Prevention and control of malaria epidemics

Tutor's Guide

World Health Organization
HIV/AIDS, Tuberculosis and Malaria
Roll Back Malaria

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Trial Edition
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Foreword

This module uses a training method based on learning by problem-solving to facilitate the understanding of the antimalarial combination therapies and formulation of treatment policies in different epidemiological situations. The underlying principle is that learners who are actively involved through a series of group exercises and discussions learn more and better than those who simply sit and listen to a single person talking for long periods of time. The reasoning and deduction required in the module makes this subject extremely suitable for this training method, but the success of the module will depend on your active participation in the training activities proposed. The module is addressed to health personnel responsible for malaria control at national and sub-national levels of the health care system who often face the challenges of increasing resistance to antimalarial drugs and policy changes. It requires some basic knowledge of malaria case management (uncomplicated and severe malaria); parasitology, and general epidemiology. However, the contents of the module are flexible enough to allow the emphasis to be placed according to the specific training needs. The main objective of this module is to inform professionals of new elements in combination therapies and methods of drug policy formulations. Combination therapies for malaria are increasingly being taken as best alternatives in countries where there is extensive resistance to antimalarial drugs to a level where the drugs have no more effect in reducing mortality and morbidity. It should therefore facilitate a better understanding of the current antimalarial treatments, their selection in different epidemiological and socio-economic circumstances; and accordingly of changing or revising drug policies.

The module is divided into two parts - Part I the Learner's Guide and Part II the Tutor's Guide. The Learner's Guide covers basic concepts and information together with a series of problems and hints or partial solutions to them. The Tutor's Guide outlines the main points to be learnt, but does not provide definitive and inflexible responses. In this way it is designed to stimulate active learning.

The basic factors influencing the mono-therapies, combination therapies and parasite dynamics are first reviewed and then the module introduces the learner to the principles of antimalarial treatments, selection of drugs, decision making, implementation of antimalarial treatment policies based on relevant epidemiological information and health system and socio-economic situations.

The module has been conceived for group work. The exercises in the Learner's Guide should be carried out in small groups to stimulate discussions and exchange of experience between the participants (who would come from different countries/areas with different experiences), the facilitators and the tutor. The guide can be used for workshops of varying duration depending upon the time available and the rate at which the exercises proceed. The module can be independently given in a separate course or be customized into a course with other subjects depending on the need of audiences. Certain exercises may be completed at a later date by the participants individually provided they have both the Learner's and Tutor's Guides. The complete module is optimally designed to be accomplished in 24 hours (3 days).
Acknowledgements

The contents of this module has been developed by Dr Charles Delacollette from the Malaria Control Department, WHO Headquarters, Geneva, Dr Job Sagbohan from WHO/AFRO, Harare and Dr Maru Aregawi from the Malaria Control Department, WHO Headquarters, Geneva. This module takes into account various formal and informal contributions from the members of the RBM Technical Support Network on Malaria Epidemics Prevention and Control created by RBM in 1998. Inputs from the following WHO staff have been highly appreciated:
Dr A. Teklehaimanot, Dr Rietveld, Dr K. Mendis, Dr A. Bosman, Dr P. Olumese, Dr P. Ringwald, Dr A. Schapira and Dr K. Cham from the Malaria Control Department, WHO Headquarters, Geneva, Dr F. Da Silveira and Dr M. Robalo from WHO/AFRO, Harare. Mrs Assil Farah has made tremendous effort to edit the document and finalize the layout.

The module is still a trial edition which needs further editing effort and scientific review. It will be field tested in various international training courses before reaching its final stage of development. Authors highly appreciate inputs and useful suggestions from readers (tutors, facilitators and participants) to be incorporated into further editions.
Introduction

This Tutor's Guide is designed primarily to help those responsible for the training of those health personnel responsible for the planning, execution and evaluation of malaria control activities. Some parts of it should be useful even to the most experienced teacher or facilitator. In case of individual studies it should be provided to learners together with the Learner's Guide so that the trainee can use it as an "answer book". This module uses a problem-solving approach when the tutor and facilitator do not in general perform supportive functions. If you are not familiar with this training system, read the introduction carefully.

For whom is this training module intended?

The module is designed for health professionals involved in malaria control, and in epidemics in particular, at national, sub-national and district levels who have responsibility for planning, executing malaria control, and monitoring activities in their respective working levels. These include medical officers, medical assistants, public health officers, environmental health officers, parasitologists, and biologists involved in malaria control either with government or NGOs. Most of these people will already have a working knowledge of the basic principles of malaria epidemiology and communicable diseases control.

Educational level of learners

As indicated in the Preface this guide is designed for health personnel responsible for malaria control at different levels of the health care system from district level to national level: These include medical officers, medical assistants, public health inspectors, parasitologists, entomologists and biologists. Most of these people have already basic knowledge about epidemiology of communicable disease.

The complete module is designed to be accomplished in 24 hours (3 days). You will find the suggested timetable in one of the following paragraphs.

How is the training designed and what is its content?

The training module is intended to facilitate the teaching malaria epidemics for better prevention and control, planning and management and post-epidemic assessment methods to health professionals involved in malaria control. The principal objectives of the training are listed in the introduction of the Learner's Guide. Please stop and read these now. This module is conceived to stimulate active learning by going through the series of exercises. These exercises will be performed on the basis of the Learner's Guide preferably in small groups. These exercises emphasis on problem based learning approaches under different eco-epidemiological and the solution to these particular problems are indicated in this tutor's guide. Answers indicated in this guide are only indicative and should not be taken as the sole solutions to the problem.

Learning objectives summarize the knowledge, skills and attitudes that each learner should have acquired by the end of that unit. You and your colleagues must satisfy yourself that each learner has achieved the stated objectives before proceeding to the next learning unit (methods of evaluating progress are described later).
Who runs the course?

It is you who is responsible for organizing and running the course. The Learner's Guide and Tutor's Guide will do much to help you, but the final results will depend upon your efforts. This may be the first time that you have organized and run such a course, or you may be an experienced teacher: in either case, the importance of using the Learner's Guide and the Tutor's Guide together as you proceed through the Learning Units is stressed.

Who helps you in the course?

Your job will be easier, and your teaching more effective, if you have colleagues who will help you. These assistants, who should have knowledge and experience in the subject, are called facilitators. You can then divide learners into small groups of four to eight persons, and allocate one facilitator to each group. The greater interaction this allows between the learners and the facilitators results in better learning and understanding.

As the overall manager of the training this module, you will be responsible for designing the timetable, explaining the learning tasks to the learners and facilitators whatever help their task is to explain or demonstrate a particular activity and to watch learners perform it. They (facilitators) must also be able to admit to learners when there is something that they do not know and be prepared to refer the question or problem to you. Impress on your facilitators that no one person can be expected to know everything about a particular subject.

There is no shame in saying "I do not know, but I will find out for you". Many problems can be avoided by giving your facilitators plenty of time to read the Learner's and Tutor's Guides, other relevant resources or handouts and discuss with you any part of it that may need clarification. It would be a good idea for you and the facilitators to go through the module together, you could then test their knowledge by asking them appropriate questions.

Why provide a learner's guide?

Providing learners with a full set of notes ensures that:

- All learners have exactly the same basic materials and guidelines on how to proceed with exercises;
- You and the facilitators can refer to any part of the Learner's Guide knowing that all learners can find the right page quickly;
- Learners can spend more time reading the notes, and therefore have a greater chance for thinking, discussion and formulation of ideas;
- There is no chance of learners making errors in note-taking;
- After the course, each learner can take home a copy of this Learner's Guide and the Tutor's Guide as a helpful reference in his or her daily work and perhaps also to use to teach others.
How is the course run?

_Tutor_

The tutor has overall responsibility for the planning and management of the course and will also introduce each of the learning units, but the tutor will not give formal presentations of this module.

_Facilitators_

The tutor is assisted by a number of facilitators who will work with you continuously through small group sessions and provide additional information whenever required. They will also assist the moderators in guiding group discussion. Together with the tutor, they are your constant source of information and experience. If you study in small groups but without a facilitator, the tutors must to some extent play the role of the facilitator.

_Presentations_

Lectures are kept to a minimum and will be replaced by limited introductory remarks by the tutor at the beginning of each subject and short examples to overcome points of common difficulty.

_Small group work_

The module is designed for 3 _days_ of training, working mainly in _small groups_, say 2 or 3 groups of 6 to 9 learners each. It is desirable for each group to have its own room, with at least one of the following: overhead projector, whiteboard, blackboard, flipcharts. For each unit the group selects, among its members, a _moderator_ and a _rapporteur_ by rotation, so that, as far as possible, each learner performs each of those two functions at least once. The sessions provide good opportunities for you and the other learners to give your opinions, develop your ideas and learn from one another. The learners will usually have different backgrounds, in terms of training and experience, so that they should have much to _learn from each other_. The exchange of experiences among participants contributes to most of the training material, the Learner's Guide providing a lead for discussions and work. A moderator chosen by the members of each group will lead discussions on the particular subjects proposed in the learning units. At the end of the group work devoted either by the moderator responsible and discussed by all participants and commented on by the tutor. These presentations and discussions are important but are not meant to be formal as working notes. The overall success of this training module will depend on the active participation of all learners in the group exercises and discussions.

The group compositions can be changed occasionally if you wish or left the same throughout the course. However, the group activities can all take place in the same room and time is saved by not having to change places.

_Use of the Tutor's and Learner's Guides_

The Tutor's and Learner's Guides may be used together for small group training when qualified facilitators are not available. In this case the tutor must, to some extent, play the
role of the facilitator. The Tutor's and Learner's Guides may also be used in combination by individuals for references. Otherwise learners will follow the group training activities using the Learner's Guide plus whatever other materials you provide them with. The Tutor's Guide will be handed to them at the end of the training (upon completion of this particular module or at the end of each learning unit). The way in which you and your facilitators should make the best use of the Guides and the audiovisuals aids will become apparent as you work through the training module.

Training facilities

A number of basic facilities and equipment must be organized before training can begin. In some countries these are readily available but in others you may need to improve or to modify existing resources but do not delay training unnecessarily because you do not have the best equipment.

Ideally, one large room should be available for presentation and group discussions, pictures projected by the overhead and slide projectors will be seen more easily if the level of lighting can be controlled. Whatever the conditions, do your best to ensure that the learners are as comfortable as possible in the circumstances: you may be surprised how much you can achieve even with relatively few facilities.

Teaching equipment

For teaching sessions and group discussions, the following items should ideally be available:

- Overhead projector
- Slide projector
- Screen for slide projection (a white sheet is an adequate substitute but the white-board is unsuitable because it will reflect projected light)
- Flipcharts - one for each small group of learners. Supplies of "butcher's paper" or "newsprint" are usually cheap and readily available.
- Chalk board or white board
- Chalks for blackboard or marker pens for white-board, in a selection of colours.
- Acetate sheets for overhead projector.
- Coloured marker pens for acetate sheets (including some permanent markers for diagrams you may wish to keep).

