the vegetation cleared to discourage breeding in the canal edges and allow free flow of water. The intervals between releasing a gush of water from an upstream dam can be adjusted to ensure adequate periodic flushing of larvae from pools in the canal beds.

9.3 Larviciding

Larviciding refers to the use of chemicals or biological agents or toxins to kill mosquito larvae. Water collections that cannot be managed by environmental control measures can be dealt with by larvicides. Like environmental control measures, the success of larvicides will depend on the identification of mosquito breeding sites and their distribution in the area, followed by sustained weekly spraying of chemicals (Figure 9.9). Larvicides should be applied in conjunction with other environmental control measures.

Figure 9.9 Applying larvicide into water collections that act as vector breeding sites. (Photo: Dr Yemane Ye-ebiyo Yihdego)

A chemical called Temephos (sold under the trade name Abate) has been the most widely used mosquito larvicide worldwide and in Ethiopia. Temephos is highly active against the nervous system of mosquito larvae and other aquatic insects, and a relatively low dosage can kill them before they reach the adult stage. Its toxicity (ability to poison) fish, birds, humans and other mammals is very low. Its low toxicity to non-target organisms and low effective dosage make Temephos the most appropriate larvicide in many situations. It is recommended for the control of mosquito larvae in drinking-water and in areas where fish, birds and mammals may come into contact with it.

According to the current Ethiopian national strategy for vector control, health posts will be supplied with spray pumps and Temephos, and you are expected to mobilise the community to undertake larviciding when necessary. Unlike indoor residual spraying (described in Study Session 10), larviciding requires little technical skill and therefore you can train community members to spray Temephos into breeding sites under your supervision and technical support. The instructions are given in Box 9.1.

Box 9.1 Preparations for spraying Temephos

1 Estimate (in square metres) the size of the breeding sites positive for *Anopheles* larvae, which cannot be dealt with by environmental management;

2 Use a disposable syringe to measure 8 ml of Temephos (Abate) and mix it into 8 litres (one spray pump) of water;

3 One spray pump should cover an area of water of 320 square metres;

4 Pump by hand 60 times to produce the necessary level of air pressure in the sprayer;

5 Use trained community volunteers to spray the chemical onto the water in the breeding site;

6 Keep good records of the accomplished activities.

9.4 Community participation and organisation of larval control measures

To ensure the prevention and control of malaria in your village, it is important that all temporary or permanent vector breeding sites are identified and dealt with through active participation of community members. This malaria control strategy becomes effective only when the mosquitoes are systematically interrupted from breeding and/or their population is substantially decreased.

In summary, methods to control larvae involve the following:

- Eliminating or changing the breeding place to make it unsuitable for development of larvae;
- Making the breeding place inaccessible to adult mosquitoes.
- Larval control is also possible without changing breeding sites by applying chemical larvicides.

The control of breeding places must be carried out around human settlements in an area with a radius greater than the flight range of the target mosquito species. For many species this is about 1.5–2 km. Control measures that are not permanently effective have to be maintained throughout the period of the mosquito breeding season. The effort and expense needed to obtain effective larval control may vary with the size of the settlement and the type and number of breeding sites.

In areas where malaria is a risk, you have to organise and educate the community to undertake environmental management activities such as draining, filling of communal mosquito breeding sites, irrigation canal water management, and chemical larviciding, etc. These activities have to be well planned (Box 9.2), performed under your supervision and assisted by volunteer community health workers. In addition to the efforts through the Health Extension Programme, community level social and traditional structures such as women's associations, youth associations, cooperatives, health committees, schools and religious and community leaders, will all play a major role in social mobilisation as well as empowerment of the community to implement community based activities.

Box 9.2 Priority actions that support implementation of environmental management for vector control

1 Identify the number and distribution of mosquito breeding sites;
2 Determine the number of people needed for action;
3 Identify working tools by type and number: spade, pick-axe, sickle, cutting knife, wheel-barrow, etc.
4 Estimate the time required to complete the implementation of the environmental vector control measures;
5 Identify the type of vector control activities: levelling and filling; drainage; cleaning and clearing ditches; clearing grass or weeds in irrigation ditches; steepening the sides of water collections, etc.
6 Coordinating and managing the environmental control programme on the scheduled day and place;
7 Keeping a record of the accomplished work.

Environmental management activities for vector control may require large numbers of human volunteers and their successful and sustained implementation can only be assured by active participation of the whole community. The vector control measures should be run at least once every week during the malaria transmission season. You have to educate and mobilise your community members to participate in the identification of the mosquito breeding sites and the environmental and other control measures to be undertaken. You will be responsible for coordinating the environmental management activities and leading the community on what to do, where to do it, when to do it and how to do it, in order to reduce the risk of malaria.

9.5 Other malaria prevention options

Malaria can also be prevented through protective measures in instances where conditions do not permit environmental control options, or the control measures are not enough to provide adequate protection. For example, use of mosquito repellents on the skin and clothes could have additional benefits and so could insecticide treated tents, blankets and fly-sheets. Selection of camping or residential sites could be important to avoid proximity to mosquito breeding grounds. Smoke from an open fire repels insects, especially in still air or poorly ventilated dwellings. The repellent effect of smoke may be increased by burning certain materials such as aromatic wood containing resins. Communities should be encouraged to use traditional and modern repellents for personal protection where it is applicable.

Similarly, due to the rapid expansion of commercial farming in the country and the location of these farms in high malaria risk areas, investors need to be advised on the importance of malaria prevention methods, including environmental management, site selection of residential areas/camps for their workers, mosquito repellents and other protection measures.

Summary of Study Session 9

In Study Session 9, you have learned that:

1 Malaria vectors breed in different types of water collections.

2 Environmental management and larval control refers to any action aimed at eliminating vectors and vector breeding sites.

3 You can modify the environment permanently in ways that are unfavourable for vector breeding.

4 The environment can also be manipulated to deter vector breeding temporarily.

5 Borrow-pits that collect rain water and are not used by humans or animals can be filled by soil, sand or stone to avoid vector breeding.

6 Micro-ponds used to harvest rainwater for irrigation and horticulture can be modified in design to deny access to egg-laying mosquitoes, or cleared of vegetation to make them unsuitable for sheltering larvae.

7 Community participation is key to mosquito larval control through environmental management interventions, such as digging drainage ditches, filling pools or covering small containers where rain water collects.

8 Temephos is the most important and widely used larvicide for larval control in Ethiopia; water collections are mainly treated using spray pumps.

Self-Assessment Questions (SAQs) for Study Session 9

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 9.1 (tests Learning Outcomes 9.1 and 9.5)

Which of the following statements about larviciding is *false*? In each case, explain what is incorrect.

A Larviciding means applying chemicals to kill adult vector mosquitoes.
B Temephos is a chemical used as a larvicide to kill larvae of vector mosquitoes.
C Temephos is sprayed onto water collections using spray pumps.
D Temephos can only be sprayed by trained experts/professionals.
E Larvicides are applied to all vector breeding sites, including those that can be removed by environmental management activities.

SAQ 9.2 (tests Learning Outcome 9.2)

You know that mosquitoes require water collections for breeding and different types of vector breeding grounds can serve as breeding habitats. From the list below, identify places that *cannot* be breeding grounds for the vectors that transmit malaria, and explain why.

- Borrow-pits
- Houses
- Micro-ponds
- Trees
- Stream beds
- Irrigation canals
- Foul smelling polluted water
- Swamps
- Road ditches.

SAQ 9.3 (tests Learning Outcome 9.2)

In most parts of Ethiopia, vector populations increase following the rainy season. What could be the reason for an increase in the vector population after the rains? What is the most important type of water collection that is very good for breeding and development of the main malaria vector in Ethiopia?

SAQ 9.4 (tests Learning Outcomes 9.1 and 9.3)

You have learned that environmental manipulation refers to making temporary changes to the environment to make it unfavourable for the vector to complete its life cycle in water. List three environmental manipulation techniques with this effect.

SAQ 9.5 (tests Learning Outcomes 9.1 and 9.4)

Environmental modification refers to making permanent changes to the environment to make it unfavourable for the vector to complete its life cycle in water. List two examples of environmental modification measures with this effect.

SAQ 9.6 (tests Learning Outcome 9.5)

Imagine that you have a vector breeding site in your community that cannot be eliminated through environmental management methods and you have to use larviciding to kill the larvae. The surface area of the water in the breeding site is 960 square metres (m^2). You have learned that 8 ml of the chemical Temephos mixed in 8 litres of water in one spray pump is enough to treat 320 m^2 surface area of water in the breeding site.

(a) How many spray pumps of Temephos chemical do you need to spray in order to treat the breeding site?

(b) What is the amount of Temephos (in ml) you need to treat the breeding site?

SAQ 9.7 (tests Learning Outcome 9.6)

You learned that most larval control activities are undertaken through community participation and you have to mobilise and convince the community to participate. What are the community organisations that can help you to mobilise local people to participate in larval control activities?

Study Session 10 Malaria Prevention: Indoor Residual Spraying of Houses

Introduction

In this study session, you will learn about one of the most important and widely used methods to control adult mosquitoes in Ethiopia: **indoor residual spraying (IRS)** of houses**.** IRS involves spraying the inside of houses with **insecticides** (chemicals that kill insects). The insecticides used in IRS are long-lasting and kill the vector when it enters houses to bite people.

Your role will be critical in the success of IRS in your community, so it is important for you to understand the objectives, techniques and challenges of undertaking IRS campaigns. We will explain how IRS helps to prevent malaria, and how to plan and carry it out. You will also learn about the safe handling of insecticides, the selection and training of spray operators, and the operation of spray pumps.

To undertake IRS effectively in your village, you will need training in several practical skills, such as spray techniques, training of spray operators, maintenance of spray pumps, etc. The additional practical training will be arranged by your Regional Health Bureau.

Learning Outcomes for Study Session 10

When you have studied this session, you should be able to:

10.1 Define and use correctly all of the key words printed in **bold**. (SAQ 10.1)

10.2 Explain how IRS works to kill malaria vectors and protect people from malaria. (SAQs 10.1 and 10.2)

10.3 Explain the logistic requirements to undertake IRS effectively, using standard IRS techniques. (SAQs 10.3, 10.4, 10.5 and 10.6)

10.4 Calculate the IRS coverage in a village. (SAQs 10.5 and 10.6)

10.5 Describe how to safely handle and dispose of insecticides. (SAQ 10.7)

10.1 Introduction to indoor residual spraying (IRS)

In Study Session 9 you learned that environmental management and other larva killing activities are important in malaria prevention. Larval control is the first line of defense in malaria prevention; its impact in reducing the burden of malaria can be significant in countries like Ethiopia, where vector breeding sites are relatively limited and generally clearly defined. However, it is impossible to identify all vector breeding sites and kill all larvae before they become flying adults. Once mosquitoes become flying adults, environmental management has little impact in controlling them, so measures to control adult mosquitoes are needed to protect people from malaria.

Indoor residual spraying (IRS) has been used in Ethiopia since the 1960s, and has three main aims:

1 To reduce the seasonal rise in malaria.

2 To prevent epidemics.

3 To control epidemics.

Until 2009, IRS was planned and implemented by specialised staff from district, zonal and regional health offices. Temporary spray operators were recruited from district towns and sent to villages to do the spraying.

However IRS will now be planned and implemented by Health Extension Workers and Health Extension Practitioners like yourself in your own village, with the co-operation of your local community. As part of this process, you will need to train **spray operators** (the people who do the spraying) selected from the community, supervise the spray operation, and carry out minor maintenance of the **spray pumps** (equipment used to spray insecticides).

10.2 How does IRS reduce the mosquito population?

In Study Session 5, you learned that mosquitoes enter houses to take blood from humans, mainly at night. Mosquitoes do not fly for long after feeding, as the blood meal they take is more than twice their unfed body weight and they need to spend some time resting. Following a blood meal, the female mosquitoes tend to rest in undisturbed sites for two to three days until their eggs develop and are ready for laying. (Remember that the males do not take blood meals and so are not vectors of malaria.) Understanding the **resting habits** (the preferred resting places and behaviour) of the malaria vectors is extremely important for IRS programmes.

In drier regions, rooms inside houses are important resting places for mosquitoes because they prefer humid environments and it is usually more humid indoors. In humid forested areas mosquitoes may also rest in vegetation outdoors. However, even species that normally rest outdoors enter houses to feed and will spend some time resting indoors after feeding.

If the inside of a house has been sprayed with insecticide, when mosquitoes rest in the house they come into contact with the **residual** (long-lasting) **insecticide** sprayed on walls and furniture, and they die within a few hours.

Parasite development inside a female mosquito takes about 10 days and mosquitoes feed and lay their eggs every two to three days. So they may have to bite people three to four times before the parasite develops fully and they are able to transmit the infection. Every time a mosquito visits a sprayed house to feed on people, it is at risk of coming into contact with the insecticide and dying.

Mosquitoes resting on sprayed walls come into contact with insecticide through their feet and are killed. Some insecticides also irritate mosquitoes and cause them to leave houses before biting. In dry or windy areas, this may also result in death due to lack of suitable outdoor resting places.

Wall-spraying may not prevent biting. Hungry mosquitoes entering a house often bite first and then rest on walls and furniture inside houses. As most anopheline vectors of malaria enter houses to bite and rest, malaria control programmes have focused primarily on the indoor application of residual insecticides to the walls and ceilings of houses.

Indoor residual spraying is one of the primary vector control interventions for reducing and interrupting malaria transmission and one of the most effective methods. The primary effects of IRS towards reducing malaria transmission are:

1 It reduces the life span of vector mosquitoes, so that they cannot live long enough to transmit malaria parasites from one person to another.

2 It reduces the density/number of the vector mosquitoes.

3 Some insecticides used in IRS also repel mosquitoes and by so doing reduce the number of mosquitoes entering the sprayed houses and thus reduce human-vector contact.

However, note that IRS may not provide individual protection – people sleeping in sprayed houses may still be bitten by mosquitoes. Unlike insecticide treated nets (ITNs are the subject of Study Session 11), which provide individual protection from mosquitoes, the aim of IRS is to provide *community* protection.