Learner's equipment

The equipment listed below should be provided for each learner. Where supplies have to be ordered, this should be done well in advance of the course; many items are difficult to obtain at short notice.

- Copy of the learner's and tutor's guide
- Notebook. This should be used only for occasional notes or instructions; as explained earlier, there should normally be no need for notes to be taken during training sessions.
- Sheets of paper for the exercises during the working groups.
- Ballpoint pen:
• Set of pencils (medium-hard graphite, plus red, blue, brown and black) for during charts and graphs during practical sessions.
• Pencil sharpener.
• Eraser.
• Ruler.
• A simple hand held calculator

Syllabus and timetable

The contents list of the Learner's Guide represents the syllabus - the list of subjects to be covered - for the training course. Go through each learning units in turn and calculate how much time you will need to devote to it and decide what kind of training activity would be most suitable for the topic. Planning the course is made easier by the division of this module into a number of learning units or main topics. Go through each of the Learning Units in turn; for each unit calculate how much time you will need to devote to it and decide what kind of training activity would be most suitable for the topic.

The following is a list of the various learning activities that you might consider using:

• **Group discussion**
  
  One participants get used to group discussions, the two-way exchange of information between them and the facilitators makes this a very effective learning activity. People share their knowledge and experiences with the rest of the group and stimulate each other's thoughts on the subject in hand.

• **Practical exercises**
  
  Practical exercises may be done individually or in groups in the classroom. Their purpose is to give learners the opportunity to practise the procedures involved. The more practice they have, the more competence they will acquire.

• **Demonstrations, examples**
  
  These are designed to reinforce the learning process. Clear examples help to clarify concepts and establish principles. The tutor and facilitators should have many examples ready to use, but in addition trainees should also be invited to give examples. This is a much stronger reinforcement.

This training module

*Use of the Learner's Guide*

This Learner's Guide consists of instructional materials and problems designed to enable you and your colleagues to achieve the objectives stated earlier. The Guide is divided into Learning Units. Before each session you should read each Unit carefully and make sure you understand it, as the tutor will not be giving a detailed presentation of the material to be learnt. If you are unclear about any part of the Learning Unit you should discuss it with your colleagues in the discussion group, your facilitator and with the tutor, if necessary. Each Learning Unit consists of a series of questions (and hints and partial solutions to some of them) to be worked through as a group. The discussions during small group work and during plenary sessions with the participation of facilitators and tutors will facilitate this process.
You must acquire the skills and knowledge contained in one unit before progressing to the next, otherwise you may have difficulty in achieving the objectives of subsequent learning units.

Individually, make maximum effort to read some of the important references and guidelines sited in the document as details are left for further reading. Annexes are given as additional sources for in-depth knowledge.

**Use of the Tutor's Guide**

During the course, the tutor's guide would be available only to the tutor and facilitators and upon completion of the course/module, all learners would get a copy of the tutor's guide so that they can use the materials for further training and reference.

The module consists, in its present state, of two major learning units addressing. Each unit consists of a Learner’s Guide and a Tutor’s Guide. The Learner’s Guide proposes a series of exercises and offers hints for some of the problems. The Tutor’s Guide gives guidance to the tutor for answers to the exercises.

The module aims at developing an approach, namely the critical analysis of precipitating factors of malaria epidemics, preparedness and responses under different epidemiological situations rather than to convey a body of facts (even though many facts may be conveyed in the process). Most facts and details are referred to relevant guidelines and other resource materials.

No document can, and this module does not, exhaust such a wide and dynamic subject. Malaria epidemics is dynamic issues and the prevention and control methods also evolve over time and so this module does. The module will be successful if it helps the learners understand the mechanics of malaria epidemics in the context of new developments to incorporate better prevention and control approaches. This will help participants continue to update their knowledge as an integral part of their professional activities.

The Learner’s Guide can also be used in conjunction with the Tutor’s Guide, for individual active self-learning.

**Evaluation**

Judging whether or not the course was a good one is difficult and involves answering the following questions:

- **How well did the group learn?**
  This may be determined by evaluating the learner's performance as they work through the Learning. Units and again at the end of the training. A further evaluation of how well they have retained their knowledge, skills and competence may be necessary 10-12 months later.

- **How did the learners view training?**
  Learners' answers to this question will yield valuable information on how useful they find this type of training, especially if they provide a short evaluation during the course and a longer one at the end of the module.
Feedback provide during the course allows you to assess how well your training is being received and to make any improvements that seem necessary. Feedback received at the end of the course will help you to improve future programmes. If you have prepared the course carefully, feedback is likely to be favourable, which is rewarding both for you and for the facilitators.

Whether this module is used for group training or individual learning, assessment of progress made by the learner in gaining skills and competence in the subject matter is essential to the learner and for the tutor.

This can be accomplished by means of a pre-test in the form of a multiple-choice questionnaire (MCQ), given before the learner reads the Learner's Guide. To be valid it must be clear that the learner must work on it alone. The post-test should be administered only after all the learning units have been completed. Since the answers to the questions, and to the exercises are included in this Tutor's Guide, it is essential that learners do not have access to it until after the training activity has been completed. The pre-and post-test evaluations, participants must be seated apart from one another under examination conditions.

The results of the pre-test can be used in two ways. The Tutor may use it to ascertain the general level of knowledge on the subject amongst the group, and have an indication of general weak areas that need emphasis and areas of general knowledge that can be re-emphasized. It could also be used to identify individuals who might be used as facilitators for certain subject areas. The other major use for the pre-test is as an individual base-line comparator for measuring the gain in knowledge, skills and competence at the end of the training as revealed by the post-test.

To be valid the question in the post-tests should be of the same difficulty as the questions in the pre-test and both tests should be given under the same conditions and the same length of time. The only sure way of knowing that the questions in the post-test are of equal difficulty to those in the pre-test is to give the same questions but in a different order and in the case of multiple choice-questions with the answers also in a different order. It is thus essential that the pre-test papers be collected and retrained (not handed back to the participant): In any event, it is not necessary for the participant to know the results of the pre-test until the end of the training when it is used to determine progress.

The tutor is encouraged to develop a bank of questions that can be used to pre-and post-testing for subsequent training sessions. The answers are scored equally because each question is considered, in this instance, to be of equal value. The preferred answers have been provided but in some instance, alternative responses are acceptable, and these have been noted.
## PROPOSED TIMETABLE

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>AM (4 hrs)</th>
<th>PM (4hrs)</th>
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</table>
| **DAY 1** | **Introduction to the module** (30 min)  
**Pre-test** (1:00 hr) | **Learning Unit 1** Introduction to malaria epidemics (1:30 hrs)  
- malaria transmission  
- zones and population prone to malaria epidemics |
| **Learning Unit 2** Early warning, detection, notification and verification of malaria epidemic | **Learning Unit 2** Early warning, detection, notification and verification of malaria epidemic  
- early detection methods (1:30)  
- verification of malaria epidemics (2:00)  
- Discussion (0:30) |
| **DAY 2** | **Learning Unit 3** Prevention and early response to malaria epidemics  
- vector control options (2:00)  
- managerial issues of response (1:00)  
- Discussion (0:30) | **Learning Unit 3** Prevention and early response to malaria epidemics  
- cost-effective interventions to prevent and control malaria epidemics (1:30)  
- case management (1:30)  
**Learning Unit 4** Post-epidemic assessment and preparedness plan of action  
- Rational for post-epidemic assessment (1:30)  
- Preparedness plan of action (PPOA) (1:30)  
**Post-test** (1:00) |


Learning unit 1

Introduction to malaria epidemics

Learning objectives

By the end of this unit you will be able to:

- define a malaria epidemic
- identify contributing / triggering factors.

It should be made clear to the participants that this Unit is not an examination but is designed to make the learners think about the malaria epidemics and its control as it pertains to their own country or place of work. Through this process and with your subsequent help as a tutor they will have a better understanding. Participants should be encouraged to answer the questions as precisely and briefly as possible.

In plenary session open a discussion between the participants regarding their experience in answering the questions, paying particular attention to difficulties encountered and the reasons, and missing information.

At the end of the day you should then review the papers and identify any specific areas which are the cause of common difficulties and which will need special emphasis in the Units that will follow.

1. Participants may answer as Yes/No depending on their respective involvement in epidemics.

2. Definition of malaria epidemics, or a malaria outbreaks

There is no universal definition for a malaria epidemic, it is generally accepted that sharp increase in malarial incidence among populations in which the disease is rare or a seasonal increase in clinical malaria in areas of low to moderate transmission constitute a malaria epidemic (Bruce-Chwatt, 1993). An increase in morbidity beyond the clear normal condition is the main feature of epidemics. However, the definition of "normal" occurrence can only be defined for a particular population in a specific area and time. Therefore, malaria epidemics can generally be considered as a disturbance of a previously existing epidemiological equilibrium (Nájera, 1999). Alternatively, epidemics could be defined when the malaria caseload exceeds the usual capacity of the existing health care facilities to handle them.

Epidemics with a small case-load are usually called outbreaks1. While large epidemics pose no problem of definition, small epidemics may be hard to distinguish from expected seasonal and periodic variations (Molineaux L., 1988).

1To avoid any confusion, the term “epidemic” is used throughout this document.
3. Types of epidemics and geographical areas where epidemics most frequently occurred

a) True epidemics—infrequent/cyclical outbreaks in relatively non-immune populations related to climatic anomalies (mainly arid and semi-arid zones). Ex. Eastern Kenya and Ethiopia, Somalia, Sahelian countries, etc.…

b) Strongly seasonal transmission—variable but relatively predictable transmission influenced by variations in normal climatology. Population living in highlands (above an altitude depending on the distance from Equator) or in Sahelian / Southern African region. Ex. Kenya, Botswana, …

c) Neglect/breakdown of control—where malaria has re-emerged due to neglected control activities (not necessarily linked to a complex emergency situation) with subsequent increase of transmission on an epidemic mode. Ex. most of ex USSR countries, Madagascar, etc.

d) Complex emergencies—malaria transmission exacerbated by population movements and country political instability. May include (a) and (b).

Example: Burundi

The situations (a), (b) and (c) indicated in the diagram (fig 1) correspond to the types of epidemics discussed above.

**Figure 1. Classification of major malaria epidemic types**

**Population at risk in epidemic prone regions**

4. Epidemics occur in areas of seasonal or low transmission because these populations do not develop adequate immunity and are vulnerable to the disease every season.

Epidemiological setting for malaria epidemics: Epidemics occur when existing equilibrium between rate of infection and the herd immunity of a population in a given area is disturbed. Malaria epidemics do not generally occur in high transmission areas (other than when there is migration of non-immunes to these areas) because the populations living in these areas develop partial immunity against the disease. It has been shown that continuous exposure to malaria infection provides partial immunity in people after a certain age but this immunity is transient. People who remain uninfected over a short time period (less than one year for *P. falciparum*) become re-susceptible to the disease.