10.3 The IRS programme in Ethiopia

The insecticide called DDT has been used for IRS in Ethiopia since the mid-1960s. However, there is now widespread resistance of malaria vectors to DDT, so it will not be used in Ethiopia for IRS after 2010. Decisions about which insecticide to spray are made at the national level. When to spray is also often decided by malaria experts at the district or regional level, but you may also have a valuable input because you have better knowledge of the malaria transmission pattern in your village.

Areas less than 2,000 metres above sea level are generally considered malarious in Ethiopia, although there are marked variations between places and seasons. As a result, most of the areas below 2,000 metres are considered IRS targeted areas. The decision on whether your village will be sprayed or not is made at the district level. Depending on the local pattern of malaria cases, the availability of resources and the forecast of the risk of malaria, your village may be sprayed once a year, twice a year, during some years but not others, or not sprayed at all.

IRS has to be done during the rainy season and be completed just before the rain stops.

10.4 Spraying requirements

Before spraying is undertaken, detailed information has to be collected on the number of households in the village, the number of unit structures (houses/rooms) in each household, the average surface area of every house in the village, and the season of malaria transmission. Effective insecticide spraying also requires trained personnel. In your case, the spray operators will be community members selected and recruited by you in consultation with your supervisor at the health centre. The spray operators will carry out spraying duties seasonally. Spraying equipment needs maintenance, and spare parts must be available. Box 10.1 on the next page, lists the supplies and equipment used for IRS.

Box 10.1 Supplies and equipment used for IRS

- Spray pumps (Figure 10.1) of eight litre capacity
- Insecticides
- Spray pump spare kits
- Tool kits for pump maintenance
- Personal protective equipment (you will see a drawing of a spray operator wearing this equipment later, in Figure 10.6):
  - coverall,
  - waterproof hats or helmets,
  - face shields or goggles,
  - respiratory masks,
  - gloves,
  - rubber boots.

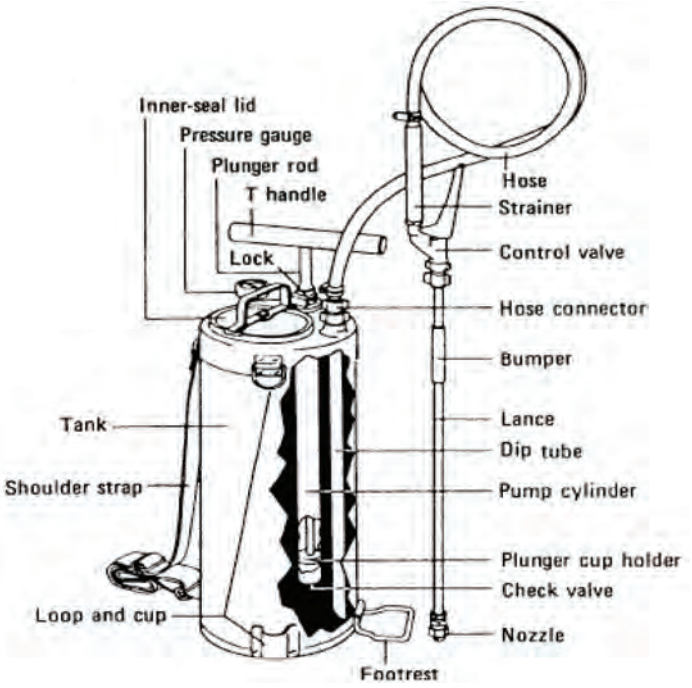


Figure 10.1 Parts of a spray pump for IRS. (WHO, 1997; source as in Figure 9.2)

All these supplies and equipment will be provided to your health post by the District Health Office. They will make sure that you have everything you need before starting to train spray operators and beginning the spraying programme.

10.5 Insecticides for IRS

10.5.1 Choice of insecticides

Insecticide(s) for IRS are selected based on evidence of effectiveness and should have the following properties. They must:

- Kill more than 90% of the mosquitoes that make contact. Note, however, that mosquitoes can develop *resistance* to the insecticide used in IRS. If people in your community experience a high number of mosquito bites even if their houses are sprayed, or there are many mosquitoes resting inside sprayed houses, these could be early signs of resistance and should be reported to your supervisor.
- Remain effective at killing mosquitoes for a long time – that is, they must be long-lasting.
- Be safe for humans and domestic animals.
- Be acceptable to the community.

10.5.2 Commonly used insecticides

Residual insecticides for IRS are generally in the form of powders or liquids. **Water-dispersible powder** consists of a powdered insecticide mixed with a substance that allows the insecticide to dissolve in water. For indoor spraying purposes, the water-dispersible powder is the most effective form. Any of the insecticides shown in Table 10.1 can be used for IRS in Ethiopia for the coming several years. Most insecticides come in pre-weighed sachets; one sachet is to be used per one spray pump of eight litre capacity.

Table 10.1 Insecticides used for IRS in Ethiopia.

Name of insecticide	Chemical type	**Dosage** (in grams per square metre)
Malathion	Organophosphorus	2 g/m^2
Fenitrothion	Organophosphorus	1 or 2 g/m^2
Propoxur	Carbamets	1 or 2 g/m^2
Bendiocarb	Carbamets	0.2–0.4 g/m^2
Deltamethrin	Synthetic pyrethroids	0.025–0.05 g/m^2
Permethrin	Synthetic pyrethroids	0.5 g/m^2
Lambdacyhalothrin	Synthetic pyrethroids	0.025–0.05 g/m^2
Cypermethrin	Synthetic pyrethroids	0.5 g/m^2

10.6 Determining insecticide requirements

The amount of insecticide required for your village depends on:

- The type of insecticide to be sprayed.
- The number of households and **housing units** (a structure/room used by households for sleeping, storage, shelter for animals or other purposes) in your village.
- The **average surface area** of the housing units; surface area refers to the area of the walls, roof and furniture to be sprayed by insecticide; if houses are big in your village, they will have more surface area to be sprayed and need more insecticide per house than will be needed to spray small houses.

The type of insecticide to be sprayed is decided nationally. Information about the number of households and housing units for your village is kept at the District Health Office (and may need to be updated by you from time to time). The average surface area of the housing units in your village is also known by the District Health Office. If necessary you can work with experts from the District or the Regional Health Office to update these measurements. Based on the above data, the amount of insecticide required for IRS in your village is calculated by experts at the District Health Office and sent to you at your health post.

You are responsible for the safe storage and handling of the insecticide at the village level. Most insecticides are pre-weighed and pre-packed in sachets that have to be dissolved in 8 litres (8,000 ml) of water to fill a spray pump. 40 ml of the insecticide needs to be sprayed per square metre (m^2) of surface area, so a full spray pump (8,000 ml) is enough to spray 200 m^2.

10.7 Housing units and structures to be sprayed with insecticide

You need to know which areas and items in a household to spray during IRS.

All potential **resting places** for mosquitoes need to be sprayed. Resting places are all walls and ceilings in the house, window frames, and both sides of doors, furniture (beds, tables and chairs), animal shelters, latrines, stores and outhouses.

- Why are the outer walls and roofs not sprayed?
- These surfaces are not generally used by mosquitoes for resting.

To ensure that IRS provides good protection against malaria vectors, you should aim to spray 100% of the housing units and other structures in your village.

Less than 85% coverage with IRS is not sufficient to provide adequate protection to your community, so it would be a waste of time and resources.

10.8 Training of spray operators

You will get a national manual with detailed instructions on the training of spray operators.

The outcome of IRS is highly dependent on the quality of training given to spray operators. This training will be your responsibility.

The training should address spray techniques, environmental and human safety issues, as well as communication of key IRS messages (explained in Section 10.11). The spray operators should be trained to cover 19 m^2 at a constant rate within one minute. This will allow the application of 40 ml of insecticide suspension per 1 m^2 of sprayable surface; 1 litre of suspension covers 25 m^2 when the nozzle tip is effectively kept at 45 cm distance from the spray surface.

The wall of a building can be used for practice. Mark an area 3 m high and 6.35 m long, divided into nine bands: the first band should be 75 cm wide and the remainder 70 cm wide (Figure 10.2). The spray nozzle will produce a swathe of spray 75 cm wide if kept at a distance of 45 cm from the wall (Figure 10.3).

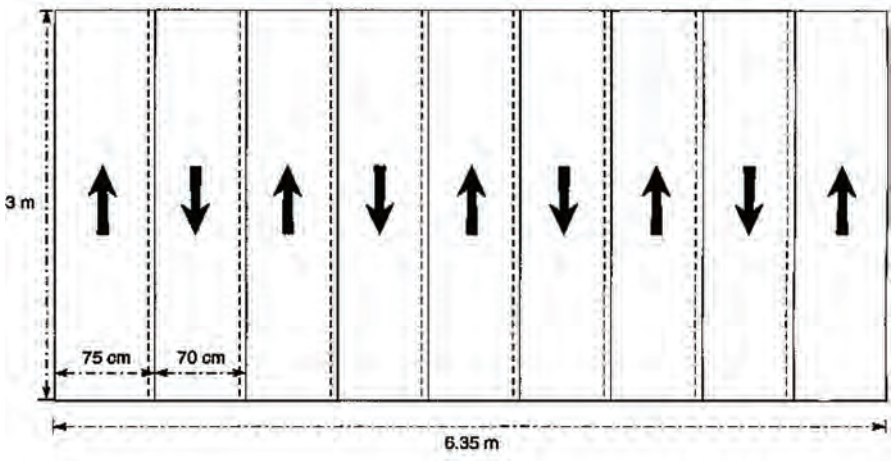


Figure 10.2 Training board for residual spraying which can be marked with chalk on the wall of a large building. (WHO, 1997; source as in Figure 9.2)

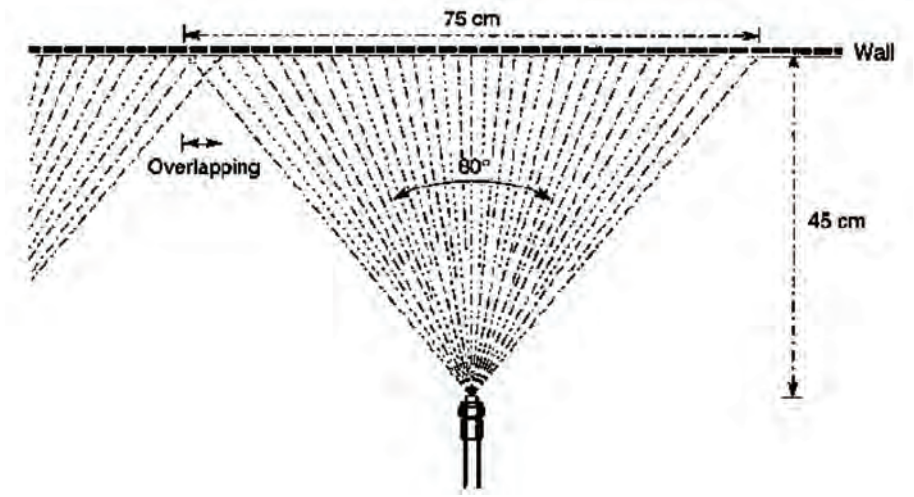


Figure 10.3 The spray nozzle discharge pattern is 75 cm wide when the nozzle is held at 45 cm from the sprayed surface. (WHO, 1997; source as in Figure 9.2)

10.9 Timing of spray operation

In areas where malaria transmission is seasonal, IRS should be completed *just before* the season begins. Generally, only one round of spraying is done per year in Ethiopia. In areas where the main transmission season is from September to late November, spraying must be completed in August at the latest. For areas with a different malaria transmission pattern, the timing of spraying should be adjusted in consultation with malaria experts at the District Health Office.

10.10 Preparation of houses before spraying

Houses need to be prepared for spraying, so householders should be informed in advance of the date and time of spraying. This should help to increase IRS coverage in the community and could be done through the village administration and other community organisations.

To prepare a house for spraying, all food, cooking utensils, bedding and clothes must be protected from the insecticide by taking them outside the house before spraying starts. Alternatively they should be placed in the centre

of a room and covered with a plastic sheet to stop the insecticide settling on them.

All portable furniture should be moved away from the walls so that the walls and all sides of all the pieces of furniture can be sprayed.

10.11 Undertaking IRS operations

You will learn IRS techniques from your local mentor during practical training. You will also receive detailed instructions via the national IRS guidelines from the Federal Ministry of Health. In this section, only the most important aspects of IRS technique will be described.

10.11.1 Correct IRS procedures

- Make sure that the house is ready for spraying (as explained in Section 10.10).
- The outside of the front door is the first surface to be sprayed.
- After entering the house, close the front door and spray it on the inside, including all frames of the door.
- Start the next swathe of spraying from the bottom corner of the wall to the right of the front door and proceed clockwise as shown in Figure 10.4. Spray all edges and corners of windows, as well as all niches and cracks where mosquitoes might rest.
- The backs, undersides and interiors of all cupboards, boxes, ovens, calendars, pictures, stools, beds, chairs and tables must be sprayed.
- Other household areas, i.e., kitchen, store, stable and latrine, should be sprayed next.

Figure 10.4 Correct indoor spraying procedure. (WHO, 1997; source as in Figure 9.2)

- After spraying, a final inspection is made by the spray operator to see that no surfaces on which mosquitoes might find a sheltered resting place remain unsprayed.
- Following inspection by you, the spray operator is assigned to another house.
- After spraying, the spray operator must tell each householder:
  - Not to enter the house for 30 minutes.
  - Not to re-plaster, mud-wash or white-wash inside the house for six months.
  - The spraying is to control malaria vector species, not bed bugs, fleas, etc.
  - To clean the floor and bury or burn the dirt, which is contaminated with insecticide.

10.11.2 What you need to do to support IRS

It is your responsibility as the local member of the Health Extension Service, to carry out the following duties during an IRS operation:

- Inspect all spray pumps daily to make sure they are in perfect working condition.
- Ensure spray operators have enough insecticide sachets for the job, and are carrying all the necessary spraying equipment.
- Carry enough spraying record forms (Table 10.2) for the number of households to be sprayed each day.
- Supervise the work of each of the spray operators to ensure the correct procedures are being followed.
- After spraying is finished, inspect the house for the quality of spraying and complete the spraying record form (Table 10.2) for all households sprayed or unsprayed
- Complete the village spraying report using the form indicated in Table 10.3 (on the next page).
- Make every effort not to leave any houses unsprayed. Householders who refuse to have their houses sprayed have to be convinced by means of proper health education during the operation. Locked houses left unsprayed during the initial visit have to be revisited before the end of the day's work or the next day.