5. The answer is NO. Because, in areas where populations have inadequate immunity, the presence of factors which increase in transmission, malaria can explode with very high morbidity incidence rate and huge case fatality rate (CFR) in all age groups.

6. Answers of participants may vary depending on where they come from and allow learners to present their situation and discuss for some minutes in the class.

7. Answers of participants may be Yes or No depending on their previous knowledge. For those who say yes, the answer could be to identify population at risk and associated precipitating factors in order to effectively prevent or control malaria epidemics and avert potential high morbidity and mortality.
8. In summary, the following conditions make human populations vulnerable to malaria epidemics:

- Migration of non-immunes to areas with high malaria transmission.
- Introduction of parasites and/or introduction of suitable vectors (for malaria transmission to areas with constant low or no transmission where populations do not achieve a high degree of immunity.
- Increasing population vulnerability after a long period of drought (and famine) with no malaria transmission followed by intensive rainfall and creation of suitable environmental conditions for epidemics.

**Zones at risk of malaria epidemics.**

9. Characteristics of epidemic-prone area:

- They are normally less favourable for malaria transmission, but certain climatic, biological and/or epidemiological conditions could change, resulting in an increased transmission far beyond the typical pattern.
- Epidemic-affected areas often constitute the borders of, or pockets within, endemic areas.
- They can also be areas undergoing rapid ecological (including human) changes. Since populations in these areas are immunologically naive towards malarial infections, changes that enable malaria transmission may cause explosive epidemics. Example:
  - Highland areas bordering endemic areas that may normally be too cool to support endemic infections.
  - Hot, dry arid areas and desert fringes surrounding a river valley.
  - Endemic areas receiving an influx of non-immune refugees.
  - Areas undergoing massive environmental changes such as deforestation, damming/irrigation and flooding.

10. **Indicators of transmission and methodologies to map out zones at risk.**

Successful transmission of the malaria parasite by the vector has two main requirements:

i. There must be sufficient human/vector contact.

ii. The survival time of the vector must be long enough to complete the life cycle of the parasite and the vector becomes infective.

11. Diseases caused by vector-born pathogens have a much higher rate of transmission than directly transmitted pathogens because of their innate capacity to increase within an intermediate host or the vector.

The expression as a basic reproductive number ($R_0$) in the equation:

$$R_0 = \frac{m a^2 p^n}{-r \log p}$$

- $R_0$ = the total number of secondary cases arising from a single primary case in a susceptible population
- $m$ = the number of female mosquitoes in relation to people
- $a$ = proportion of vectors feeding on man averaged over the length of the gonotrophic cycle
- $p$ = the probability of a vector surviving through one day
- $n$ = the number of days needed to complete the sporogonic cycle
18

$$r = \text{the total number of days a malaria patient remains infectious}$$

This equation expresses the functional relationship between the various factors responsible for malaria transmission. However, the influence of immunity and other barriers to super-infection in the host are not accounted for in this equation.

Within the equation, the most important factors impacting human malaria transmission are duration of the sporogonic cycle, vector survival, and the average number of times a mosquito bites a human. Therefore, any parameters that may directly or indirectly affect any of these factors play an important role in determining the level of malaria transmission.

Another key concept in malaria transmission is **Entomological Inoculation Rate (EIR)**, the number of infective bites per person per time. Based on the EIR, Onori and Grab (1980) have defined the direct and indirect factors responsible for malaria transmission. "Direct" factors appear in the equation, but these parameters are frequently difficult or impossible to measure. The following are a list of direct parameters that affect the level of transmission and are, in turn, affected by the corresponding indirect parameters.

13. Provide learner's hints on the relationship of these two columns and let them first complete the empty column as per their understanding. The factors that influence the determinants are given below and compare these answers to that of the participants'.

*The indirect or influencing factors that affect the level of transmission are usually used as indicators to predict or monitor the level of malaria transmission in a given region and are easy to measure.*

**Table 1. Direct and indirect factors that contribute to occurrence of malaria epidemic**

<table>
<thead>
<tr>
<th>Determinants (Direct)</th>
<th>Influencing factors (Indirect)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Vector density</strong></td>
<td>Rainfall, drought, incorrect maintenance of irrigation systems changed in vector breeding habitats</td>
</tr>
<tr>
<td><strong>Man biting</strong></td>
<td>Housing, behaviour, disaster, socio-economic factors</td>
</tr>
<tr>
<td><strong>Rate of gametocyte carriers</strong></td>
<td>Importation of malaria parasite</td>
</tr>
<tr>
<td><strong>Length of sporogony</strong></td>
<td>Temperature</td>
</tr>
<tr>
<td><strong>Daily survival rate of vectors</strong></td>
<td>Temperature, humidity</td>
</tr>
</tbody>
</table>

**Mapping areas of epidemic risk**

Discuss in panel with learners on the review of geographical information system and its importance to prediction of malaria epidemics raised in the learner's guide.
The use of health statistics to differentiate endemic and epidemic prone areas

14. The answer is Yes it is useful! With the assumption that everybody has equal access to functioning health care facilities, epidemiological statistics on attendance rate reflect age distribution according to demographic data.

If health statistics coming from various sources (hospitals, health clinics, communities) are quite well collected and maintained with breakdown by age, months and place of residence over a certain period of time (1 year at least), they can be used to identify age groups who develop most the disease as well as to correlate them to usual place of residence. In epidemic prone areas where immunity is low, all age groups are at risk. It means for example that in epidemic prone areas roughly 20% and 80% (according to demographic census) of suspected malaria fever cases are expected to be noticed in respectively under 5 children and above 5. If the majority of those attending most health facilities with fever are under 5 or pregnant women, the region is probably endemic because in this transmission setting, infants and children are the most affected by the disease.

Precipitating factors to malaria epidemics

The level of immunity acquired by the exposed population plays a decisive role in the occurrence and severity of malaria epidemics. Malaria immunity cannot be maintained unless exposure and man-vector contact are frequent and regular.

15. Factors which may cause an "unexpected" increase in transmission are numerous. They mainly operate by modifying the environment thereby increasing vectorial capacity. They can be classified into as follows:

I. Man-made:

- socio-economic development activities modifying or destroying environment (directly linked to human activities) and leading to the temporary or permanent displacement of immune or non-immune people. As a result, secondary larval breeding sites are often created, vector density is increasing, behaviour of vectors may change and new vectors may adapt to the new conditions. People also can move into recently exploited areas where vectors occur. For example:
  - forest and jungle areas subjected to economic exploitation (Amazon region, South-East Asia),
  - large-scale agricultural projects or extensive cultivation of marshes particularly in highlands (irrigated rice fields, sugar cane cultivation) in Rwanda, Burundi, Tanzania (Usambara mountains), Madagascar, etc.
  - hydraulic projects, dams (Sahel countries, etc.),
  - Mining and logging activities (Brazil, Sahel countries, South and S-E Asian countries)
  - refugees making borrow-pits in resettlements (Pakistan),
  - New roads better connecting endemic lowlands to highlands virtually free of malaria (Madagascar, Rwanda, Burundi, Algeria...)
  - Fast growing process of urbanization leading to new overcrowded settlements in periurban areas (Somalia, Mozambique). “Urban malaria” has also been
described in some Asian countries (India, Bangladesh, Burma, Indonesia, Nepal, Maldives, Sri Lanka and Thailand). *A. stephensi* was considered as the main vector (resistant to DDT) in big cities, and *A. culicifacies* in the periphery. In cities, the following factors have been identified to increase the risk of malaria transmission: (i) changes in topography and socio-economic conditions due to the expansion of the cities, as well as to rapid industrial growth, (ii) increasing movement of population from rural areas to find jobs, (iii) huge housing projects with borrow pits, water accumulation and ponds, open drainage with blocked drains, uncovered overhead tanks ..., (iv) (unauthorized) temporary huts with extremely poor sanitation, (v) inadequate or outdated sewage and drainage systems, etc.

- low economic status, overcrowding, deprivation and, in certain circumstances, the absence of community spirit, also contribute to the magnitude of diseases like malaria.

- **overpopulation** leading to the increase of the population pressure on the available agricultural land: For example:
  - extensive cultivation of natural marshes in Highlands (Rwanda, Burundi, Eastern Zaïre, India, etc.),
  - population movements exploiting natural resources, changing the microclimate for the insect fauna and driving wild animal population away (India) (Mathur KK et al., 1992).

- **war and sociopolitical disturbances leading to**:
  - large population movements contributing to modify environment (large refugee camps),
  - resettlement of non-immune people in malarious areas (Rwanda),
  - the deterioration of the PHC system including breakdown of surveillance and malaria control activities (Rwanda and neighbouring countries, Sudan, ...)

II. **Natural disasters** leading to profoundly modified environment (cyclones in Madagascar, hurricanes in Carribeans ...) and to population movements,

- natural disasters, and other disturbances can lead to unexpected environment modifications and population movements.

- **meteorological** climatic changes leading to more rapid development of infective stages of *Plasmodium* in adult mosquitoes and development of aquatic stage of vector (Rwanda, Tanzania, ...). Temperature, humidity and precipitation modify vector’s metabolic processes. Vectors need to feed more frequently when increased temperature and egg production is also increasing in accordance to the higher biting rate. Low humidity level cause some vectors to feed more frequently whereas high temperature and high humidity may prolong the survival of most vectors. Precipitation greatly influence breeding sites. The impact of depends on local evaporation rates, soil percolation rates, slope of the ground and proximity of large water bodies and rivers, modification of environment in case of unusual rainfall, heavy flooding (Sahel countries, Kenya, India, ...), destruction of irrigated system (Madagascar),
III. Break down of health services:

In addition the problems of epidemics may be compounded by factors related to poor health services, insufficient knowledge of health workers and communities, for example:

(i) the lack of information on malarial disease, its diagnosis and treatment,
(ii) severe cases (especially cerebral malaria) may be treated by “traditional” practitioners and as a consequence, many deaths may occur at home during epidemics. Few people may be aware that malaria is transmitted by mosquitoes and that it may be prevented by personal protection measures.

a) After listening to results or responses of learners, provide them with copies of Table 2 for comparison and further discussion. Also provide participants with the second Table 2a or chart that shows the classification of the precipitating factors.

Table 2a. Precipitating factors for malaria epidemics and their consequences

<table>
<thead>
<tr>
<th>Cause</th>
<th>potentially leading to:</th>
<th>Examples of Where? When?</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic development activities</td>
<td>- Modification/destruction of environment (ecological disturbances)</td>
<td>Tanzania, &gt;1980</td>
<td>Matola YG et al., 1987</td>
</tr>
<tr>
<td></td>
<td>- High mobility of population (seasonal non-immune workers and/or migrants seeking new settlements)</td>
<td>Rwanda-Burundi, &gt;1950</td>
<td>Meyus et al., 1962</td>
</tr>
<tr>
<td></td>
<td>- Displacement of populations by hydroelectric projects</td>
<td>India, 1983, 90, 92, 93, 94</td>
<td>Tyagi et al., 1995</td>
</tr>
<tr>
<td></td>
<td>- Islands of Mascareignes, (end of XIXs)</td>
<td>Islands of South-East Asian countries</td>
<td>Julvez J. et al., 1990</td>
</tr>
<tr>
<td>Overpopulation</td>
<td>- population pressure on available agricultural land : cultivation of natural marshes in highlands, destruction of trees, ...)</td>
<td>Haiti, 1991</td>
<td>Kondrashin AV et al., 1987</td>
</tr>
<tr>
<td>War/civil disturbances</td>
<td>- large scale uncontrolled population movements</td>
<td>Rwanda &gt;1993</td>
<td>Matlhor KK et al., 1992</td>
</tr>
<tr>
<td></td>
<td>- modification of the environment (~large-refugee camps)</td>
<td>Angola, Sudan Mozambique, 1992</td>
<td>Schapira A. et al., 1993</td>
</tr>
<tr>
<td>Road construction / Improvement in transport facilities</td>
<td>- poor housing and sanitary conditions</td>
<td>Madagascar, &gt;1983</td>
<td>Lepers JP. et al., 1990</td>
</tr>
<tr>
<td>Global and local climate changes</td>
<td>modification of vector-borne disease distribution and biology in altitude</td>
<td>Rwanda, &gt;1986 Highlands of Africa and South America</td>
<td>Loewinsohn ME, 1994 Martens et al., 1995</td>
</tr>
<tr>
<td>Natural disasters</td>
<td>- increased breeding sites</td>
<td>Islands of Mascareignes South-Africa, Kenya, &gt;1962</td>
<td>Julvez J. et al., 1990</td>
</tr>
<tr>
<td>Expected or unexpected meteorological events (heavy)</td>
<td>- create secondary larval breeding-sites,</td>
<td>Tanzania, &gt;1980</td>
<td>Matola YG et al., 1987</td>
</tr>
<tr>
<td></td>
<td>- increase density of vectors</td>
<td>Rwanda, &gt;1986</td>
<td>Gascon J. et al., 1988</td>
</tr>
<tr>
<td>rainfall, unusual heavy flooding, cyclones, climatic changes...)</td>
<td>- change the behaviour of vector(s), - modify the duration of the sporogonic cycle in vectors and aquatic stages of vectors - “seasonal” epidemics</td>
<td>Haiti, 1963; Thar desert, India, 1994; Somalia, 1988; Brazil, India (Thar desert), 1990; Madagascar, &gt;1983; Southern African countries, 1996</td>
<td>Mason J. et al., 1965; Bouma et al., 1994; Warsame M. et al., 1995; Camargo LMA et al., 1994; Mathur, 1992; Kassatski AI., 1990; de Zulueta J., 1988; See references</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Break down of health services (degradation of preventive and curative health services)</td>
<td>absence of drugs / inappropriate case management especially for severe cases</td>
<td>Somalia &gt;1986; Madagascar, &gt;1983</td>
<td>Warsame M. et al., 1995; Kassatski AI, 1990</td>
</tr>
<tr>
<td>Deficient surveillance within the control services</td>
<td>Malaria disease is no more under control while the environment is still favourable for malaria transmission</td>
<td>Madagascar, &gt;1983; Islands of Grenada, 1966 &amp; 78; Namibia, 1990; Sao Tome, Principe; Zanzibar; Swaziland; India, 1993; India, &gt;1970; India, 1991</td>
<td>Razanamparahy M. et al., 1989; Tikasingh et al., 1980; Tueumuna TT., 1992</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sharma et al., 1985; Sharma VP., 1987; Prasad RN et al., 1992</td>
</tr>
<tr>
<td>- malaria prevention activities are deteriorating (such as lack/shortage of insecticide and/or inadequate or poor spray coverage)</td>
<td>“post-eradication” epidemics</td>
<td>Sri Lanka, 68, 75, 86; Grenada, 1966 &amp; 78; India, &gt;1970; Sudan, 1975; Turkey, 1976-77; South-Africa, 1978; Somalia, 1988; India, 1990; India 1991; Madagascar, &gt;1983; USA, Cuba, Southern USSR, Mauritius; India, 1990; Southern African Countries, 1996</td>
<td>Pinikahana J. et al., 1993; Tikasingh, 1980; Sharma VP, 1987; Onori E. et al., 1980; Mphahlele M., 1980; Warsame M. et al., 1995; Mathur, 1992; Prasad, 1992; Follies L., 1994; Lepers JP et al., 1990</td>
</tr>
<tr>
<td>- reluctance of villagers concerning some Malaria Control Activities (especially spraying operations)</td>
<td>persistence of malaria foci</td>
<td></td>
<td>Mathur, 1992; See references</td>
</tr>
</tbody>
</table>

- **Loss or breakdowns in epidemiological surveillance** (irregular monthly reports, faulty examination of slides ...) leading to abnormalities being neglected (Madagascar, India, Islands of Grenada, Namibia, etc.)

- **Deterioration of health services (including malaria control activities). For example:**
  - because malaria is no longer a public health concern resulting in shortage of insecticide and/or inadequate and/or poor spray coverage. The increasing reluctance of householders to accept some malaria control activities such as indoor spraying has been documented in many countries and may have played a role in malaria epidemics (Sri Lanka, Sudan, Turkey, India, Sudan, South Africa, Madagascar ...). However, it is still unclear whether increased Plasmodium resistance to antimalarial drugs or increased vector resistance to insecticides have really caused malaria epidemics. In epidemics a higher level than usual of plasmodium resistance to drugs is often measured, but that might be related to: (i) the low status of immunity in investigated patients, (ii) the heavy drug pressure already instituted.
- insufficient PHC coverage influencing rapid access to essential drugs and appropriate treatment of severe cases,
- weaknesses in disease management such as (i) unreliable malaria diagnosis, (ii) lack of antimalarials among the essential drugs in health facilities, (iii) *P. Falciparum* resistance to available drugs (iv) high cost of the available drugs in governmental and private health facilities and in drugstores,
- inadequacies of the health information system regarding (i) long delays in the analysis of routine monthly reports at district level, (ii) overburdened regional epidemiological section leading to delay in computing the data, (iii) irregular reporting and collection of irrelevant epidemiological data, (vi) insufficient coverage by the surveillance system,
Table 2b. Classification of the precipitating factors for malaria epidemics (additional information)

<table>
<thead>
<tr>
<th>Man-made factors</th>
<th>Natural factors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population movements</td>
<td>Climatic</td>
</tr>
<tr>
<td>Environmental changes in rural and peri-urban areas</td>
<td>Preventive (including drug resistance)</td>
</tr>
<tr>
<td>Degradation of control/Health services</td>
<td>Lack in Surveillance (including insecticide resistance)</td>
</tr>
<tr>
<td>War/Civil disturbances</td>
<td>Not cyclical meteorological events</td>
</tr>
<tr>
<td>Economic causes</td>
<td>Regular cyclical heavy rainfall or cyclones</td>
</tr>
<tr>
<td>New roads connecting endemic and &quot;non endemic&quot; areas</td>
<td>Natural disasters</td>
</tr>
<tr>
<td>Large socio-economic projects</td>
<td>Population pressure on available agricultural land</td>
</tr>
<tr>
<td>Population pressure on available agricultural land</td>
<td>Fast peri-urbanization with overcrowded settlements</td>
</tr>
</tbody>
</table>
b) It is necessary to identify precipitating factors for malaria epidemics in order to select proper preventive and control options; and to plan early warning and preparedness, mechanisms.

**Essential past and current information requested to explore potential contributing factors to any malaria epidemics**

Allow participants to discuss the factors relevant to this section mentioned in the learner's guide and summarize.

16. **The information could be obtained as follows:**

- Epidemiological health records: at clinics, district or national level,
- Meteorological stations: facilities at peripheral or/and national level,
- Population movements/displacements: through local authorities, NGOs, humanitarian community, other survey reports
Learning unit 2

Early warning, early detection, notification and verification of a malaria epidemic

Learning objectives

By the end of this unit, you will be able to:

- Describe the usual channels of notification and develop appropriate recommendations
- Describe the concept and rationale of early warning and detection system.
- Describe how to identify / detect a malaria epidemic on a timely basis,
- Describe how to quickly verify a malaria epidemic?
- Describe urgent measures to be taken on the ground.

Early malaria epidemic detection systems

1. Allow participants to first discuss their findings and provide them with a copy of the diagram given below for comparison. Discuss the discrepancies.

Figure 2. Current way of reporting any unusual events from communities/villages

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2. The rationale to set up an early detection weekly-based system is as follows

In most countries, the health information system routinely collects and reports health data on a monthly basis, sometimes on a quarterly basis. Interval for reporting to the higher level (for example from health care facilities to district management team) is at least 10 days and most of the time quite longer. In addition, peripheral health workers are not trained to look at data they are generating and don't take any decision based on their routine data. Experience shows that malaria epidemics runs very fast with an average duration of 3-4 months. It's obvious that a monthly reporting system cannot capture an upsurge of suspected malaria cases at early stage and, as a result, cannot mobilise control resources in a timely manner. This is the reason why Heads of State and Ministries of Health agree in Abuja in 2000 to identify key Roll Back Malaria targets which, among others, is the states "to detect and control epidemics within 2 weeks of onset" (see further).

It must be noticed that other epidemic diseases like Meningitis, cholera, Yellow fever, etc, are monitored on a weekly basis and that malaria should be part of this list only in well delimited / recognized prone regions for epidemics.

Methods for determining epidemic thresholds

3. Epidemic thresholds detection systems include

Routinely, epidemic threshold is used for early detection within 2 weeks of onset of malaria epidemic. Attempts have been made by WHO and other institutions to identify epidemic thresholds which clearly define an epidemic against the previous experience of the disease. Such thresholds can been worked out in areas where historical epidemiological data / pattern exist for some years, and the population has remained stable. If this information is available it makes the declaration of an epidemic very straightforward. The following methods can be proposed to develop epidemic thresholds.

i. Constant case count thresholds
ii. Mean + 2SD
iii. Medium + upper 3rd quartile
iv. the Cumulative Sum (C-SUM) method
v. Incidence thresholds (Meningitis as an example)

Many epidemics occur in situations where previous data is either not available, or irrelevant due to significant contextual changes. In these circumstances, precise thresholds will be difficult to set up and an epidemic situation is more practically noticed by:

• the rapid (noticed on a weekly basis) increase in numbers
• a high case fatality rate (due to late specific treatment at community level)
• the fact that the existing health services are overwhelmed (e.g. shortage of health personnel and drugs).
Early warning, early detection, notification and verification of a malaria epidemic  Learning unit 2

Method 1: Constant case count thresholds

In Botswana three alert thresholds based on both unconfirmed and confirmed malaria, cases are used for malaria epidemic prediction at the district level. In this system, 400 absolute cases/week in one district indicates an alert which should be acted upon at the district level, 800 cases/week indicates the national authorities should be informed and 1200 cases/week indicates a national emergency. The simplicity of this method is reinforced by a data entry system in which the values of case numbers above the threshold are automatically highlighted in red drawing the information to the attention of those reviewing the data. Botswana is unusual with respect to much of Africa because laboratory diagnosis is made of all suspected cases. This system seems appropriate to the district structure in Botswana, which is largely determined by population size (~100,000 persons per district).