Table 10.2 Household spraying record.

Region _____ **Zone** _____ **District** _____**Village** _____ **Spray Period** _____

Household No.	**Name of head of household or family**	**No. of people in the family**	**Sprayed housing units**	**Not sprayed housing units**	**Spray operator number**	**Remark**
Total						

Table 10.3 Village spraying report by a Health Extension Practitioner

Region _____ District _____ Zone _____ Village _____ Spray Period _____

HEP Name _____

Name of sub-village	Households			Housing units			Population protected		No. of insecticide sachets used	Remark
	Total	Sprayed	Not sprayed	Total	Sprayed	Not sprayed	No. of people in sprayed housing units	No. of people in unsprayed housing units		
Total										

10.12 The role of the health post, health centre and District Health Office in IRS operations

Now that IRS will be decentralised to the health post level, the responsibility of planning, and organising a spray operation is shared between the District Health Office, the Health Extension Supervisor (at the health centre) and you, the Health Extension Worker or Practitioner (at the health post).

Decentralisation of the IRS operation has several advantages compared to the previous method of planning and undertaking it from the district. For example:

- The operation could be more quickly organised at community level and implemented to control epidemics.
- The spraying is undertaken by you, an important and familiar person in the community, and trusted spray operators selected from the community; this will increase acceptability of the operation.
- Pumps will now be available at the health post and can be used for other malaria control purposes, such as larviciding whenever necessary.

Your responsibility in IRS operations in the village will be to:

1 Select capable spray operators from the community.

2 Train the spray operators for 5–7 days; (spray techniques, communication, safe handling of chemicals, etc).

3 Plan when to start and finish the IRS operation in your village; consult also the village leaders.

4 Undertake the IRS operation as the leading person guiding and supervising the spray operators.

5 Mobilise the community to cooperate and participate.

6 Educate the people about the benefits of IRS and what to do after their houses are sprayed.

7 Keep records of your daily output and usage of insecticides.

The operation you undertake in your village will be supervised by the Health Extension Supervisor at the health centre and experts from the District Health Office. They will provide you with any technical support and equipment that you need (spray pumps, insecticides, spray pump spare kits, tool kits for pump maintenance, personal protective equipment), and answer any questions you might have.

10.13 Safe handling of insecticides

All insecticides are poisonous and must be handled with care. The following precautions are recommended and should always be practiced:

- Anyone handling insecticides should be informed of the risks involved in their use, and should receive instructions for handling them safely.
- You should adequately supervise spray operators to ensure they are following instructions.
- The spray operator must wear a hat and clothing that covers as much of the body as possible, including arms and legs; the nose and mouth should be covered with a disposable or washable mask (Figure 10.5).

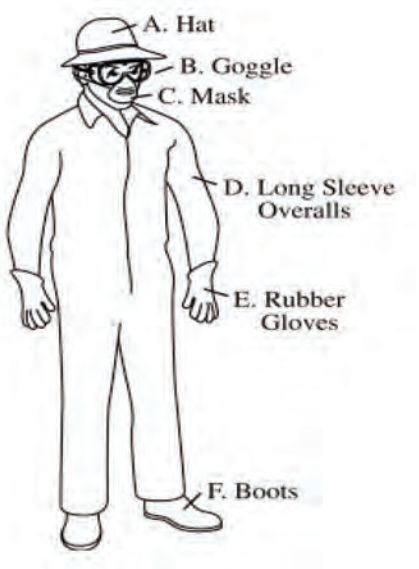


Figure 10.5 Personal protective equipment for spray operators engaged in IRS. (WHO, 1997; source as in Figure 9.2)

- Hands and faces should be washed with soap and water after spraying and before eating, smoking or drinking.
- Insecticide spray should not fall onto arms, legs or other parts of the body. If the insecticide gets on to skin, it should be washed off immediately with soap and water.
- Leaky spray equipment should be repaired.
- Operators should bathe at the end of every day's work and change into clean clothes
- Clothes should be changed immediately if they become contaminated with insecticides.
- Operators should inform you immediately if they do not feel well.
- At the end of the day's work, washings from the sprayer should be put into pit latrines, if available, or into pits dug especially for this purpose and away from sources of drinking water.

- Any leftover insecticide must not be poured into rivers, pools or drinking water sources.
- Empty insecticide containers should not be re-used.

10.14 Some problems related to house-spraying

1 In some areas mosquitoes may become resistant to commonly used insecticides. If resistance develops, insecticides are changed by the national experts.

2 Spraying walls often leaves a visible deposit of insecticide, especially when a wettable powder suspension is used. To prevent objections to spraying on these grounds, you should educate householders on the benefits of IRS.

3 Some people may object to wall-spraying on religious grounds; the education and communication you offer is important.

4 The washing or re-plastering of walls, for religious or cultural reasons, reduces or eliminates the killing-power of insecticides; households should know that re-plastering during the malaria season is bad for their health.

5 The community may be reluctant to allow strangers into their houses, for fear that they will interfere with women or steal; this will not be a problem if spray operators are recruited from the community.

6 The insecticides may not kill other domestic pests, such as bedbugs; acceptability increases when the insecticides also kill other pests, but households should know that the objective of IRS is to kill mosquitoes and prevent malaria.

Summary of Study Session 10

In Study Session 10, you have learned that:

1 IRS is one of the most important vector control and malaria prevention methods widely used in Ethiopia.

2 Insecticides are sprayed onto the inner walls of houses, furniture and other structures using hand-operated spray pumps.

3 The main objective of IRS is to kill adult mosquitoes that enter houses to bite people and rest inside houses after a blood meal.

4 IRS may not provide individual protection; people sleeping in sprayed houses can still be bitten by mosquitoes.

5 Unlike ITNs which provide individual protection, the aim of IRS is to provide community protection. All structures that could be used as resting places should be carefully sprayed to deny any safe shelter for the vector mosquito; achieving high coverage is extremely important.

6 It very important that instructions on safe handling and disposal of insecticides are strictly followed.

7 Proper communication and education of the population will help to increase acceptability of IRS operation; people have to know that re-plastering of houses before three to six months would make IRS ineffective.

8 IRS operations should be completed just before the beginning of the malaria transmission season.

9 Quality of spray operation is very important for IRS to be effective and the quality depends on effective training of the spray operators.

10 The community should understand that the objective of IRS is to kill the mosquitoes and protect people from malaria; it is not to kill bedbugs or other pests.

11 You are the key person in planning and implementation of IRS in your village; ask for support from community leaders, the health centre and District Health Office whenever necessary.

Self-Assessment Questions (SAQs) for Study Session 10

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 10.1 (tests Learning Outcomes 10.1 and 10.2)

The *resting habits* of mosquitoes are very important for IRS. Which of the following sites can serve as resting places for a blood-fed mosquito, so they should be sprayed with insecticide? Which ones cannot be sprayed?

- Walls of houses
- Furniture in houses
- Streams
- Animal shelters
- Lakes
- Rivers
- Latrines.

SAQ 10.2 (tests Learning Outcome 10.2)

Which of the following statements is *false*? In each case, explain what is incorrect.

A Blood-fed mosquitoes rest on either the inside of houses or in vegetation outdoors.

B Mosquitoes that rest outside houses after feeding are easier to control with IRS.

C After taking a blood meal, mosquitoes have to rest about 10 days before laying their eggs and seeking their next blood meal.

D Blood-fed mosquitoes can often rest on the outside walls of houses.

E IRS kills mosquitoes entering houses and resting on sprayed walls and furniture.

SAQ 10.3 (tests Learning Outcome 10.3)

You will be responsible for undertaking IRS in your village and before you start the operation you have to make sure you have all the resources ready. What are the items you have to request from the District Health Office, and what do you have to do at the community level?

SAQs 10.4, 10.5, 10.6 and 10.7 are on the next page.

SAQ 10.4 (tests Learning Outcome 10.3)

What is the capacity of the spray pump used for IRS in Ethiopia? What is the surface area that can be sprayed by one full spray pump of insecticide?

SAQ 10.5 (tests Learning Outcomes 10.3 and 10.5)

Your village has 800 households and the average housing unit per household is 1.5. At the end of your spray operation, your record shows that 900 housing units were sprayed and the rest were unsprayed.

(a) How many housing units were expected to be sprayed?
(b) How many housing units were unsprayed?
(c) What is the coverage of this IRS operation? Express you answer as % of housing units sprayed.
(d) Is the coverage of this IRS operation acceptable? Say why or why not.

SAQ 10.6 (tests Learning Outcomes 10.3 and 10.5)

Read Case Study 10.1 carefully and then answer the questions below it.

Case Study 10.1 A village IRS programme

Your village has 500 households and each household has two housing units. One spray operator sprays 20 housing units per day. You have five spray operators with five spray pumps to undertake the operation. The average surface area of one housing unit is 100 m^2. From Section 10.5 you have learned that one spray pump of insecticide (one sachet) covers 200 m^2 surface area.

(a) How many working days will be needed to spray the entire village?
(b) How many sachets of insecticide do you need for the village?
(c) How many sachets does one spray operator need to carry for one day's work?

In each case, explain how you arrived at your answer.

SAQ 10.7 (tests Learning Outcome 10.6)

Which of the following statements about the safe handling of insecticides is *false*? In each case, explain what is incorrect.

A Spray operators need to wear a shirt and trousers during spraying.
B Hands and faces should be washed with soap after spraying, and before eating or drinking.
C Any leftover insecticide should be poured into rivers.
D Spray operators can keep wearing contaminated clothes for a week without washing.

Study Session 11 Malaria Prevention: Insecticide Treated Nets

Introduction

In Study Sessions 9 and 10 you learned about two important malaria prevention methods targeted at malaria vectors: killing mosquito larvae as they develop in water, and using IRS to kill adult mosquitoes that enter houses to bite people. In this study session, you will learn about another malaria prevention strategy directed against adult mosquitoes, which is widely used in malaria risk areas: the use of **insecticide-treated nets** (**ITNs**). An ITN is a mosquito net impregnated with insecticide that repels, disables or kills mosquitoes coming into contact with it.

An important part of your responsibility is distributing ITNs to the community and maintaining high coverage through replacement of damaged nets, sustained coverage of people at risk, educating households on how to hang the nets, how to use them properly and consistently, and how to repair them when damaged. In this study session you will learn the objectives of using ITNs for malaria prevention, and about methods of effective net distribution, replacing old nets and monitoring their use. It will help you understand your role in the ITN programme, including what you need to do to make sure people in your community benefit fully from using ITNs.

The skill and knowledge you obtain from this study session about ITNs as a malaria prevention strategy will help you ensure that people in your community get the maximum benefits from the nets distributed. Like other malaria control and prevention tools, ITNs protect people from malaria and save lives.

Learning Outcomes for Study Session 11

When you have studied this session, you should be able to:

11.1 Define and use correctly all of the key words printed in **bold**. (SAQ 11.1)

11.2 Discuss the principles of bed net use in malaria prevention. (SAQs 11.2 and 11.3)

11.3 Describe the different mechanisms of net distribution. (SAQs 11.4 and 11.5)

11.4 Explain the importance of correct and sustained net use and the mechanisms for monitoring your local ITN programme. (SAQs 11.6 and 11.7)

11.1 ITNs as a malaria prevention tool

Insecticide treated nets (**ITNs**) are one of the most effective methods of preventing malaria in malaria-risk areas. The insecticides used for treating bed nets kill mosquitoes, as well as other insects, and they also repel mosquitoes, reducing the number entering the house to feed on the people inside. In addition, if high community coverage of ITNs is achieved, the numbers of mosquitoes, as well as their life span, will be reduced. When this happens, all members of the community are protected, regardless of whether or not they are using a bed net. To achieve such effects, high community coverage is

required. The use of ITNs has repeatedly been shown to reduce the incidence of severe disease and mortality due to malaria in malaria-affected regions. ITNs can also have a beneficial effect on other insect pests, such as head lice, ticks, bedbugs and cockroaches.

11.1.1 How ITNs work

Mosquito nets fall into two groups: those that are *not* treated with insect killing or repelling chemicals, and those that *are* treated with such chemicals (i.e. ITNs). All mosquito nets act as a physical barrier, preventing bites by vector mosquitoes and thus providing personal protection against malaria to the individual(s) using the nets. In addition, ITNs can kill or disable mosquitoes by contact with the insecticide.

ITNs are most useful when a large proportion of biting by local mosquitoes takes place after people have gone to sleep inside houses. ITNs have three main functions:

- ITNs (like all nets) reduce contact between the person and mosquito by acting as a physical barrier.
- When mosquitoes are in contact with the ITN, the insecticide on the nets kills them.
- The insecticide on the nets also has a *repellent effect*, that is, it prevents mosquitoes from coming close to a person sleeping under ITNs, and to some extent it prevents mosquitoes from entering and staying in a house. The repellent effect adds a chemical barrier to the physical one, further reducing human–vector contact and increasing the protective effect of the mosquito nets.

Individuals sleeping under ITNs have effective personal protection against malaria vectors. However, if ITN use is widespread in a village or community, it can actually increase protection against malaria vectors even for those who are not sleeping under nets.

■ Can you explain why widespread ITN use in a community could increase protection against malaria vectors even for people who are *not* sleeping under ITNs?

□ ITNs can kill mosquitoes on contact. For this reason, if ITN use is widespread, the local malaria vector population will be reduced, so even people who do not have ITNs will be less likely to be bitten by a malaria vector.

Thus ITNs can be a very effective vector control intervention for reducing malaria transmission for individuals and communities.

11.2 Types of ITNs

Pyrethroids are the only family of insecticides used to treat bed nets, as they are safe to humans. Nets requiring re-treatment every six months are no longer used in malaria control programmes in Ethiopia or elsewhere. Therefore, the term ITN in the rest of this study session refers to LLINs.

There are two types of ITNs: conventionally treated nets and **long-lasting insecticidal nets** or **LLINs**. A conventionally treated net is a mosquito net that has been treated by dipping in a pyrethroid insecticide. Dipping is often done at the village level, by health workers or communities themselves. However, to ensure its continued insecticidal effect, the net needs to be re-treated after three washes, or at least every six months. A much better alternative is the long-lasting insecticidal net. LLINs are factory-treated mosquito nets made with a netting material that has insecticide incorporated into the fibres, or as a coating on the fibres. LLINs are effective against

mosquitoes for at least 20 standard washes, or three to five years under field conditions. As the lifespan of most nets is three to four years, the insecticides in LLINs remain effective for the whole life of the net. Therefore, there is no need to re-treat LLINs.

11.3 Mosquito net models

Mosquito nets are produced in different sizes and shapes. A net should cover the sleepers completely and should cover sufficient space for them to avoid contact with the fabric. Sufficient length is needed so that the net can be tucked in under the mattress or sleeping mat. Different models have been developed for different situations. They differ in convenience for daily use, and prices vary widely. The method of suspension is an important consideration.

11.3.1 Rectangular nets

The rectangular net (Figure 11.1) is normally used over a bed or sleeping mat. It is the model widely used in Ethiopia. It is suspended from four or more loops along the upper edges.

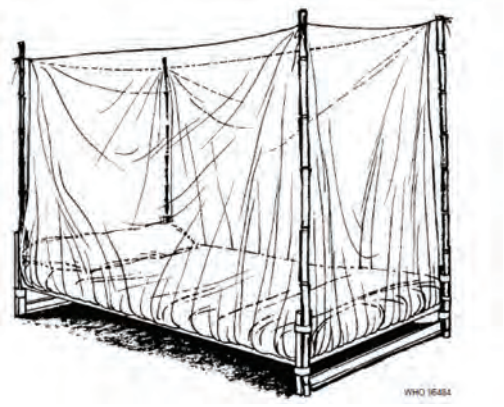


Figure 11.1 Rectangular bed net. (WHO, 1997; source as in Figure 9.2)

Dimensions vary: most nets have a height of about 150 cm and a length of 180–190 cm. A single-size net has a width of 70–80 cm, contains about 9 m^2 of netting material and is used to cover one person on a single bed or sleeping mat. Double nets with a width of 100–110 cm (10–11 m^2 of netting) and family-size or large double nets with a width of 130–140 cm (12–13 m^2 of netting) are used for larger beds. The optimal size depends on sleeping habits and available space. All nets distributed in Ethiopia are family size nets.

Special supports for rectangular bed nets

Indoor supports: Where it is customary to rearrange and use beds for seating during daytime, nets should be supported using detachable poles or mosquito net supports attached to the ceiling or walls.

Outdoor supports: In some villages where the climate is hot, people tend to sleep outdoors during the peak malaria season. People may also stay late outdoors working or chatting before going indoors to sleep. In many cases, people let their children sleep outdoors until the adults go indoors to sleep late at night. Where people usually sleep outdoors, or stay outdoors late into the night during the hot season, nets should be used outdoors. Outdoors, nets are best supported by a frame that can be easily detached from the bed (Figure 11.2). Most vectors of malaria bite people from sunset to dawn. To get

If possible children should go to sleep as early as possible indoors under nets; if they have to sleep outdoors they *must* sleep under nets.

full protection from the nets, people must use nets from dusk to dawn. If people stay late outdoors chatting, they should use the nets outdoors too. In particular, children should not be left to sleep outdoors without nets.

Figure 11.2 Special supports for rectangular nets for outdoor use. (WHO, 1997; source as in Figure 9.2)

11.3.2 Circular nets

Circular, or conical, nets are sometimes preferred because they can be hung from a single support (Figure 11.3a). The nets are mostly available in double size. Compared with the rectangular net, more care has to be taken to avoid contact between the body and the net, which would allow mosquitoes to feed. Circular nets could be better suited to circular houses with limited space, which are very common in Ethiopia (Figure 11.3b).

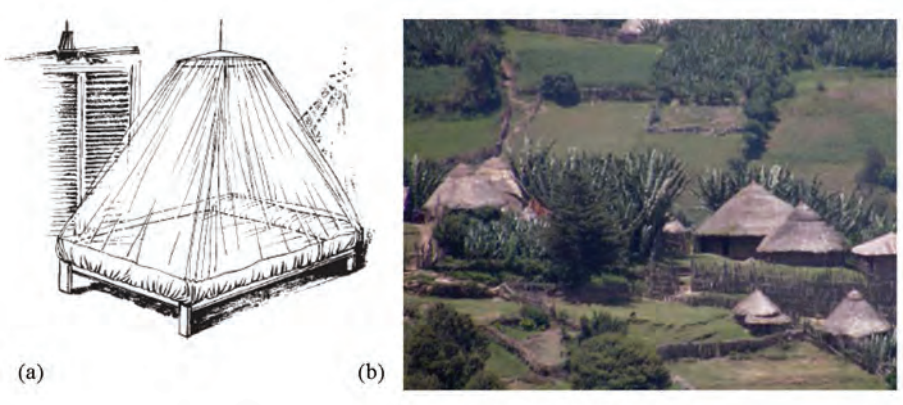


Figure 11.3 (a) A circular bed net. (WHO, 1997; source as in Figure 9.2); (b) Traditional Ethiopian 'tukul' round houses. (Photo: Basiro Davey)

11.4 Deciding the number of ITNs per household

The first step in ITN programmes is making the nets available to the community. Several methods have been tried to make ITNs available to a large number of people in malaria-risk areas. They included encouraging people to buy nets from the market at full price, making nets available at subsidised or reduced prices, and credit schemes.

However, none of these methods was effective in scaling up coverage of nets in poor communities like those in rural Ethiopia. Therefore the current policy of the malaria programme in Ethiopia is to distribute nets free of charge to all population groups, using the methods described in Section 11.5 of this study session.

The objective is to ensure that communities living in malaria-risk villages have enough nets to cover all sleeping sites in the household. In Ethiopia, the strategy since 2005 has been to provide, on average, two ITNs per household in all malaria-risk areas. Between 2005 and 2007 this strategy provided access to ITNs to an estimated 10 million households, or approximately 50 million people, living in malaria-risk areas.

- Approximately how many ITNs were distributed in Ethiopia between 2005 and 2007?

- 10 million households received ITNs. Households received on average two ITNs per family; so around 20 million ITNs were distributed.

Although an *average* of two ITNs per household is used for logistical or planning purposes, it does not mean that every household will get two nets. The number of ITNs a household will receive depends on family size, and is based on the general principles shown in Table 11.1.

Table 11.1 General guide to determine the number of nets per household based on family size.

Family size	Number of ITNs to be supplied
1 to 2	1
3 to 5	2
6 to 7	3
More than or equal to 8	4

The number of sleeping sites in the household must also be taken into account during distribution of the nets. For example, even if there are only two people in the household, if they sleep separately in two different sleeping sites, the household needs two nets — not just one as indicated in Table 11.1. You must also make sure that pregnant mothers and children under five years old always get *priority access* to ITNs, even if this means supplying extra ITNs to the household.

- Why should children and pregnant mothers get special attention during ITN distribution?

- Because children and pregnant mothers are at higher risk of getting ill and dying of malaria (Study Session 6).

11.5 Methods of ITN distribution

There are two main methods of supplying nets to the community and maintaining high coverage. One is *mass distribution*, which is termed **catch-up distribution** of nets. This is a method used to achieve coverage of the entire community, or of target groups, as quickly as possible. The other method is termed **keep-up distribution** of nets. This is a method employed to *maintain* the coverage achieved by mass distribution by replacing nets as needed and providing nets for newcomers and newborns in a community.

There are a number of advantages of distributing ITNs through the Health Extension Programme under your supervision:

- ITN distribution is integrated into the existing health system, instead of relying on special campaigns.
- All malaria-risk villages of 5,000 people should have at least two Health Extension Workers or Practitioners like yourself deployed close to the community. Your knowledge of the customs and culture of your community will be very helpful in increasing the acceptability and use of ITNs. You will also have first hand information about family size and the number of sleeping sites in each household, which determines the number of nets needed in your community (as in Table 11.1).
- Through your activities, ITNs can quickly be replaced or supplied as needed, ensuring continuous access to ITNs (summarized in Box 11.1). This should reduce the proportion of people in your community remaining uncovered due to damage or loss of nets, and ensure that additional nets are available for pregnant mothers and newborn babies.
- Planning the requirement of ITNs for continuous replacement and additional distribution can be based on precise information collected by community-based health workers such as yourself, so it is more likely to reflect ITN requirements accurately.

Box 11.1 Health Extension Programme activities in ITN distribution in malarious villages

You are expected to perform the following activities in order to effectively and efficiently undertake ITN distribution in your village:

1 Determine the number of households in your village.

2 Determine the average family size in your village (the total number of people in your village divided by the total number of households in the village).

3 Prepare a record of the number of people in each family and if possible the number of sleeping sites in each household.

4 Submit your plan, including the above data, to the District Health Office.

5 Discuss with community leaders and elders, and with community health workers, how to distribute the nets as quickly as possible, and involve them in distribution of the nets.

6 Transport the required number of nets from the District Health Office to the health post.

7 Arrange temporary storage of the ITNs.

8 Train community health workers on procedures of ITN distribution and the key messages about proper and consistent use, which they should communicate to the households during ITN distribution.

9 Always give priority to children under five years old and pregnant women, when there are not enough nets to cover the whole population. Pass the message to the households about prioritising the nets to protect their young children.

10 Distribute nets as soon as they arrive at the health post.

11 Consider distributing the nets through house-to-house visits, as this will be the best way to assist the households with hanging the nets and teaching them the proper use of the nets.

12 Ask households to remove badly damaged nets, tear them down to be used as window screens or put them under the mattress or mat to kill other pests, like bedbugs. Never allow households to keep using damaged old nets while keeping new nets unused.

13 Always unpack nets before handing them to beneficiaries.

14 Convince households to repair damaged nets promptly, to extend their useful life.

The following are different ITN distribution mechanisms that you have to know to do your job effectively. Remember that appropriate mechanisms of nets distribution and replacement should be discussed with your supervisors at the health centre and District Health Office. The choice of distribution and replacement methods depend on the availability of nets at Regional and District levels.

11.5.1 Mass distribution (catch-up) of nets

A variety of methods are available to distribute ITNs to a whole community, as described below.

ITN distribution via house-to-house visits

The best way to distribute ITNs in the community is to visit every house to distribute them. In this way you can ensure that:

- The nets are given to the right people.
- The nets are hung up and not left in their packages.
- The nets are hung properly.
- People get information about how to hang and use the nets outdoors, if outdoor sleeping is common in the village.
- Non-functional old nets are removed and used for other purposes.
- People receive face-to-face education on the benefits of proper and consistent use of ITNs, including the benefits of putting children under nets as early as possible at night.

However, the problem with house-to-house distribution is that it is time-consuming, so it might take you and your colleagues a lot of time to visit 1,000 or so households. To overcome this problem, you should train volunteer community health workers and village leaders to help with the mass distribution of the nets via house-to-house visits.

Stand-alone ITN distribution campaigns

ITNs can also be distributed to all households in the village that need them by inviting people to come to central distribution points, where households are given ITNs based on the village register. At the same time, education and demonstrations can be given collectively to a large number of people. The advantage of this kind of distribution is that a large number of nets can be distributed quickly. However, the health education messages and practical demonstrations may not be adequately communicated to individuals (Figure 11.4).

Figure 11.4 Campaigns like this one can distribute a large number of nets quickly, but the practical demonstrations of how to use the nets may not be adequately communicated to everyone. (Photo: UNICEF Ethiopia/Indrias Getachew)

Distribution integrated with immunization or outreach campaigns

ITNs can also be delivered through the systems and organisations used to deliver immunization, so immunization and ITNs can be delivered at the same time. ITN distribution can also be linked to the other outreach services such as the structure used to deliver bi-annual vitamin A supplements, de-worming, and nutrition screening campaigns.

The disadvantage of linking ITN distribution to immunization and other outreach programmes is that only households with young children (one to five years old) are targeted by these programmes, so other households will not be covered. In fact, such distribution methods are not generally recommended in Ethiopia, as the country has strong community-based health delivery systems, such as the Health Extension Programme, of which you are a part.

11.5.2 Replacement or 'keep-up' distribution

As you learned above, the aim of ITN distribution in Ethiopia is to protect everyone living in malaria-risk areas, so every effort is made to achieve 100% coverage of all people living in malaria-risk villages.

After the initial distribution of ITNs to as many people as possible via 'catch-up' campaigns, you need to maintain high coverage continuously, so as many people as possible remain protected and the disease can be controlled. Such follow-up distribution of ITNs is known as 'keep-up' distribution, and it is necessary because:

- Currently the ITNs used for malaria prevention are only functional for three to four years. After three to four years, the ITNs become damaged and have to be replaced by new ones. Nets can also be torn or damaged before three to four years, for a variety of reasons. You should replace any damaged nets regularly to keep the coverage high.
- Mothers who become pregnant after the 'catch-up' distribution may move to their own sleeping site separate from other family members and may need to be provided with their own ITN. Giving ITNs to all pregnant mothers attending antenatal care (ANC) will keep them protected from malaria. This could also serve as an incentive for mothers to attend ANC, where attendance in rural Ethiopia is generally low.
- Newcomers to a village and newborns will need additional ITNs.

11.6 Proper and sustained use of ITNs

To give the required protection, ITNs need to be used properly and regularly. One of the biggest challenges for the ITN programme in Ethiopia, and in many other African countries, is *to ensure proper and consistent use of ITNs*. A malaria indicator survey (MIS) conducted in Ethiopia in 2007 showed that, despite a national ITN coverage rate of 68% of households in malaria-risk areas, less than 50% of the people who have nets slept under an ITN. The MIS results also showed that many people do not understand how malaria is transmitted, or why ITNs are important for malaria prevention.

Understanding how malaria is transmitted, and why it is important to sleep under ITNs, is important for people to change their behaviour. This needs education. Mass media and education materials such as posters and banners can provide information and create awareness about the need to use ITNs correctly. Personal messages from you are even more effective.

11.7 The role of the health worker in education about ITNs

Health workers at all levels of the health system need to try and make sure that ITNs are used properly by the community. However, as a locally-based Health Extension Worker or Practitioner you are the person in the best position to make a significant difference, by educating and convincing the people in your community to use ITNs properly and consistently. The success or failure of the ITN programme depends on your efforts to make people aware of the benefits of ITNs, and to change their behaviour so they use ITNs properly. Please consult your supervisors at the health centre and District Health Office if you face any problems in this regard.