In Vietnam, in non-endemic areas, when the number of local confirmed malaria cases is over 10 within 2 weeks, an epidemic is declared.

Other methods based on Statistical Monitoring

Setting epidemic thresholds is more commonly achieved by comparing the normal mean/medium cases of the at least 5 previous years with the current case numbers over a set time (preferably weekly than monthly-based due to the fast sharp increase of cases when transmission starts on an epidemic mode). Initially this may be from suspected malaria cases only but subsequent confirmation using a thick blood film or rapid diagnosis tests (RDT) will confirm or deny the suspected change in malaria case numbers.

Method 2: Mean + 2SD

This involves the calculation of the long-term mean of monthly malaria cases (derived from a minimum 5 year data set from which abnormal years have been excluded) and an epidemic threshold set at two times the standard deviation of the mean. This method has been promoted in Africa as a result of the promising results of a study in northern Thailand in the early 1980’s (Cullen et al., 1984).

Experience from Madagascar, where this threshold method has been tested, indicates that it has high sensitivity, but low specificity and predictive value. Out of 69 epidemic alerts signalled by this system only 17 of these were reported within 30 days and only 5/69 were found, on further investigation, to represent a real increase in malaria cases. The main causes of alerts being given were poor reporting and closure of neighbouring health facilities (Raveloson et al., 1998), (Albonico et al., 1999).

Method 3: Medium + upper 3rd quartile

For some time WHO has used the expression ‘normal epidemic channel’ to describe the normal seasonal pattern of malaria in an area (Najera, 1998). The recommended method for obtaining the normal channel is to compute the monthly median value and the upper 3rd quartile from a time series of monthly data. Months in which cases exceed the 3rd quartile will be declared routinely as epidemic months. This method has the advantage over Method 2 in that results are less influenced by abnormal years and the values are easier to calculate without computing facilities. Again a minimum of 5 years data is required. However, if the historical data does not include any epidemic years any value marginally exceeding those that have occurred could result in an epidemic being
declared— even though the case numbers may be well within the normal range. In Uganda historical malaria morbidity data (3-5 years) from sentinel sites are used to define median and quartile values for malaria incidence on a monthly basis. Health workers are trained to plot malaria cases onto this graph on a weekly basis. When cases are in excess of the median a report is sent to the District Medical Officer (DMO) to provide an initial alert. If cases rise above the 3rd quartile then an epidemic is declared and the local DMO, MoH and DMOs in other epidemic prone districts are notified immediately.

4. Divide participants into small working groups to do the exercises (a, b, c, d, and e) related to the data given in table 3a below.

Table 3a. Malaria cases reported from El Obeid (Sudan)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1994</td>
<td>1609</td>
<td>2235</td>
<td>2035</td>
<td>1597</td>
<td>4927</td>
<td>2442</td>
<td>2857</td>
<td>5159</td>
<td>9245</td>
<td>1490</td>
<td>1299</td>
<td>2267</td>
</tr>
<tr>
<td>1995</td>
<td>1214</td>
<td>1322</td>
<td>1784</td>
<td>1880</td>
<td>1958</td>
<td>398</td>
<td>2815</td>
<td>4761</td>
<td>5845</td>
<td>2588</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>1198</td>
<td>1099</td>
<td>2010</td>
<td>1411</td>
<td>1449</td>
<td>2018</td>
<td>1737</td>
<td>1902</td>
<td>1939</td>
<td>1842</td>
<td>2332</td>
<td>2321</td>
</tr>
<tr>
<td>1997</td>
<td>2597</td>
<td>2219</td>
<td>2988</td>
<td>2977</td>
<td>3534</td>
<td>2822</td>
<td>4028</td>
<td>3188</td>
<td>3395</td>
<td>2269</td>
<td>2223</td>
<td></td>
</tr>
<tr>
<td>1998</td>
<td>2941</td>
<td>2449</td>
<td>2619</td>
<td>2462</td>
<td>2973</td>
<td>2200</td>
<td>2612</td>
<td>2424</td>
<td>8658</td>
<td>10158</td>
<td>4274</td>
<td>2944</td>
</tr>
</tbody>
</table>

a) In order to determine the median and quartiles the data need to be re-arranged in ascending order for each month. This would be best done by feeding the data on computer using Excel. When sorted on an ascending order, the second lowest figure in the month is the 1st quartile and the second highest value is the 3rd quartile. The 2nd quartile, which is the middle of the mid-value throughout the 5 years observation of that month, is the Median. Compare results of working groups with table 3b.

Table 3b. Malaria cases reported from El Obeid (Sudan)

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
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<tbody>
<tr>
<td>1994</td>
<td>1198</td>
<td>1099</td>
<td>1784</td>
<td>1411</td>
<td>1449</td>
<td>1958</td>
<td>398</td>
<td>1902</td>
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<td>1995</td>
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<td>1597</td>
<td>1863</td>
<td>2018</td>
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<td>2449</td>
<td>2988</td>
<td>5276</td>
<td>3534</td>
<td>2857</td>
<td>5159</td>
<td>9245</td>
<td>10158</td>
<td>4274</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b) Allow learners to feed the data on Excel and sort the figures in ascending order. Then ask them to plot the figures on a graph.

In the absence of a computer, learners can do these exercises on paper and for graphs they can plot using graph paper or simple squared paper to construct a graph of the median and the 3rd quartile. The plating should look like figure 3.
c) The upper line - the 3rd quartile – indicates a level above which you should consider the possibility of an epidemic.

d) After each group has presented its findings compare with the following results. Add the row of figures for 1999 into the previously constructed table (1994-1998) and plot another graph to see the situation of the year you are monitoring.

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>1364</td>
<td>2560</td>
<td>2817</td>
<td>1656</td>
<td>1958</td>
<td>2021</td>
<td>2255</td>
<td>3169</td>
<td>4897</td>
<td>9158</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The graph should look like what is indicated in figure 4.

From the graph, the October figure is rising steeply above the 3rd quartile signalling the beginning of an epidemic.
5. Similar to the Sudan data, learners need to rearrange the data in an ascending order as shown in table 4 then ask them to bold the columns that contain median, lower and upper quartiles.

<table>
<thead>
<tr>
<th>Month</th>
<th>Week</th>
<th>1st Quartile</th>
<th>Median</th>
<th>3rd Quartile</th>
<th>19992 Epidemic</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>1</td>
<td>9</td>
<td>20</td>
<td>44</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>29</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>8</td>
<td>13</td>
<td>31</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>1</td>
<td>15</td>
<td>35</td>
<td>46</td>
</tr>
<tr>
<td>February</td>
<td>1</td>
<td>7</td>
<td>9</td>
<td>38</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>2</td>
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a) The graph plots for the Median, Upper and Lower Quartiles is indicated in figure 5.
b) From the figure it can be concluded that the case load from the epidemic year of 1992 clearly exceeds the 3rd Quartile during the latter quarter.

![Figure 5. 3rd Qrtl and Median of the malaria data, Zwai, Ethiopia](image)

**Method 4: the Cumulative SUM (C-SUM) method**

6. The same example will be used to define the threshold using **C-SUM method**.

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
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<td>16328</td>
<td>27791</td>
<td>22730</td>
<td>12762</td>
<td>9755</td>
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</table>

To calculate the C-SUM for January add the sum for December, January and February, and divide the total by 15. Similarly the C-SUM for February is calculated by adding the sum of January, February and March and dividing by 15.

The figures for C-SUMS for each month are then as follows.

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<tr>
<td>C-SUM</td>
<td>1902</td>
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</table>
a) The above calculated figures can be shown on a graph as in Fig 6.

![Figure 6. C-SUM of morbidity data 1988-1998, Zwai, Ethiopia](image)

This line represents the threshold above which you should be alert for an epidemic.

b) If you then add the figures for 1999, the graph looks like this.

![Figure 7. Comparison of 1999 data with the C-SUM of morbidity data 1988-1998, Zwai, Ethiopia](image)

It is easily seen that the numbers for October are far above the threshold signalling an epidemic.

c) All these methods use monthly figures. The disadvantage is that by the time figures are collected, reported and analysed it could be 4 weeks or more after the onset of an epidemic, with unacceptable delays to the investigation and response. Ideally data should be collected and analysed at the peripheral level on a weekly basis, and both the methods described above can be adapted to weekly figures. However, few places have weekly figures going back 5 years. The following method is suggested to use the thresholds developed from 5 years of monthly data and apply them to current weekly data.
Advice learners to use graph paper with the C-SUM or quartile threshold clearly marked as above.

As the weekly data are collected, mark the number as a column under the month in question. The next week, add the number to that of the first week, and extend the column to the new figure. Using a different colour for each week will make it clearer. Participants should do the same for the 3rd and 4th weeks. If the column is already at the threshold by the 2nd or 3rd week, it will be possible to raise the alert of an epidemic much sooner than waiting for the whole month’s figures (see fig. 8 example of figure manually plotted on a graph paper).

**Figure 8. Manually prepared graph comparing C-Sum used and weekly***

Make it clear to learners to note that by the end of the second week in October the numbers had already exceeded the threshold, allowing the earlier investigation and declaration of an epidemic. Let participants compare their results with the diagram given.

**Method 5: Incidence thresholds (Meningitis as an example)**

Incidence thresholds are used as early epidemic detection indicators for other epidemic diseases in Africa such as meningococcal meningitis. As with malaria, in countries where meningococcal disease is highly endemic, there is a need to distinguish an emerging epidemic of meningitis from a simple seasonal rise in incidence, in order to implement emergency control measures.

Further work on the use of epidemic thresholds for meningitis has revealed that sensitivity and specificity are time dependent - i.e. an early crossing of the threshold should raise greater concern than a late one. WHO have since recommended that two thresholds, developed using surveillance data, be used for meningitis (Anon, 2000a).
The first, an *alert threshold*, should be used to (a) sound an early warning and launch an investigation at the start of an epidemic; (b) check epidemic preparedness; (c) start a vaccination campaign if there is an epidemic in a neighbouring area and (d) prioritize areas for vaccination campaigns in the course of an epidemic. A subsequent threshold, the *epidemic threshold* is used to confirm the emergence of an epidemic so as to step up control measures, i.e. mass vaccination and appropriate case management. The epidemic threshold depends on the context, and when the risk of an epidemic is high, a lower threshold, more effective in this situation, is recommended.