Many health posts now also have a network of volunteer community health workers (CHWs) to support you in community-based activities. You need to use these CHWs to help you increase contact with each household in a more organised way, in order to increase the use of ITNs in your village.

Using CHWs effectively is covered in the Module on *Health Education, Advocacy and Community Mobilisation*.

Misuse of ITNs by community members, for example for covering hair, for fishing and for carrying goods, should be identified and discouraged. Not sleeping under ITNs consistently, or sleeping outdoors without ITNs (whether for adults or children) needs to be addressed if they are part of the problem. Some people may also be selling their nets.

Multiple contacts and one-to-one interactions are known to be important in bringing about changes in behaviour.

11.8 Monitoring ITN utilisation

Continuous monitoring of the possession and proper use of ITNs is also very important if ITN programmes for preventing malaria are to be successful. You should visit a sample of households regularly and check:

- Whether all the nets you gave the family are physically present in the household.
- Whether the nets have been hung properly (Figure 11.5).
- Whether everyone in the household slept under the nets the previous night.
- The physical condition of the nets and advise the family to repair minor damage.

- The names of the family members who sleep under each net.
- If possible ask them what time children under five years and adults normally go to sleep in the evening; advise alternative solutions if outdoor sleeping or staying out late is an issue.
- Address any concerns or problems about net use from the household.

Figure 11.5 A correctly hung bed net. (Photo: Dr Yemane Ye-ebiyo Yihdego)

As a health worker providing antenatal care (ANC) and immunization services to the community, you should always ask pregnant women at every ANC visit, and parents of children at all vaccination visits, whether they have nets and whether they are using them properly. You should check if the mothers and their children slept under ITNs the previous night, and you should record their responses on the Expanded Programme of Immunization (EPI) monthly form.

As you learned from this study session, the most important components of an ITN programme in malaria prevention are distributing the ITNs correctly, maintaining high coverage, educating people on proper and consistent use, and monitoring their utilization. You are the key person who can effectively implement all the above activities and protect people from malaria-related illnesses and deaths.

Summary of Study Session 11

In Study Session 11, you have learned that:

1 ITNs are one of the most important malaria prevention methods and are widely used in Ethiopia.

2 ITNs provide personal protection for individuals who use them properly.

3 When coverage with ITNs is high, they can provide community protection by killing a large number of mosquitoes trying to feed on humans.

4 To achieve high coverage, ITNs need to be distributed to the community free of charge.

5 The most effective way to distribute ITNs is through house-to-house visits; however other methods can also be used (e.g. stand-alone campaigns).

6 You are the most important person in planning and undertaking distribution of nets to the community.

7 Volunteer community health workers and village leaders can support ITN distribution campaigns in the village.

8 Keeping coverage high through replacement of damaged nets, and distributing new ones to people in need, is important for effective community protection.

9 Proper and consistent utilisation of nets is important for ITNs to be effective.

10 Educating people on proper and consistent use of nets and monitoring behaviour change is one of your most important tasks in the ITN programme.

Self-Assessment Questions (SAQs) for Study Session 11

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering these questions. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 11.1 (tests Learning Outcome 11.1)

Sleeping under an insecticide treated net (ITN) protects people from getting malaria. Which of the following statements about ITNs is *false*? In each case, explain what is incorrect.

A ITNs protect people from malaria by killing the malaria parasites.
B ITNs do not kill mosquitoes that come in contact with the nets.
C ITNs can repel mosquitoes from coming closer to people sleeping under nets.
D ITNs have chemicals in (or coated onto) their fibres, which can kill mosquitoes.
E The chemical on ITNs kills only mosquitoes.
F The chemicals coated on ITNs are harmful to humans.

SAQ 11.2 (tests Learning Outcome 11.2)

Describe the difference between non-treated and insecticide-treated nets (ITNs).

SAQ 11.3 (tests Learning Outcome 11.2)

What is the difference between regularly/conventionally treated nets and long lasting insecticidal nets (LLINs)?

SAQ 11.4 (tests Learning Outcome 11.3)

Different methods are used to distribute nets to communities. State two important mechanisms of mass net distribution, in each case with their advantages and disadvantages.

SAQs 11.5, 11.6 and 11.7 are on the next page.

SAQ 11.5 (tests Learning Outcome 11.3)

What methods can you use to keep coverage of nets high in your community, after they have been distributed by mass (catch-up) methods?

SAQ 11.6 (tests Learning Outcome 11.4)

One of the most important challenges in ITN programmes is a low rate of net utilisation. State at least two behaviours of people that are not considered to be proper use of nets.

SAQ 11.7 (tests Learning Outcome 11.4)

High net coverage is expected to protect people from malaria and reduce the incidence of new cases. Imagine that, in spite of high net coverage in your village, many people are getting infected with malaria and coming to your health post for treatment. What could be the possible explanation for this problem?

Study Session 12 Monitoring and Control of Malaria Epidemics

Introduction

Early detection and a prompt response to malaria epidemics is essential to minimise the impact of the illness (including deaths) and the socio-economic burden following malaria epidemics. In this study session you will learn how a malaria epidemic is defined in general and how it can be recognised in your village. You will also learn about factors that can trigger epidemics, about the supplies and drugs you need to be prepared for epidemics, and the different ways to contain epidemics. All this information will enable you to detect malaria epidemics early and to implement interventions to contain them fast.

Disease surveillance and epidemic monitoring and control are discussed in detail in Study Sessions 40–42 of *Communicable Diseases*, Part 4.

Learning Outcomes for Study Session 12

When you have studied this session, you should be able to:

12.1 Define and use correctly all of the key words printed in **bold**. (SAQs 12.1, 12.5, 12.6 and 12.7)

12.2 Define a malaria epidemic in general and in your village. (SAQs 12.1, 12.2 and 12.5)

12.3 List and explain how you would monitor the factors that trigger malaria epidemics. (SAQs 12.1 and 12.2)

12.4 Explain why you have to prepare for malaria epidemics, and list the supplies and drugs you need in reserve in case an epidemic occurs. (SAQs 12.1 and 12.3)

12.5 Explain the measures that can be taken to prevent malaria epidemics. (SAQ 12.4)

12.6 Describe how to use early warning and detection tools for malaria epidemics. (SAQs 12.1 and 12.5)

12.7 Describe the measures used to control malaria epidemics. (SAQ 12.6)

12.8 Describe the importance of post-epidemic evaluation. (SAQ 12.7)

12.1 What is a malaria epidemic?

An **epidemic**, in general, is defined as the occurrence of cases *in excess* of the number *expected* in a given place and time period. **Malaria epidemics** are defined in this way.

In some places, malaria transmission increases after the rainy season and then decreases during the dry season every year. If this is what normally occurs in your village, then an abnormal increase above this normally expected seasonal variation is considered an epidemic.

■ Imagine that your village is in an area where there is no malaria. How many malaria cases would be expected? Giving reasons, say how many malaria cases would have to occur in your village for an epidemic to be recognised?

□ Zero malaria cases would be expected. If even one case of malaria occurs in the village, then this would be recognised as a malaria epidemic, because it is *more* than the number that would be *expected* in this village.

In order to know whether there is malaria in the village you are working in, look at the patient register in your Health Post and see if there are malaria cases for the past three to five years. If there are malaria cases, and the patients had no travel history to a malarious area prior to their infection, then your village is in a malarious area. If there are no malaria cases for these years, then your village is malaria-free.

12.2 Factors that trigger epidemics

In Study Session 7 you learned about factors that affect the transmission of malaria. In this section you will learn how some of those factors are also associated with the occurrence of malaria epidemics.

The 'host' is the infected organism — in malaria, the host is always a human.

Malaria epidemics are triggered by factors linked to the human host, the mosquito vector (the environment) and malaria parasites, as you can see in Figure 12.1. The change or disruption of the 'balance', between these three factors at any one time may increase the likelihood of an epidemic. That is, there is an increased risk of a malaria epidemic, if there is an increase in:

- the susceptible human population
- the number of mosquito vectors
- an increase in the number of people who have the malaria parasite in their blood.

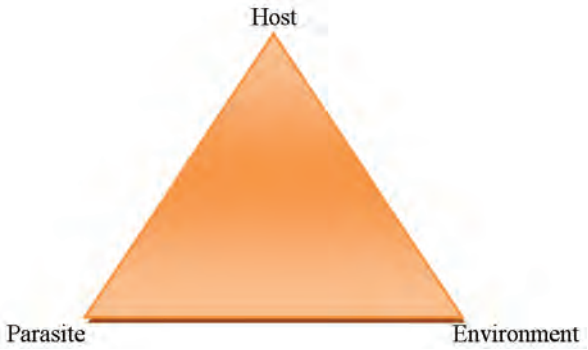


Figure 12.1 The three factors that affect the malaria transmission (host, parasite and environment).

You need to carefully and closely monitor changes in these factors in order to predict the risk of an epidemic. How some of these factors can be monitored is described next.

12.2.1 Environmental factors

Temperature, humidity and rainfall are major environmental factors affecting the development of both mosquitoes and parasites, as you learned in Study Session 6.

Higher environmental temperatures, between 22°C and 30°C, increase the potential lifespan of mosquitoes, and also increase the frequency of blood meals taken by female mosquitoes. Higher temperatures also speed up development of the mosquito larvae, shortening the amount of time it takes the mosquito to develop from egg to adult. All these increase the risk of malaria transmission.

■ Can you mention the stages of the lifecycle of the *Anopheles* mosquito?

□ Egg →larva → pupa → adult.

Increased rainfall generally leads to the creation of new water pools, allowing mosquitoes to breed in larger numbers. Increased rainfall also leads to increased humidity. On the other hand, sometimes during the *dry* season, rivers and streams can shrink to create water pools, making them ideal for mosquito breeding.

So observing significant changes in rainfall, temperature and humidity in your village can help you assess the risk of malaria epidemics.

12.2.2 Human factors

Immunity

Lack of immunity or low immunity to malaria in the human population makes epidemics more likely. In areas of unstable transmission, such as Ethiopia, population immunity is generally low, so epidemics are more likely. Indeed, malaria is a risk in 75% of the villages in Ethiopia and epidemics can occur in those villages.

Migration

Movements of people can contribute to malaria epidemics in two ways. First, people with malaria moving into an area where malaria has been controlled or eliminated can be sources of *Plasmodium* parasites for local mosquitoes, precipitating an epidemic. Second, non-immune people moving to areas where malaria is highly endemic can cause an apparent epidemic, as they are more susceptible than the local population to malaria.

Interruption of vector control efforts

In Study Sessions 9, 10 and 11 you learned that larval control, indoor residual spraying (IRS) of households with insecticides, and use of insecticide treated nets (ITNs), are important malaria prevention tools. If the implementation of these measures is stopped, vector populations and thus malaria transmission may increase dramatically. Similarly, epidemics can occur if vectors become resistant to insecticides and are no longer killed by spraying.

12.2.3 Parasite factors

Drug resistance

Use of non-effective drugs may cause a malaria epidemic since *Plasmodium* infections will not be properly cleared, allowing parasites to stay longer in the blood of an infected person. This increases the number of people who carry the parasite in their blood, which in turn increases the opportunities for the mosquito vector to take an infected blood meal and then transmit parasites to new susceptible hosts.

12.3 Preparedness for malaria epidemics

As you have learned above, malaria epidemics can be triggered by a variety of factors, making it difficult to predict an occurrence. As malaria epidemics could occur in all malaria prone areas at *any* time, you need to be prepared for them at *all* times.

At Health Post level, preparedness includes having a stock of anti-malarial drugs, RDTs, insecticides and other supplies that are important to prevent or contain a malaria epidemic, *in addition* to the amount that is required for normal situations. This added amount (25% of the annual need) is called a **contingency stock**. You must keep the contingency stock in your store for use during epidemics. Following an epidemic, the contingency stock should be replenished.

■ If the usual annual requirement of the anti-malarial drug Coartem for your village is 800 doses, calculate the contingency requirement for the year. What is the total requirement of Coartem for your Health Post?

□ The contingency requirement is 200 doses. (To calculate the contingency multiply 800 by 25% or by 0.25. This gives 200 doses.) The total doses of Coartem required for the year for your Health Post is therefore 800+200 which is equal to 1,000 doses.

In this way, you should calculate the contingency stock for all the drugs and supplies listed in Box 12.1 below, and keep them in your store. If an epidemic does not occur, make sure you use the contingency stock before the expiry date.

Box 12.1 List of drugs and supplies needed in your contingency stock for a possible malaria epidemic

- Chloroquine tablets
- Chloroquine syrup
- Coartem tablets
- Quinine tablets
- Artemether injections
- Artesunate suppositories
- Multi-species Rapid Diagnostic Tests (RDTs)
- Insecticides for indoor residual spraying (IRS)
- Temephos for larval control.

12.4 Prevention of epidemics

Epidemic prevention depends on close monitoring of the epidemic-triggering factors described in Section 12.2. If you suspect that there is a favourable condition for malaria epidemics to occur, you must implement the following prevention activities immediately.

Indoor residual insecticide spraying (IRS)

In some villages IRS is undertaken every year in anticipation of epidemics following the rainy season. In other areas IRS is done when there is a change in one or more epidemic-triggering factors and the risk of an epidemic seems high. It is essential to apply IRS *before* the malaria transmission season or the anticipated epidemic. In this way it can have a significant effect on the incidence of transmission and reduce the likelihood of an epidemic.

Larval control

This is another important measure to prevent epidemics. As you learned in Study Session 9, anti-larval measures can easily be organised by mobilising the community. They are also cheap to implement. Larval control measures can only be implemented very close to or during the transmission season.

Insecticide treated nets (ITNs)

Providing ITNs to 100% of households in malaria-risk villages aims to reduce the risk of malaria epidemics.

12.5 Detection of malaria epidemics

In this section you will learn about methods for the **early detection** of malaria epidemics. Early detection means recognising potential epidemics as early as possible, so action can be taken to contain them before they get out of control and affect a large number of people. As a Health Extension Practitioner, you are the first to take action against any malaria epidemic that is detected.

Two major early detection methods for malaria are used in Ethiopia:

- Constructing an epidemic monitoring chart, using the 'second largest number' method;
- Doubling of weekly malaria cases compared to last year's data.

These methods are described below.