*Developing two thresholds – an alert threshold for early warning and an epidemic threshold for early detection may also prove valuable for the prevention and control of malaria epidemics.* It would also seem likely that thresholds will need to be developed for particular localities, as their sensitivity and specificity are likely to vary according to local epidemiological factors. This is an important area for operational research in epidemic prone areas.

**Early detection and overall management systems**

7. **Measures/systems to be taken for early detection overall management systems at all levels.**

At peripheral level:

i. The weekly-based reporting system is expected to work at the peripheral level. Those in frontline of any unusual events are those working at community / village or health center level.

ii. Peripheral health workers should be able to make a simple analysis of data they are generating daily. Analysis should include a weekly notification / reporting on a graph, as quick reporting to health district management team in case of an unusual increase (see thresholds) of fever cases.

iii. Quick verification procedures should also take place at the periphery by using either microscopy or Rapid diagnostic tests (RDTs).

At district level:

i. District management team should be able to compile clinics data and establish / update thresholds as a result of past data analysis.

ii. District teams should also be able at least to correlate epidemiological data with any other relevant warning indicators such as meteorological data, population movements or situations which impact on environment.

At national level:

i. National malaria control programme (NMCP) team should provide strategic direction to carefully analyze data and ensure regular links and articulated work with other sectors relevant in this area.
ii. Strengthening capacity of health workers to analyse data, ensure verification procedures, maintain emergency stocks and start with urgent actions is key element of success.

Also explain to learners the following.

i. Analysing properly past epidemiological data preferably on a weekly basis is the first step to be done preferably at district level with the support of the NMCP.

ii. Particular attention should be paid at data generated during past epidemics and correlation with potential warning indicators. This process needs sometimes to go back to clinic records since most of data are not available at national or district level, and rarely on a weekly basis.

iii. At least past 5 year historical data should be investigated which should include an epidemic year. From these data, attempts could be made to define epidemic thresholds and develop an operational warning system.

**Verification of malaria epidemics**

8. The steps for verification of a detected malaria epidemics at different levels is described as follows.

At peripheral level:

i. *Rapid assessment to confirm:* malaria epidemic is often reported outside the health care system and the first task of a malaria control team or peripheral health team is to make whether or not the cause of the unusual increase of fever cases is due to malaria.

ii. *Laboratory investigation:* expert team to evaluate the situation should be mobilized in parallel to immediate laboratory investigation made by peripheral health (see further). For example, a mobile malaria epidemic detection team comprising a medical officer, epidemiologist and trained staff with adequate facilities to perform diagnostics could be made available for quick dispatch.

- Rapid diagnostic kits such as Parasight that use dip sticks to make a quick malaria diagnosis in the field (without the need for staining, microscopes or skilled technicians that are usually required for slide examinations).
- If Parasite kits are too expensive, other tools for blood-film examination are necessary for verifying epidemics.
- Some entomological tools for larval and/or adult mosquito collection would be helpful in making a quick investigation of the cause and to determine what vector control measures need to be taken, or if vector control is necessary at all.

iii. *Notification:* upon evaluation, if the expert team determines that it is an actual epidemic, the district monitoring centre should notify the national emergency team immediately.

9. Support learners to come-up with a flowchart similar to figure 9 given below for timely detection, verification and notification of a malaria epidemic using routine clinical data weekly recorded. Verification process starts at peripheral level by using either microscopy or RDTs.
Figure 9. Logical flowchart of detection, verification and notification of malaria epidemics

Health centre level

Tabulate or plot weekly number of suspected malaria patients

The weekly number (or 2 consecutive weeks) exceeds the calculated threshold

YES

PRE-ALERT PHASE:
- Rapid notification
- Slides taken in a definite sample of suspected patients
- district team sent.

NO

Routine notification

District level

Proportion of positive slides > x % (a)

YES

- Rapid situation analysis
- Implementation of pre planned appropriate malaria control measures
- Partnership mobilization

NO

Investigation of other possible causes

(a) according to the landscape epidemiology of malaria, as well as the previous experience of the epidemiologist (Pull, 1972).

Local authorities, community health workers, peripheral health workers are those in frontline of any unusual events. As stated before, "hot information" does not pass through the "health channel" but rather through administrative authorities and local media who are wide spreading rather rumours than facts. It's important that health workers ensure regular communication with local / political authorities to avoid panics and unnecessary attitudes, ensure quick verification procedures and define / articulate early specific interventions with field partners according to preparedness plan of action. It's important also that peripheral health workers have the requested equipment (like RDT and emergency drugs in stock) to take early action without delay due for example by waiting for district or central decision and support.
When an usual increase of suspected malaria cases is detected in any peripheral health care facilities, in parallel to district team action, urgent actions should be initiated by the health worker. The first action is to verify that among a sample size of suspected malaria cases (sick patients with fever), a significant (or not) proportion is infected by either *P. falciparum* or / and by *P. vivax*. The epidemic threshold proportion of confirmed malaria cases varies locally and depends on the epidemiological landscape.

10. Since clinical diagnosis is notoriously inaccurate, it is necessary to monitor the percentage of clinical diagnoses that are proven malaria cases by regularly sampling a given number of clinical cases for parasitaemia. In arid and semi arid areas, the proportion of sick people with fever and blood parasites is expected to be low (≤5% to above 50% during epidemics). In Highlands or regions with short seasonal transmission, the Slide Positive Rate or positive RDT rate might be higher (30-40%) during normal transmission seasons and above 70% during epidemics. It's obvious to insist again on the fact that baseline data are essential to set up a SPR threshold. It should be noted also that in case of epidemics, everybody even with minor symptoms is encouraged to quickly go to HC with free access to drugs, it could affect the SPR trends.

*The accuracy of clinical diagnosis in arid and highland areas with seasonal transmission would not be similar because of varying prevalence. Laboratory diagnose is required more in low transmission areas where confirmation of diagnosis and treatment if cost-effective is necessary as population as less immune. In areas with higher prevalence of malaria the clinical accuracy would be better. Please refer learners to more reading materials on specificity, sensitivity and Positive Predictive Value of diagnostic tools including clinical diagnosis in relation to varying prevalence*.3

11. Allow working groups enough time to analyse the model in figure 10 and explain answers to the questions as follows. Provide copies of this figure to learners at the end of discussion for comparison of their thoughts.

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3 Introduction to basic epidemiology and statistics for control of tropical diseases. Learner ans Tutor module. WHO
Figure 10. Forecasting, early warning and early detection model resulting from the Salt Rock Meeting, South Africa, Anon, 1999

a) In the operational concept example presented above:
   - a long range weather forecasting (first warning) would be assumed in flag (Flag 1). At this level the flag could be raised at the regional level after sea-surface temperatures suggest an impending El Niño/La Nina event.
   - Early warning based on meteorological indicators: Subsequent rainfall is monitored directly as part of an early warning system and if in excess Flag 2 is raised.
   - Early detection: Malaria cases are monitored at the individual facility level and if a defined threshold is exceeded (Flag 3) an epidemic is declared.

b) Indicators and responses for each flag are indicated on the figure itself.

Thus, in general, risk indicators which may be used routinely by health services in order to assess the likelihood of an epidemic occurring in the near future (i.e. the following transmission season) include seasonal climate forecasts, weather and environmental monitoring, vulnerability assessment and morbidity surveillance.
Learning unit 3

Prevention and early response to confirmed *P. falciparum* malaria epidemics

Learning objectives

By the end of this unit you will be able to:

- Identify the most cost-effective malaria epidemic control options
- Identify the most cost-effective malaria epidemic preventive options

Cost-effective interventions to control of *P. falciparum* malaria epidemics

1. The most important cost-effective measures to control malaria epidemic are as follows: These interventions or options are ranked as per their relative importance or cost-effectiveness.

   i. **Early diagnosis and effective treatment** to all non-immune people severely or not affected by the disease in communities. It will impact directly on mortality pertaining the fact that sick people have easy access to efficient drugs.

   ii. **Early vector control measures** targeting adult mosquitoes transmitting malaria parasites. Well prepared and managed **indoor residual spraying** of all houses quickly impacts on transmission and significantly reduce morbidity and mortality rates. **Re-impregnation of all existing bed nets** if house coverage rate is greater than 85% can have an impact. In emergency context (e.g. refugee camps), more expensive space spraying of insecticides with special equipment (Ultra-low-volume sprays) and of limited effect duration can be considered as complementary measure to IRS.

   iii. **Mass drug administration** (MDA) to all the (well controlled / relatively small) population considered to be at risk. If well managed and jointly used with other vector control methods, this is one of the most effective way to rapidly reduce the parasite population. Not all drugs can be used for MDA and few of them are safe enough to be given to everybody and have a significant effect on gametocytes to reduce gametocyte carriers. **Mass fever treatment** is a more acceptable / cost-effective variant of the previous one since it proactively targeting only household members with fever suspected to be due to malaria.
a) The essential measure to be set up at early stages of any notified malaria epidemics is: early diagnosis and effective treatment either for uncomplicated or severe cases.

b) The guiding principle/s for a drug to have a significant effect on transmission during epidemics should be: (i) a drug that has gameto cidal effect and (ii) a drug that can be properly and massively used.

c) NO! Even good case management procedures have little effect on transmission using Chloroquine and Sulfadoxine-pyrimethamine as these are only blood schizontocidal drugs and have no gametocidal effects. Use of artemisinin-based combinations or primaquine, which have impact on gametocytes, could have effect on reducing transmission if they are widely, properly and massively used. In such emergency context, effective drugs must be used free of charge.

d) In case of malaria epidemics in remote areas, usually access to health care by those who are sick at home sick people is often the major problem. Possible solution to this could be establishing new health posts (mobile clinics) as well as the use of local collaborators in communities quickly through refresher training and social mobilization. Particular attention must be paid to management of severe cases either at peripheral level (early pre referral or full treatment) and/or in referral health care facilities.

**Most important control interventions**

2. For operational and biological reasons vector control options may or may not be applicable in cases of epidemics. After small group discussions, allow groups to present their arguments and encourage panel exchange of views.

   Operationally, vector control options would be viable if prone districts are well prepared and emergency stocks established and maintained.

   Biologically, they are feasible when implemented at early stage of the epidemics.

   a) **Vector control options** mainly target adult mosquitoes, to have a direct impact on malaria transmission and hence on the malaria burden.

   b) Indoor residual spraying (IRS) is feasible when well planned and conducted; when the coverage rate is above 85% and when the vector involved has an indoor resting habit.

   c) Use of ITNs or re-impregnation of existing bed nets is feasible when the coverage rate is above 85%.

   d) In complex emergency situations, where a set up of refugee camps is possible, the use of pre-impregnated tents or prefabricated impregnated plastic sheets have great impact.

   e) Space spraying of insecticides (usually done regularly on a weekly basis) could be of benefit in particular conditions such as highly dense population overcrowded in small shelters in acute emergency settlements. Vector control activities need to be well prepared in advance and staff adequately trained and supervised.
3. Divide learners into working small groups and ask them to use the data given in the table in the learning guide. This will lead them to exercise of different scenarios of early detection and interventions of epidemics and implications of not doing so. If learners do not have access to computers, advise them to plot the columns into figures using paper graphs.

a) From the data given in table let learners first present their findings to compare with the graphs shown below.