12.5.1 Epidemic monitoring charts using 'second largest number' method

An **epidemic monitoring chart** is a chart drawn on a large sheet of paper. The x-axis (bottom or horizontal axis) of the chart shows the number of weeks, and the y-axis (the left-side, or vertical axis) shows the number of malaria cases (see Figure 12.2 on the next page).

The epidemic monitoring chart is a tool that you can use only if you have data on malaria cases for the past five years.

You construct the epidemic monitoring chart using the second largest number seen on a weekly basis, in order to determine the *expected* number of malaria cases in your village.

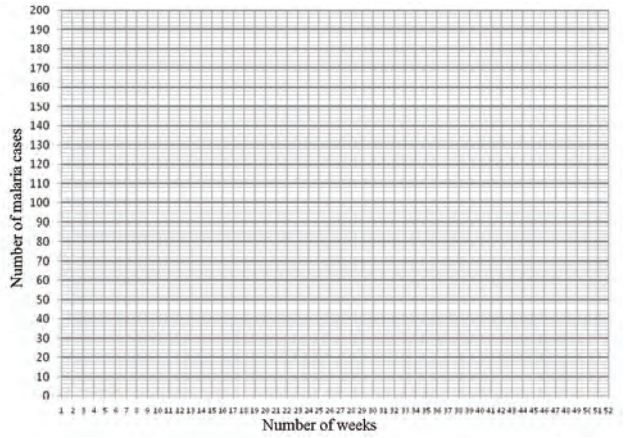


Figure 12.2 Epidemic Monitoring Chart. (You will use this to complete SAQ 12.5.)

Weeks are labelled as 1, 2, 3, 4 up to 52, which sometimes becomes 53. They are World Health Organization (WHO)'s epidemiological weeks. Week 1 always starts around the end of Tahsas. Note that every week starts on Monday and ends on Sunday. Table 12.1 shows the exact dates of the start of the weeks for the Ethiopian calendar (EC) for 2003, 2004, 2005 and part of 2006. Following the same pattern, you can calculate the week number for any year in the future.

Table 12.1 WHO epidemiological weeks for 2003–2006 in the Ethiopian calendar (EC).

Week No	2003/2004 EC	2004/2005EC	2005/2006 EC
Week 1	Tahsas 25–Tir 1/2003	Tahsas 23–29/2004	Tahsas 22–28/2005
Week 2	Tir 2–8/2003	Tahsas 30–Tir 6/2004	Tahsas 29–Tir 5/2005
Week 3	Tir 9–15/2003	Tir 7–13/2004	Tir 6–12/2005
Week 4	Tir 16–22/2003	Tir 14–20/2004	Tir 13–19/2005
Week 5	Tir 23–29/2003	Tir 21–27/2004	Tir 20–26/2005
Week 6	Tir 30–Yekatit 6/2003	Tir 28–Yekatit 4/2004	Tir 27–Yekatit 3/2005
Week 7	Yekatit 7–13/2003	Yekatit 5–11/2004	Yekatit 4–10/2005
Week 8	Yekatit 14–20/2003	Yekatit 12–18/2004	Yekatit 11–17/2005
Week 9	Yekatit 21–27/2003	Yekatit 19–25/2004	Yekatit 18–24/2005
Week 10	Yekatit 28–Megabit 4/2003	Yekatit 26–Megabit 2/2004	Yekatit 25–Megabit 1/2005
Week 11	Megabit 5–11/2003	Megabit 3–9/2004	Megabit 2–8/2005
etc.	etc.	etc.	etc.
Week 35	Nehase 23–29/2003	Nehase 21–27/2004	Nehase 20–26/2005
Week 36	Nehase 30–Pagume 6/2003	Nehase 28–Pagume 4/2004	Nehase 27–Pagume 3/2005
Week 37	Meskerem 1–7/2004	Pagume 5–Meskerem 6/2005	Pagume 4–Meskerem 5/2006
Week 38	Meskerem 8–14/2004	Meskerem 7–13/2005	Meskerem 6–12/2006
etc.	etc.	etc.	etc.
Week 51	Tahsas 9–15/2004	Tahsas 8–14/2005	Tahsas 7–13/2006
Week 52	Tahsas 16–22/2004	Tahsas 15–21/2005	Tahsas 14–20/2006

Steps for plotting an epidemic monitoring chart

To establish a threshold or reference line for the expected number of malaria cases, you need to have data for malaria cases over the past five years, week by week (as shown in Table 12.2). Using the data you need to follow the steps below to graphically plot the relevant information on the epidemic monitoring chart. This will help you to detect a possible malaria epidemic as early as possible.

Table 12.2 The number of malaria cases per numbered week in each year from 1998–2002 (EC), the second largest number of cases per numbered week over this period, and the number of cases per week in the current year (2003).

Week No.	1998	1999	2000	2001	2002	Second largest number (1998–2002)	Current year (2003)
1	8	42	6	36	14	36	20
2	12	42	27	38	17	38	22
3	10	42	43	49	21	43	35
4	20	17	34	59	32	34	37
5	34	17	46	20	30	34	36
6	18	10	34	22	23	23	30
7	12	19	33	24	25	25	29
8	37	10	27	41	23	37	32
9	32	18	37	29	26	32	30
10	31	24	28	17	13	28	25
11	22	19	22	12	23	22	
.	.	.	.	.	.	.	.
51	26	40	34	32	39	39	
52	23	35	10	27	25	27	

Step 1 The villages that your Health Post serves is your catchment area. Therefore the data you use to determine the upper limit of the expected number of malaria cases are the cases from your catchment area.

Step 2 Check whether your data are arranged in weeks, as indicated in Table 12.2. One of the sources of the weekly data is the weekly surveillance report that you send to the higher level health facility. The weeks you use are the same as those used in your weekly surveillance report.

Step 3 Tabulate your malaria case data for the previous five to six years (as in Table 12.2). Look at the data: if there was a major epidemic with a large number of malaria cases in the previous five years ignore that year and consider data from the year before.

Step 4 If you have weekly data on malaria cases for five years, note the *second largest number* of cases from the previous 5 years' data for a particular week. For example in the five years from 1998 to 2002 (EC), the *second largest number* of cases during week one is 36, and in week two it is 38 (see Table 12.2). Identify the second largest number of cases for each of the 52 weeks.

Step 5 Plot the *second largest number* for each week on the epidemic monitoring chart. The line in blue ink in Figure 12.3 is a plot of the upper limit or second largest number, based on the data in Table 12.2. (Note that not all the data plotted in Figure 12.3 are shown in Table 12.2, for reasons of space). This line represents the normal upper limit for the *number* of cases, or the *expected* cases of malaria, in the catchment area. It is called the **reference line**, because it serves as a reference point with which to compare weekly data on malaria cases for the following year.

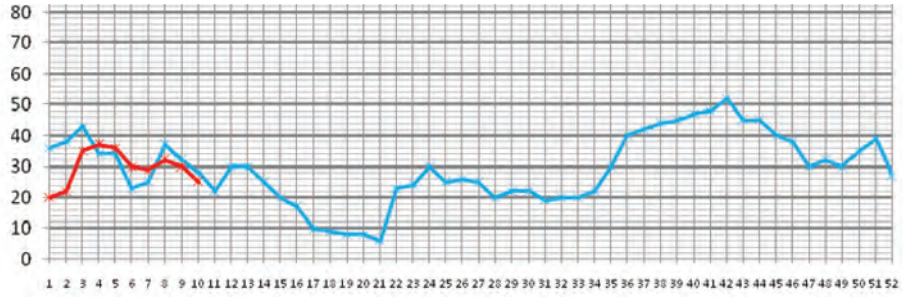


Figure 12.3 Sample epidemic monitoring chart with reference line (blue) plotted using the second largest number of cases per numbered week from 1998–2002 (see Table 12.2). The red line shows the number of cases of malaria in the 'current' year, 2003 (see data in Table 12.2).

Step 6 During the following year (in the case of Table 12.2 this is 2003, EC), using a different colour of ink, plot the number of malaria cases seen each week on the epidemic monitoring chart (on which you already have the reference line). Plot the previous week's data on Monday morning.

Step 7 If the number of cases for a particular week in 2003 exceeds the number on the reference line, it indicates the beginning of an epidemic. For example in Table 12.2, in weeks 4, 5 and 6, the number of malaria cases seen are *above* the reference line. Therefore, by definition, there is an epidemic in these weeks. We say an epidemic has stopped when the weekly number of cases drops *below* the reference line.

Step 8 After data from all 52 weeks have been plotted for comparison with the reference line, you should draw a new reference line, using the most recent five-year data, to use for the following year. For example in Table 12.2 you would drop the 1998 data, and using the 1999–2003 data, identify a *new* second largest number for each week. Then using the new second largest number, you would plot the new reference line, against which you would plot data from 2004.

12.5.2 'Doubling of cases in a week method'

Doubling of the number of malaria cases in a given week compared to the same week in the previous year is another method used to detect epidemics early. You can use this method when you have less than five years of previous data (see Table 12.3). For example, if you only have data from 2003 that is broken down into weeks, you can compare data from the current year (2004, in this example) with the number of cases in the *same* week from the *previous* year, 2003. That is, you should compare Week 1 of 2003 with Week 1 of 2004, and so on.

You declare an epidemic if the number of cases in a particular week is double, or more than double, the number of cases in the same week of the previous year. For example in the data shown in Table 12.3, the data cases are doubled, or more than that, in Weeks 4 and 5.

Table 12.3 The weekly number of malaria cases for 2003 and 2004 (EC).

Week No.	2003	This year (2004)
Week 1	20	19
Week 2	22	20
Week 3	35	35
Week 4	37	74
Week 5	36	75
Week 6	30	38
Week 7	29	29
Week 8	32	29
.	.	.
Week 51	20	33
Week 52	25	31

If you do not have last year's data, then you can compare last *week's* data with *this* week. If cases become doubled, or more than double, in this week, then you can consider it as an epidemic.

12.6 Epidemic control

If, using the methods described above, you detect a malaria epidemic, you must implement epidemic control measures *immediately*. You should also start searching for cases actively (active surveillance is described below) until the number of cases falls below the reference line. The epidemic control measures and actions you should take are summarised in the flow chart in Figure 12.4 on the next page.

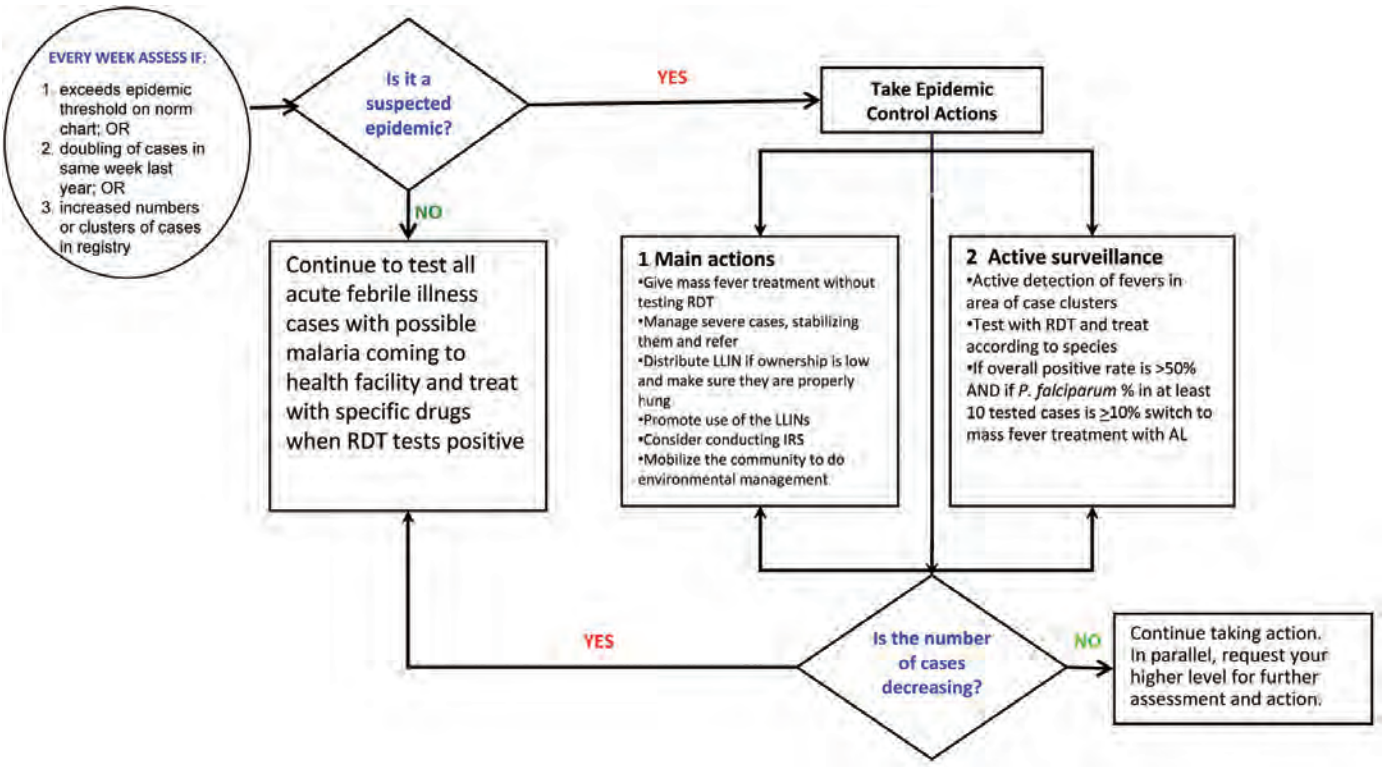


Figure 12.4 Flow chart for the early detection of malaria epidemics, and for control measures and actions to be taken if an epidemic is detected. (Source: Adapted from Ethiopian Federal Ministry of Health, *Guidelines for Epidemic Prevention and Control in Ethiopia*, 3rd edition, 2010)

12.6.1 Epidemic control measures

Mass fever treatment

Once a malaria epidemic is detected and confirmed, treat all those people with fever *without testing* with RDTs. This is called **mass fever treatment**. Give Coartem to treat cases during mass fever treatment, unless the epidemic is definitely confirmed to be caused by *P. vivax* only, in which case you can use Chloroquine. Oral quinine is recommended for the treatment of infants of less than 5 kg body weight or less than four months old, and pregnant women with uncomplicated malaria (for dosage see Study Session 8). Severe cases should be treated as indicated in Study Session 8.