**Figure 11. Malaria epidemics and different scenarios of intervention timings**

![Graphs showing different scenarios of intervention timings](https://example.com)
b) The differences are that:

Fig (i) represents a graph of column 2, a suddenly occurring fully blown epidemic with no detection and intervention taken place. It phases out by itself as the precipitating factors disappear or reduce.

Fig (ii) represents a graph of column 3 as compared to column 2, an epidemic which is lately detected and intervened with expensive control measures. Considerable number of cases have occurred due to delayed response.

Fig (iii) represents a graph of column 4 as compared to column 2, an epidemic which is detected and intervened with some delay but relatively better than fig (ii).

Fig (iv) represents a graph of column 5, an epidemic which has been averted due to better detection timing, better preparedness and response. This could result from better community awareness, better health service with trained health workers. This intervention and application control measures at early stage has enabled minimize occurrences of cases.

c) Column 5 or figure (iv) shows existence of proper preparedness and response (better malaria control programme) as discussed in (b).

d) Figure (v) would be the ideal time sequence of forecasting, early warning and detection to for a complete prevention of the epidemics with cost effective monitoring system. This would lead to either of the following:
   - very early recognition of emergency and immediate control measures
   - implementation of preventive measures before epidemic state

Case management and drug policy during epidemics.

Managing uncomplicated malaria cases during epidemics.

As stated above, early access by everybody to efficient drugs during a malaria epidemic is key intervention to minimise the malaria burden. People at risk are non immune and existing cheap monotherapies especially in Africa are not longer fully effective. There is a need to shift to other policy options such as combination therapies in endemic countries but also in prone countries to perhaps set up specific approaches.

4. Yes, during epidemics it could be possible to use drugs (for uncomplicated malaria) that are different from the ones used in normal endemic settings in the same country. There is perhaps a need to decide on emergency drugs which have a potential impact on malaria transmission.

Managing severe malaria cases during epidemics.

5. To manage severe malaria cases, due to the huge and acute workload, there is a need to develop more practical approaches during epidemics as compared to the "normal" routine situation. WHO recommends the use either of quinine IV widely available or artemether IM less much available to manage severe malaria. Managing severe malaria cases with quinine IV is not easy at all even in "normal" contexts where
referral hospitals have set-up intensive case units with special equipment and trained specialised health staff. During epidemics cost effective alternatives to quinine IV or IM 3 times a day can be recommended such as artemether IM once a day which is easier to implement outside intensive care units in peripheral health clinics, with limited side effects, minimum follow-up and high efficacy rate. Availability, use and stock management of such more expensive drugs at country level should be decided by NMCP and partners as part of preparedness plan of action.

**Failure rate threshold to shift from one drug to another during epidemics.**

6. The answer is No! There is a general consensus among experts to state that, at least in endemic areas, a 25% therapeutic failure rate with a specific monotherapy means that this monotherapy cannot be used any longer even in combinations. However, in epidemic-prone regions where inhabitants are non-immune against *P. falciparum*, a highly effective drug must be promoted. So even a failure threshold of 10% can be considered as highly costly to tolerate in this particular context. Efficacious combination therapies become the best options to be widely used in the field even if CQ and SP failure rate is documented to be less than 25%. With limited knowledge of current monotherapies failure rates, available artemisinin-based combinations (ACT) should be used building on information compiled from neighbouring countries.

7. **Mass drug administration (MDA)** Mass Drug Administration is a treatment given to all population considered to be at risk (irrespective of presence of fever) to quickly reduce malaria burden.

   a) The principle behind MDA is that by using gametocidal drugs (such as Primaquine or ATCs) it is possible to dramatically reduce gametocytes carriers and hence a significant impact on transmission reduction.

   b) MDA has limited use since very few antimalarial drugs have the potential, with acceptable side effects / contraindications to significantly reduce gametocytes carriers. Primaquine, which is considered as the reference gametocytocidal drug, shows high side effects rate and numerous contraindications particularly in pregnant women and G-6-PD deficient residents. These facts render this particular drug problematic to be used for mass administration except in relatively small and well controlled population.

Some ACT are safe enough to be used widely and should preferably target people at risk with fever (so-called Mass Fever Treatment) rather than the entire population considered at risk. However, the efficacy of ACT on transmission during epidemics needs further investigation.

**Vector control options for prevention and control of malaria epidemics**

8. Allow learners to discuss this in small working groups to estimate the time required for the development of infective vector and transmission of gametocytes to non-immune individuals. Effectiveness of IRS for prevention of epidemics basically depends on the residual effect of the insecticides and surfaces where applied. It also depends on the accuracy and reliability of the prediction. An IRS applied at least one month earlier to the onset of an epidemics can effectively prevent a predicted malaria epidemics.
a) In a situation where epidemics is detected a bit late, for IRS to be effective (see graph on the scenarios depicted in fig i, ii, iii, iv), it need to be carried out within 2 weeks of epidemic onset (see also Abuja's targets) and coverage need to be higher than 85%. It is not rare to see that, under such circumstances when political pressure is high without appropriate preparedness, vector control measures like IRS are employed after the transmission peak or long after transmission has almost ceased.

b) Coverage is so important for effectiveness of IRS because vectors in sprayed houses do not rest long enough on the walls before biting. A sprayed house does not protect its occupants from transmission if most of the houses in the neighbourhood are not sprayed as the vectors survive. If coverage is low people can still be bitten and infected in the unsprayed houses.

c) Modelling of the economics of early warning systems suggests that one should carry out vector control interventions such as IRS when the mosquito population is small and that there is a cut-off point when spraying becomes ineffective in terms of lives saved (refere the equation on Ro). This has considerable implications for the choice of insecticide, as the residual effect must last long enough to remain active throughout the season. Effectiveness of IRS also depends on the resting behaviour of the vector involved. This model supports the use of DDT (expected efficacy of six months) which is currently being re-introduced in Southern Africa.

9. The following important issues (criteria) need to be considered when indoor residual spraying operations are planned:

- Using an insecticide with adequate residual effect that covers the entire transmission season (DDT has a residual effect of at least 6 months as compared to pyrethroids which last 2-3 months)
- Good susceptibility of vectors to the selected insecticide
- Good insecticide stability for storage, easy formulation and application
- Acceptable Cost (DDT is the cheapest)
- Insecticides are safe to the general population, as well as for spray-men and domestic animals including honey bees
- Good acceptance by the population (odour, stain etc.)
- Good effectiveness against other household pests (bed bugs, fleas, etc.)
- Minimum environmental effect

DDT could be taken as an example that had qualified to most of the criteria mentioned above. But because of controversial environmental concerns and increasing resistance of the vector to the insecticide, it does not fulfil some of the above criteria. Challenges of replacing this insecticide with other recent ones include short residual effect, high cost and safety.

DDT is the most widely used insecticide in IRS operations in Africa and elsewhere. The advantages of DDT are that it is less expensive compared to many other insecticides, has a longer residual effect (usually more than 6 months) and is relatively safe to humans and domestic animals when used strictly for indoor spraying of houses. Of course, due to its long and extensive use in malaria endemic regions, resistance of vectors to DDT is a problem in many areas. Many households have become resistant, thereby compromising DDT's acceptance by the general public, as is commonly observed in Ethiopia where the insecticide has been in use for over four decades.
Impregnated treated materials (ITMs)

Another vector control strategy relates to the use of Impregnated Treated Materials (ITMs) such as impregnated treated bed nets. The use of ITNs is gaining momentum in many parts of Africa where malaria is endemic, although the coverage in many epidemic prone areas is still low. Though distribution of ITNs might not be a practical option given the urgency of epidemic prevention and control operations, re-impregnation of nets could provide a sufficient degree of protection in areas where a high level of coverage has been achieved. In such situations, arrangements should be made to provide the re-impregnation service free of charge.

10. As IRS to be fully effective, ITNs coverage and re-impregnation rate must be higher than 85%. Such high coverage is important because of the need for mass killing effect (to the vector) and if ITN is only used by few members of the community where transmission is likely, the burden will still be maintained.

a) Coverage and acceptance in epidemic areas is low. Because the insect nuisance is not seen as a problem by residents. In endemic areas where nuisance is high ITNs coverage is still less than 5% in most African endemic countries. Although coverage is relatively better in endemic areas than epidemic prone areas, the coverage has only individual effect and is still low enough to produce a significant protective effect or impact on transmission. That is why the coverage should be higher than 85%.

b) In regions with short and important seasonal transmission, effort can be made to make ITNs available to cover all households as well as to re-impregnate them preferably free of charge before the transmission season especially when the warning system indicates / predicts an unusually high transmission season. As stated before, emergency vector control measures such as the use of pre-impregnated shelters or space spraying operations can be conducted in emergency settings such as in refugee camps targeting mainly Aedes or Culex transmitted diseases and other insect nuisances.

The use of ITNs is gaining momentum in many parts of Africa where malaria is endemic, although the coverage in many epidemic prone areas is still low. Though distribution of ITNs might not be a practical option given the urgency of epidemic prevention and control operations, re-impregnation of nets could provide a sufficient degree of protection in areas where a high level of coverage has been achieved. In such situations, arrangements should be made to provide the re-impregnation service free of charge.

Space spray application

Aerial spraying of insecticides could also be useful in emergency situations when a large number of displaced non-immune populations are forced to live in malaria-endemic areas under poor housing conditions.

11. Aerial sprays mainly target adult mosquitoes actively flying or resting outdoors. These operations are obviously expensive and can only be considered during special occasions like emergency situations in refugee camps or urban centres and in collaboration with multilateral agencies like the UNHCR.
**Larval control (chemical, environmental)**

Larval control could be an important tool for reducing the vector population in some ecological settings. Interventions against larvae should be undertaken in situations where breeding habitats are limited or clearly identifiable. Larval control can be made using larviciding chemicals or source reduction measures. Selection of either option depends on the availability of resources and the nature of larval breeding habitats.

12. Given the above limitations, larval control can be applied in:
   - urban centres
   - near irrigation projects
   - rural villages and in arid areas with limited and well known breeding habitats.

While considering larval control the following biological and operational factors need to be considered:

- knowledge on the breeding preference of local vectors
- that breeding sites are manageable and high coverage could be attained
- to have the necessary logistics and resources
- secure a high level of community participation

It should be noted that larval control measures are more effective when undertaken prior to the occurrence of epidemics or at the very early indications of increased transmission than when employed late to mitigate ongoing epidemics. Such measures should be based on sound meteorological warnings and actual data on the abundance and persistence of mosquito breeding habitats.

Entomological information such as the abundance of larvae could be often be misleading as larval abundance climaxes after the peak in adult population and thus action could be too late to have an impact in epidemic control.