Vector control

Implement the following vector control measures immediately:

ITNs: If ITN coverage is low or if existing ITNs are worn out, distribute ITNs and make sure that they are hung properly and used by all family members.

Indoor residual spraying of all houses (IRS): This has a quick impact on transmission. In an epidemic this technique is highly reliable and recommended since its efficacy has little or no dependency on human behaviour.

Larval control: This should be undertaken by mobilising and organising the community to take action.

12.6.2 Active surveillance

After mass fever treatment, actively search for fever cases, test with RDTs and treat them according to the species of *Plasmodium* detected. Continue **active** surveillance until the number of cases has decreased to normal levels or to zero.

12.7 Post-epidemic assessment

So far in this study session you have learned how to prepare for, detect and control malaria epidemics. However, sometimes malaria epidemics occur in spite of your best efforts. In such cases you need to assess various aspects of the epidemic after it is over. The aim of **post-epidemic assessment** is to learn lessons that may strengthen your preparedness, detection, prevention and control methods in case of future epidemics.

12.7.1 Assess adequacy of epidemic detection and response

Some of the questions you should ask during post-epidemic assessment are:

- Did you use an epidemic monitoring chart?

If yes,

- How effective was it in detecting the epidemic early?
- How adequate were your contingency stocks?
- How speedy were your actions for vector control?
- How successful were your case management activities?

Careful post-epidemic assessment will show the strengths and weaknesses of the system in place at your Health Post level and of your actions in tackling the epidemic. The investigation should focus on how efficient the system was in *confirming* the epidemic, the status of *preparedness* (drugs, insecticides, logistics, etc), the *timing* and *impact* of intervention measures, and the *participation* of the community and other partners. Identify both the strengths and weaknesses of the response to the malaria epidemic so you can build on the strengths and take appropriate actions to correct weaknesses. Your report or assessment will help you and your supervisors to improve the epidemic response system.

The following indicators will help you to monitor the success of your interventions.

Input indicators

- Availability and quality of active epidemic monitoring
- Stockpile of anti-malaria commodities, mainly RDTs, Coartem and other anti-malarial drugs and insecticides
- Community participation.

Process indicators

- Number of houses sprayed
- Number of larval control measures
- Number of trained village volunteers for emergency interventions such as spraying.

Output indicators

- Volunteers trained and people educated
- High coverage of vector control measures (LLINs and IRS).

Outcome indicators

- Time taken by cases to seek treatment
- Adherence to treatment
- Percentage of patients developing severe disease who were referred
- Flattening or sharp falling of the epidemic curve.

Summary of Study Session 12

In Study Session 12, you have learned that:

1 A malaria epidemic is defined as the occurrence of cases in excess of the number expected in a given place and time period.

2 The factors that trigger the occurrence of malaria epidemics are linked to environmental factors, human factors and parasite-related factors; the change in the balance between these factors leads to malaria epidemics.

3 It is important to get prepared by having 25% contingency stock of anti-malaria drugs and other supplies to control unexpected malaria epidemics that might happen at any time.

4 The three major interventions that you have to implement to prevent the occurrence of predicted malaria epidemics are indoor residual insecticide spraying, larval control, and distribution and correct use of ITNs.

5 The two main methods you use to detect malaria epidemics as early as possible are construction of an epidemic monitoring chart using the second largest number method, and the use of doubling of weekly malaria cases compared to last year's data.

6 To contain a malaria epidemic, you implement mass fever treatment and vector control measures.

7 Post-epidemic assessment of the response to malaria epidemics helps to evaluate the weaknesses and strengths of the response activities for better preparation for future epidemics.

Self-Assessment Questions (SAQs) for Study Session 12

Now that you have completed this study session, you can assess how well you have achieved its Learning Outcomes by answering the questions below. Write your answers in your Study Diary and discuss them with your Tutor at the next Study Support Meeting. You can check your answers with the Notes on the Self-Assessment Questions at the end of this Module.

SAQ 12.1 (tests Learning Outcomes 12.1, 12.2, 12.3, 12.4 and 12.6)

Which of the following statements is *false*? In each case, state why it is incorrect.

A Malaria epidemics are defined as the occurrence of cases *in excess* of the number *expected* in a given place and time period.
B Malaria epidemics can sometimes occur during the dry season.
C The contingency stock of Chloroquine tablets is 25% of the stock that is required to treat all *P. vivax* cases in a non-epidemic year.
D The reason why you use an epidemic monitoring chart or doubling of weekly cases at Health Post level is to detect epidemics early and report to district level without taking any control measures.

SAQ 12.2 (tests Learning Outcome 12.3)

Assume your village is located in a malaria epidemic risk area. An unusually heavy rain in your area ended one week ago. Now the weather becomes full of sunshine. About 500 migrant workers come to your village from a non-malarious area one week after the rain ends to work on agriculture. From this story list the factors that might trigger a malaria epidemic.

SAQ 12.3 (tests Learning Outcome 12.4)

List the drugs and supplies that you are required to keep in your contingency stock.

SAQ 12.4 (tests Learning Outcome 12.5)

What are the main malaria epidemic prevention strategies?

SAQs 12.5, 12.6 and 12.7 are on the next page.

SAQ 12.5 (tests Learning Outcome 12.6)

Table 12.4 contains seven years of weekly data on malaria cases. Study the table and then answer the questions below it.

Table 12.4 Weekly malaria cases in 1998–2004.

Week No.	1998	1999	2000	2001	2002	2003	second largest number	This year (2004)
1	16	42	105	36	14	42		33
2	12	42	100	38	17	22		35
3	16	42	103	49	21	34		40
4	20	17	134	59	32	40		39
5	34	17	146	20	30	39		33
6	18	10	134	29	23	27		30
7	30	19	133	24	25	25		29
8	37	10	127	41	23	42		42
9	32	18	137	29	26	29		35
10	31	24	128	17	13	32		30
.	.	.	.	.	.	.		.
51	26	40	134	32	39	39		.
52	23	35	110	27	25	33		.

(a) Which year do you think the data shows an abnormally high number of malaria cases? What do you do with this year before you start identifying the second largest number?
(b) Identify the second largest number for the six years of data (1998–2003) and fill in the column in the table.
(c) Use the blank epidemic monitoring chart in Figure 12.2 to plot a reference line of the second largest numbers and the data for the year 2004 against it.
(d) Does the graph show weeks when an epidemic occurred? If yes, in which weeks?

SAQ 12.6 (tests Learning Outcome 12.7)

What is mass fever treatment and which drug do you use for it?

SAQ 12.7 (tests Learning Outcome 12.8)

What do you think is the benefit of post-epidemic assessment?

Notes on the Self-Assessment Questions (SAQs) for *Communicable Diseases*, Part 1

Study Session 1

SAQ 1.1

Diabetes mellitus is not communicable; rather it is non-communicable for the following reasons:

- The main cause of the disease is not an infectious agent
- It cannot be transmitted from a person with diabetes mellitus to another person.

SAQ 1.2

C *Protozoa* is the correct answer. This group of infectious agents are single-celled organisms, which are bigger than bacteria but not visible with the naked eye.

SAQ 1.3

A The infectious agents are hookworms.
B Humans are the reservoir for this parasite.
C The mode of transmission is indirectly by contaminated soil.
D The route of exit is through the anus with faeces, and the route of entry is through the skin.

SAQ 1.4

The risk factors for hookworm infection include walking barefooted and poor environmental hygiene due to expelling faeces into the soil.

SAQ 1.5

(a) The likely modes of transmission are contaminated food and water served in the café.
(b) Abebe and two of the five infected persons who did not develop the disease are carriers; whereas the three persons who developed the disease are active cases.
(c) All the 20 people who Abebe served in the cafe were in the stage of exposure. Only five of these persons were infected and hence were in the stage of infection. Among the five infected, the three who developed typhoid fever were in the stage of infectious disease. And among these, the stage of outcome for two was recovery and for one it was death.

Study Session 2

SAQ 2.1

Using the given information, the classification could be based on the clinical manifestations of the disease (cough and shortness of breath); accordingly tuberculosis is classed as a respiratory disease.

SAQ 2.2

Pulmonary tuberculosis is classified epidemiologically as an airborne disease. Such classification helps you in applying prevention and control measures against the disease.

SAQ 2.3

(a) Treatment of each patient targets the human reservoir.
(b) Eradication of breeding sites targets the mode of transmission.
(c) Bed net use targets the susceptible host.

SAQ 2.4

A is *false*. It is true that isolation is applied for severe and easily transmitted diseases, but it is applied to the *infected* hosts (not the susceptible hosts) until the risk of transmission is reduced or stops.
B is *true*. Sterilisation kills all forms of micro-organisms, unlike disinfection which kills most but not all forms.
C is *false.* Vaccination mostly targets the *susceptible* host and vector control targets the mode of transmission.

SAQ 2.5

(a) The other criteria to be considered include the severity of the diseases, the feasibility of implementing effective interventions, and the concern of the community and the government.
(b) Malaria has priority in two out of the five criteria: that is severity, community and government concern, whereas ascariasis has priority in only one criterion, which is the higher prevalence. Both diseases have equal priority in feasibility of implementing interventions. Therefore, malaria should be given higher priority for prevention and control.

Study Session 3

SAQ 3.1

Pneumonia, meningitis, tuberculosis, pertussis and diphtheria all have the same mode of transmission: they are airborne bacteria.

SAQ 3.2

The preventive strategies of meningitis include early case identification and treatment, education of the community on the preventive methods such as avoiding close contacts with meningitis cases, and vaccination against meningitis.

SAQ 3.3

Fever, neck stiffness and rigid posture (as in Figure 3.6) are the signs of meningitis in a child. A young baby will also have bulging of the fontanelle. Tetanus can also be manifested with rigid posture. You should immediately inform the family and refer the child to hospital for urgent diagnosis and treatment.

SAQ 3.4

Neisseria meningitidis and *Streptococcus pneumoniae* are the two major bacteria that cause meningitis in children and adults. The two bacteria have similar symptoms (Table 3.1) and it is difficult to differentiate them by symptoms alone. As a Health Extension Practitioner, you need to refer patients with symptoms of meningitis to the nearest hospital or health centre.

Study Session 4

SAQ 4.1

A is true. Pneumonia and clouding of the cornea are two of the common complications of severe measles.
B is *false.* Measles can be fatal, particularly in malnourished children. Around 165,000 children died of measles worldwide in 2008.
C is *false.* The transmission of poliovirus is easily prevented by routine vaccination of all children. The aim is to eradicate polio totally from the world by this measure.
D is true. Acute flaccid paralysis (AFP) is a rare complication of polio; most children infected with poliovirus show no symptoms.
E is *false.* 90% of adults infected with hepatitis B virus (HBV) will get rid of the virus from their bodies within six months.
F is true. Jaundice is a common complication of hepatitis B disease.

SAQ 4.2

The child is showing the characteristic signs of measles, and in his case the ear infection shows the illness is severe. For severe measles cases, give the child the first dose of vitamin A according to his age, and refer him immediately to the nearest health centre. He may need antibiotics to treat the ear infection and prevent other complications.

SAQ 4.3

The completed version of Table 4.2 is shown below.

Table 4.2 Modes of transmission and prevention of three common viral diseases.

Disease	Mode of transmission	Prevention
measles	Respiratory route	measles vaccination and vitamin A drops
polio	Faeco-oral route	oral polio vaccination
hepatitis B	Unprotected sex or other contact with infected blood or body fluids	hepatitis B vaccination

Study Session 5

SAQ 5.1

P. falciparum is the most likely cause of the infection, because the symptoms began after 8 days. The period between infection with the parasites that cause the disease and the beginning of malaria symptoms (incubation period) for *P. falciparum* is 7–14 days. It is longer for the other species of *Plasmodium*.

SAQ 5.2

- Malaria incidence is high in countries around the tropics or closer to the equator.
- It is low in northern and southern African countries.

SAQ 5.3

- Malaria incidence is high in the western lowlands of Ethiopia where the temperature and humidity is high and favourable for mosquito and parasite development.
- There is no malaria in the highlands because of low temperature.
- There is less malaria in the eastern lowlands because rainfall and humidity are low.

SAQ 5.4

The body parts directly associated with the development and reproduction of the malaria parasites are:

- Mosquito: gut and salivary glands.
- Human: liver and red blood cells.

SAQ 5.5

A is *false*. The malaria vector mosquito lays its eggs on water surfaces (not grass).

B is true. The malaria vector life cycle has four stages: eggs, larvae, pupae and adults.

C is true. The mosquito needs to feed on human or animal blood to develop its eggs.

D is *false*. The adult female mosquito lays eggs several times in its life cycle.

E is *false*. The stage that hatches from the eggs is the larvae.

SAQ 5.6

Two characteristics that distinguish the *Anopheles* larvae from other types are:

- It has no breathing siphon.
- It rests parallel or horizontal to the water surface.

SAQ 5.7

(a) Yes; the 10% of mosquitoes living more than 10 days will have the potential to transmit malaria.

(b) Malaria transmission will be higher in September because a larger percentage of mosquitoes live more than 10 days during September.

Study Session 6

SAQ 6.1

There will be malaria transmission in September, but not in February. At 40% humidity, mosquitoes cannot live long enough to transmit malaria in February.

SAQ 6.2

A daily average temperature of 12°C is not enough for the parasites to develop inside the mosquito vector. It is too cold.

SAQ 6.3

- Located at 1,000 metres above sea level, your village will have favourable temperatures for mosquito growth and parasite development.
- High vegetation coverage increases humidity and high humidity helps the vector to live longer; malaria is transmitted by long-living vectors.

SAQ 6.4

The rains create several vector breeding grounds; many vector breeding sites produce many vectors; more vectors mean more malaria transmission.

SAQ 6.5

- *An. arabiensis* will be a better vector of malaria.
- Mosquitoes that prefer to feed on humans have a better chance of picking up the parasite from an infected person and transmitting it to another person.

SAQ 6.6

- Village A will have more deaths due to malaria than village B.
- *Falciparum* malaria is the more dangerous form of malaria that often causes deaths; people very rarely die of *vivax* malaria.

Study Session 7

SAQ 7.1

The RDT or Rapid Diagnostic Test for malaria is available at health post level.

SAQ 7.2

You would ask him about his travel history to malaria-endemic areas in the last two weeks. You would also ask him if he has had fever in the last two to three days.

SAQ 7.3

The danger signs of severe malaria are anaemia, convulsions, repeated vomiting, high fever (>39°C), shivering, sweating, severe dehydration, drowsiness or confusion, and reduced urine output.

SAQ 7.4

- The RDT is simpler than microscopy and can be easily handled at health post level, whereas microscopy tests can only be done at a health centre.
- RDT results are ready within 15–20 minutes, whereas microscopy tests may take much longer as the patient has to go to the health centre.

SAQ 7.5

Write each patient's name on the RDT cassette to avoid mixing-up the results if you have to do several tests at the same time.

SAQ 7.6

- Wear gloves when handling blood from patients.
- Use one pair of gloves for each patient.
- Swab the patient's finger with alcohol before and after pricking it with the lancet.
- Use one lancet for each patient.
- Dispose of the lancet and gloves safely immediately after use.

SAQ 7.7

(a) Refer the child to the health centre for microscopic examination of his blood; RDT positive results after three days of anti-malaria treatment are not reliable, because RDTs can give a positive test up to two weeks after treatment.

(b) The advantages of microscopy over RDT are:

- Microscopy can tell you if parasites are cleared and a patient is cured immediately after anti-malarial treatment.
- Microscopy can tell you the number of parasites in the patient's blood; a high number of parasites could mean a high risk of developing severe complicated malaria.

Study Session 8

SAQ 8.1

A is *false*. Supportive treatment is what is given to treat other conditions at the same time as the malaria treatment. It is not the supportive treatment that kills the parasites; rather it is the anti-malaria drugs that you give to the patient that kills the parasites in the blood circulation.
B is true. Malaria patients with high grade fever should be given supportive treatment such as paracetamol tablets, or cooling the body of the patient with clean pieces of cloth dipped in slightly warm water, or by fanning.
C is *false*. Malaria patients with moderate dehydration should be given oral rehydration salts (ORS) as supportive treatment. The patient should also be advised to drink increased amounts of clean water or other fluids.
D is true. If the temperature is normal, there is no sign of dehydration and no anaemia, you do not need to give supportive treatment to a malaria patient even if she is breastfeeding. Just treat the malaria.
E is true. Malaria patients with mild or moderate anaemia should be treated with ferrous sulphate (iron tablets) 200 mg once daily for two months, and advised to return for recheck in two months.

SAQ 8.2

If you diagnose malaria clinically (if there is no RDT) you give the patient Coartem, unless the patient is a pregnant woman in the first trimester, or an infant under 5 kg or under four months (they get quinine tablets instead).

Coartem is given two times a day (in the morning and in the evening) for three days. The first dose is given in front of you immediately after the diagnosis of malaria. The rest of the drug is given to the patient/ caregivers to take at home.

SAQ 8.3

Give pre-referral treatment to Malomo (one 50 mg rectal suppository of Artesunate — see Table 8.4) and immediately refer him to the nearest health centre.

SAQ 8.4

Severe malaria should be referred to the health centre very fast. Before referring the patient it is important to give a pre-referral treatment with rectal Artesunate (or intramuscular injection of Artemether, if available). This will help to prevent the patient's condition from getting worse.

SAQ 8.5

If the patient does not adhere to the treatment he or she will not get cured completely and the disease will come back. It also leads to the development of resistance to the drug by the malaria parasites.

SAQ 8.6

(a) Uncomplicated malaria is the diagnosis you should give to Beka.

(b) Coartem is the correct treatment for a child of five years. The full dose is 12 tablets. Beka takes two tablets in the morning and two tablets in the evening for three days. You give two tablets to swallow immediately and give the remaining 10 tablets to Beka's mother to take home.

(c) Advise Beka's mother on the following issues:

- Tell her the reason for giving the drug.
- Demonstrate to her on how to give the correct dose.
- Tell her to watch while Beka is taking each dose of the drug.
- Explain that the drugs must be finished even if Beka feels well.
- Advise her on when to return if Beka does not improve.

Study Session 9

SAQ 9.1

A is *false*. Larviciding is a method of killing mosquito larvae using chemicals or toxins; not the adults.

B is true. Temephos is a chemical widely used as larvicide in Ethiopia.

C is true. Temephos is sprayed to vector breeding water collections using spray pumps.

D is *false*. Temephos can be sprayed by HEWs or community health workers.

E is *false*. Larviciding is done in vector breeding sites that cannot be treated through environmental management measures.

SAQ 9.2

Borrow-pits, micro-ponds, stream beds, irrigation canals, swamps, and road ditches can serve as water collection sites and thus vector breeding grounds. Houses and trees are not water collection places and cannot be vector breeding sites. Foul smelling polluted water is not good for breeding of malaria transmitting mosquitoes.

SAQ 9.3

Rainfall creates several water collections that serve as vector breeding grounds. Small rain water pools are the most important breeding sites for the main vector of malaria in Ethiopia.

SAQ 9.4

You may have thought of removing water plants from water collections, removing obstructions from streams, flushing, shading ponds and river banks, etc.

SAQ 9.5

You may have thought of filling of pits and depressions, levelling uneven ground, shore lining, planting trees to drink up ground water, etc.

SAQ 9.6

(a) 960 m^2 divided by 320 m^2 = 3, so you need three spray pumps of Temephos to treat the vector breeding site.
(b) 3 multiplied by 8 ml of Temephos in each spray pump = 24 ml of the chemical to treat the vector breeding site.

SAQ 9.7

Women's and youth associations, cooperatives, health committees, schools and religious leaders and community leaders, all may help you to mobilize local people to undertake larval control activities.

Study Session 10

SAQ 10.1

Walls of houses, animal shelters and latrines, as well as household furniture, can serve as resting places for blood-fed mosquitoes, and should be sprayed with insecticides.

Streams, lakes and rivers are not resting places for adult mosquitoes.

SAQ 10.2

A is true. Blood-fed mosquitoes can rest either indoors or outdoors.
B is *false*. Mosquitoes that rest outside houses are *harder* to control using IRS.
C is *false*. After taking a blood meal mosquitoes rest for about two days (not 10 days) before laying eggs.
D is *false*. Blood-fed mosquitoes do not usually rest on the outside walls of houses. They prefer shaded and undisturbed sites.
E is true. IRS only kills mosquitoes entering and/or resting in sprayed houses.

SAQ 10.3

You have to request the following items from the District Health Office:

- Spray pumps, insecticides, spray pump spare kits, tool kits for pump maintenance, personal protective equipment.
- At the community level you have to select and train spray operators.

SAQ 10.4

- The spray pumps used in Ethiopia have eight litres capacity.
- One spray pump full of insecticide can spray 200 m^2 of surface area.

SAQ 10.5

(a) 800 households multiplied by 1.5 housing units per household = 1,200 housing units.
(b) 900 housing units were sprayed. Therefore 1,200 – 900 = 300 housing units were unsprayed.
(c) The coverage of this IRS operation is (900/1,200) × 100 = 75%.
(d) The coverage is not acceptable; the minimum coverage acceptable for IRS to be effective is 85%.

SAQ 10.6 (tests Learning Outcome 10.6)

(a) Ten days. This is worked out as follows: there are 500 × 2 = 1,000 housing units. Number of units 5 spray operators can spray in one day = 5 (spray operators) × 20 (units each operator sprays in a day) = 100 units. So the number of days to spray the entire village of 1,000 units at 100 units per day = 10 days.
(b) Five hundred sachets. This is worked out as follows: one sachet sprays 200 m^2 which is equal to 2 housing units. 1,000 housing units divided by 2 units per sachet = 500 sachets.
(c) Ten sachets. This is worked out as follows: one spray operator sprays 20 housing units per day. One sachet is needed to spray 200 m^2 surface area, which is enough for 2 housing units of 100 m^2 each. To spray 20 housing units at 2 housing units per sachet = 10 sachets.

SAQ 10.7 (tests Learning Outcome 10.7)

A is *false.* Shirts and trousers do not give enough protection. Spray operators also need to wear a hat, mask, goggles and gloves etc. to protect themselves from contamination.
B is true. Hands and faces should be washed with soap after spraying and before eating or drinking
C is *false*. Any leftover insecticides should be disposed of in a pit prepared for this purpose; they should *never* be poured into a river (or other water body).
D is *false*. Contaminated clothes have to be changed and washed immediately.

Study Session 11

SAQ 11.1

A is *false.* ITNs protect people by killing or repelling the *mosquitoes* (not the parasites).
B is *false.* ITNs do kill mosquitoes that come in contact with the nets.
C is true. ITNs can repel mosquitoes from coming closer to people sleeping under nets
D is true. ITNs are impregnated with chemicals that kill mosquitoes.
E is *false.* ITNs also kill other household pests like bedbugs that come in contact with the nets.
D is *false.* The chemicals used to treat nets are harmless to humans and animals.

SAQ 11.2

Non-treated nets have no chemicals, so they cannot kill mosquitoes and other insects. Treated nets do have insecticides coated or incorporated into them. Untreated nets only act as physical barriers against mosquito bites, while ITNs can also kill or repel mosquitoes.

SAQ 11.3

Conventionally treated nets have to be dipped in chemicals every six months or after three washes; LLINs have chemicals in them that remain effective for the life of the nets (three to four years).

SAQ 11.4

- House-to-house visits: The advantage is that these visits ensure that nets are given to the right people and effective face-to-face education on net use is provided. However, it can take a lot of time to distribute nets to all households in this way.
- Inviting people to come to the health facility or other central location in the village: this is a good method to distribute a lot of nets rapidly. However, education about using the nets may not be effective as it is given to everyone and some individuals may not understand or accept the messages.

SAQ 11.5

- Giving nets to pregnant mothers during antenatal care visits
- Giving nets to children during immunization visits
- Giving nets to newcomers to the village
- Giving nets to replace old or torn nets.

SAQ 11.6

At least two of the following:

- Not sleeping under nets.
- Using nets for fishing or other purposes.
- Selling them.
- Not hanging nets properly.
- Not using nets for sleeping outdoors.

SAQ 11.7

- A large number of people are not sleeping under their nets.
- Many people are sleeping under nets, but too late in the night, after mosquitoes have already begun to feed on humans.
- Many of the nets are old and damaged.

Study Session 12

SAQ 12.1

A is true. Like any other epidemics, a malaria epidemic is defined as the occurrence of cases *in excess* of the number *expected* in a given place and time period.

B is true. Malaria epidemics can occur during the dry season because the rivers that might get interrupted or shrink can create breeding sites for the *Anopheles* mosquitoes, and lead to epidemics.

C is true. As a rule 25% of contingency stock should be kept for the drugs and supplies that are required for the management of epidemics.

D is *false*. The purpose of early detection of malaria epidemics is so action can be taken to contain them before they get out of control and affect a large number of people. You are the first to take action against any malaria epidemics that are detected. Of course you also report to the district level.

SAQ 12.2

The factors in the story that might trigger a malaria epidemic are:

- Heavy rainfall, followed by sunshine and warm temperatures, can lead to good breeding conditions for mosquitoes.
- High numbers of migrants who were not immune to malaria parasites because they came from a non-malarious area.

SAQ 12.3

The following are the lists for your contingency stock:

Drugs

- Chloroquine tablets
- Chloroquine syrup
- Coartem tablets
- Quinine tablets
- Artemether injections
- Artesunate suppositories

Supplies

- Multispecies Rapid Diagnostic Tests (RDTs)
- Insecticide for indoor residual spraying
- Temephos for larval control.

SAQ 12.4

IRS, larval control and distribution of ITNs are the main malaria epidemic prevention strategies

SAQ 12.5

The completed version of Table 12.4 is below.

Week No	1998	1999	2000	2001	2002	2003	2nd largest number	This year (2004)
1	16	42	105	36	14	42	36	33
2	12	42	100	38	17	22	38	35
3	16	42	103	49	21	34	42	40
4	20	17	134	59	32	40	40	39
5	34	17	146	20	30	39	34	33
6	18	10	134	29	23	27	27	30
7	30	19	133	24	25	25	25	29
8	37	10	127	41	23	42	41	42
9	32	18	137	29	26	29	29	35
10	31	24	128	17	13	32	31	30
.	.	.	.	.	.	.		.
51	26	40	134	32	39	39	39	.
52	23	35	110	27	25	33	33	.

(a) It is the year 2000. As you can see from Table 12.4 the weekly cases in 2000 are abnormally higher than the other five years of data. As a principle you do not use the 2000 data in constructing the normal chart. So before you identify the second largest number, remove the year 2000 from the data.

(b) See the table for the second largest number for the six years of data filled in the correct column.

(c) The reference line of the second largest numbers and the data for the year 2004 are shown in Figure 12.5.

(d) As you can see from Figure 12.5, epidemics occurred in weeks 7 to 10.

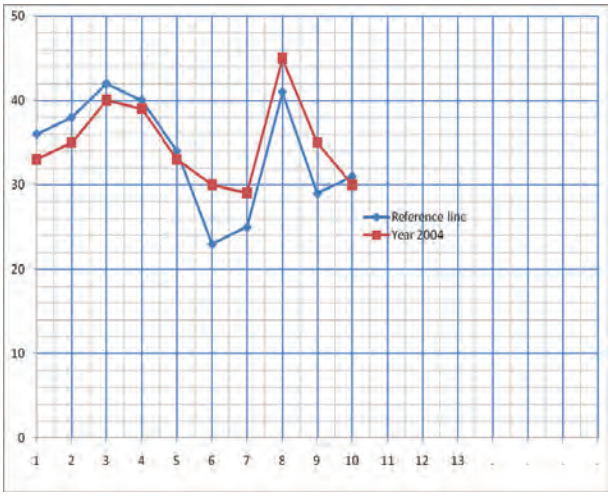


Figure 12.5 Completed epidemic monitoring chart for SAQ 12.5.

SAQ 12.6

Mass fever treatment means treating all the people who have fever *without* testing with RDTs, followed by malaria treatment to contain epidemics. The drug you give is Coartem, except for those contraindicated for whom you give quinine tablets.

SAQ 12.7

Post-epidemic assessment benefits you in such a way that you learn your strengths and weakness. During the next epidemic you will correct your weaknesses and become more efficient in preparedness, detection, prevention and control of the epidemic.