13. The Abuja targets set in 2000 which aims for 2005 at reaching 60% of malaria prone countries would detect and control malaria epidemics within 2 weeks of onset seems far from reality and would not be achievable. Because most epidemic prone countries in Africa still have poor health system, resources and capacity, inefficient surveillance and monitoring systems.

**Malaria as part of the list of epidemic diseases**

Standard case definitions have been agreed upon and peripheral staff trained to use such definitions and quickly report any cases to district authorities. In recognised prone districts, suspected malaria cases can be reported on a weekly basis alongside with other epidemic diseases.

14. In areas without appropriate laboratory facilities, the definition of malaria case is empirical and clinically based. Yes, all patients who have received an antimalarial drug treatment can be considered as malaria cases (see XXth malaria expert committee). What is really important from an epidemiological point of view is the consistency of recording suspected malaria cases over time rather than ensuring a valid malaria diagnosis. Effort should be made to improve clinically or laboratory-based diagnosis.
15. Prevention and control of malaria epidemics should not be handled in isolation. Suspected epidemic-prone diseases such as yellow fever, meningitis, cholera, diarrhoea with blood, viral haemorrhagic fevers, measles, plague, etc⁴ (see for) are recommended by WHO to be investigated, notified, verified and reported.

In case of unusual increase of suspected cases, RDT or blood smears in small sample size, can be performed to confirm a malaria outbreak.

**Preventive interventions of malaria epidemics**

16. It is generally believed that monitoring relevant epidemic-precipitating factors as warning indicators to predict an unusual increase of transmission to undertake preventive measures reasonably in advance is more cost effective as compared to measures taken during or after epidemics. Of course, cost-effectiveness aspects are strongly correlated with the level of accuracy of warning indictors to predict or not an unusual increase of transmission.

**Measuring the impact of preventive / control measures**

17. The number of morbidity and mortality cases averted in a targeted population can be measured against the following conservative assumptions:

- Estimated prevalence of malaria during epidemics: 0.5 malaria episode per person is expected during epidemic periods
- Proportion or prevalence of severe cases depending on the localities and species of parasite involved: Up to 5% of malaria episodes are severe malaria
- Case Fatality Rate: CFR of severe malaria (according to WHO criteria) is expected to be around 10% in reasonably well equipped referral hospitals and more than 20% during epidemics depending on availability of staff and drugs.
- Socio-economic impact

18. In acute emergency situations with limited knowledge of the malaria situation and background immunity of concerned people (including the set up of refugees camps), the following interventions can be recommended:

- Case management of uncomplicated malaria preferably with ACT. Since capacity is weak, use RDT to improve malaria diagnosis and give expensive antimalarial drugs only to confirmed malaria cases.
- Case management of severe malaria preferably with artemether IM once a day and/or artesunate suppositories or quinine IM 3 times a day (see other modules for details)
- Pre impregnated treated plastic sheets or/and other impregnated materials like blankets in refugee camps
- Indoor residual spraying operations if early implemented and NGOs, / local staff familiar with this intervention
- Re-impregnation of ITNs if there is a documented high coverage rate and/or quick distribution of ITNs to all population at risk or if people are already familiar with ITNs and use it.

⁴ AFRO technical guideline for integrated disease surveillance and response
19. Assign small working groups to discuss on the different stages of malaria epidemics and fill in the check list as right (✓) or wrong (X). Encourage learners to fill in this on full understanding of the logic and reason behind the answers.

**Figure 12. Detection of malaria epidemics at different stages**

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Impact</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i)</td>
<td>Epidemic detected just at starting point</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(ii)</td>
<td>Epidemic detected after some progression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(iii)</td>
<td>Epidemic detected at its peak</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 6. Operational responses to different stages of malaria epidemics

<table>
<thead>
<tr>
<th>No</th>
<th>Interventions or operational measures</th>
<th>Starting Epidemic</th>
<th>Accelerated Epidemic</th>
<th>Epidemic peak</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ensure all clinics and health facilities are operational and have sufficient drugs, equipment and trained staff</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>Establish treatment centres (temporary clinics or mobile clinics) where access is a problem or health facility coverage is low</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>Ensure that the correct diagnosis and treatment is provided at all health facilities and at community level</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>Promote pro-active clinical case detection and management/referral</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Reinforce the referral system and consider the introduction of artesunate suppositories and artemether IM as a temporary measure where these are not already used</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>Intensify/maintain effective preventive measures for pregnant women</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Reinforce health information systems for reporting and epidemic monitoring, preferably on a weekly basis</td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Conduct specific epidemic health education campaigns</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Organize regular press releases/conferences/articles for public information</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>IRS if area is previously sprayed:</td>
<td>✓ coverage and quality using techniques such as bio-assays.</td>
<td>✓ same as for starting epidemics change chemicals for IRS if observed susceptibility is low</td>
<td>✓ less public health impact at this stage if the previous spray did not yet help</td>
</tr>
<tr>
<td>11</td>
<td>IRS in areas previously not sprayed.</td>
<td>✓ malaria epidemiology, type of housing is established, rapid deployment of logistics and effective IRS in target areas is possible.</td>
<td>✓ same as for starting epidemics</td>
<td>X</td>
</tr>
<tr>
<td>12</td>
<td>Fogging</td>
<td>✓ if properly-timed, in highly populated areas such as refugee/IDP camps especially if shelters are small, and if IRS is not an option</td>
<td>✓ same as for starting epidemics</td>
<td>X</td>
</tr>
<tr>
<td>13</td>
<td>Insecticide Treated Materials (ITMs)</td>
<td>✓ if there is has a history of ITMs use in the area or the capacity to enforce such a programme in short time exists. Same for re-impregnation</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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Learning unit 4

Post-epidemic assessment and preparedness plan of action

Learning objectives
By the end of this unit you will be able to

- Undertake a quick assessment of the epidemic detection and control response
- Develop a preparedness plan of action

Rationale and direction for conducting a post-epidemic assessment exercise

The post-epidemic assessment exercise is one vital step within the epidemic circle to identify success and failure of all interventions planned or unplanned and ultimately consider if detecting systems and control options have had an impact on the malaria burden. This important exercise is frequently neglected by implementing partners and MOH. It means that good or bad lessons are not seriously taking on board and cannot be used to modify or strengthen existing interventions. Building on past lessons will improve an update preparedness plan of action.

1. Assign small working groups to discuss on a logical flow and steps of an epidemic cycle and request them to produce a diagram and present it for class discussion. Provide them hint to consider what have been so far covered in previous learning units (1-3) and including the post epidemic assessment exercise. All elements which are part of the classical epidemic described earlier must be carefully analysed. The diagram should look like the following. Groups may come with different patterns but should have a logical flow.

![Diagram of the epidemic cycle](image)

Pre-season preparedness and early identification provides the malaria manager with an increasing number of tools to deal with an epidemic. Maintain surveillance, keep database up-to-date, think ahead, BE PREPARED.
2. During the post-epidemic assessment exercise, the factors that could be assessed include:

- if early warning and detection systems were useful
- the cost effectiveness of the response components including budget matters.
- role and usefulness of partnership before and during epidemic including

**Preparedness plan of action**

NMCP from MOH with partners in prone epidemic countries are supposed to develop a national document which highlights strategic approaches to cope with malaria epidemics with the ultimate aim of minimizing as much as possible the malaria burden in such emergency circumstances. This strategic document should be part of a comprehensive emergency health document expected to cover other health emergencies. The most complete, accurate and agreed with partners the strategic elements are (based on the best understanding of the epidemiology, the best choice of preventive and control options of malaria in prone areas), the best is the preparedness plan of action (PPOA). The PPOA is expected to detail and budget all planned interventions at all levels with all partners. Malaria epidemic budget should be part of the overall disaster department budget covered both by GVT and country partners.

3. Assign small working groups to discuss on a logical flow and steps for strategic elements that need to be included in a preparedness plan of action prevention and control of malaria epidemic. Let learners produce a simple diagram that summarizes these steps and present it for class discussion. Lead them and provide them hints to consider what have discussed of indicators for epidemics, investigation, reporting and response. The diagram should look like the following. Groups may come with different patterns but should have a logical flow.
4. No! Preparedness plan of action should not be planned in isolation and has to be co-ordinated and integrated with other emergency or epidemic diseases. First the plan should be developed at national level targeting population living in epidemic prone areas. As part of the national planning exercise, prone districts, when developing their overall / annual plan of action, should include and budget interventions which are directly linked to emergency diseases including malaria epidemics.

In addition, since epidemics can affect several countries at the same time, it's vital to ensure / facilitate exchange of information especially between countries and with neighbouring prone districts. Exchange of information with neighbouring countries, through sub regional meetings organised by WHO or other partners, should have the opportunity to adopt similar strategies / interventions which can speed up the national, inter country response, set up and maintain sub-regional emergency stocks of agreed antimalarial drugs, insecticides and other emergency facilities.
5. **Reasons why most countries are not prepared to cope with epidemics**

Assign small working groups to discuss on the reasons. There is no right or wrong answer for this question as the reasons may vary from place to place depending on local situations, socio-economic status and culture. Learners may give varied responses which could have field relevance and you may encourage free responses and then try to get consensus in class to rank them as to their feelings and experience.

Some examples are below:

- No system in place for quick detection: Monitoring malaria epidemics on weekly basis is hardly practised in most epidemic prone areas and most are monthly data which usually tend to be either late or not useful at all.
- Lack of capacity and resources at the district or peripheral levels to take action/response: Inadequate or poor laboratory facilities and capacity to verify suspected malaria epidemics. Even in situations where malaria epidemics are detected earlier, these levels usually have no the necessary preparedness, guidance and capacity and have to wait for interventions from higher levels.
- Poor communication and poor reporting mechanisms among local authorities and health office at district and peripheral levels. Parallel reporting to their respective offices without horizontal communication which results in delayed response or inaction.
- Poor communication and coordination with other diseases of emergency diseases
- Late response from higher levels either due to delayed information or due to inadequate preparedness.
Preparedness checklist - situation analysis

Technical Support Network on Malaria Epidemic Prevention and Control

Roll Back Malaria

DRAFT

Policy, management and support system review for prevention and control of malaria epidemics

Major areas to be investigated:

1. Forecasting and prevention of epidemics including malaria.
2. Preparedness, early detection and control of epidemics including malaria.

Objectives:

1. To review the national health goals, policies and strategies on epidemics.
2. To assess institutional framework and capacity for epidemic preparedness and response.
3. To assess the design and implementation of an early warning system for forecasting and prevention of epidemics including malaria.

Name of Country............................................................................................................

Name of Province ..........................................................................................................

Name of Locality .........................................................................................................

Desk reviewer / Interviewer........................................Date........................................
POLICIES

1. Is there a national/local health policy document?

..................................................................................................................Y/N

If YES

What is the date on the document and which period does it cover
............................................................................................................................

Does it cover the prevention and control of epidemics including malaria?
............................................................................................................................Y/N

If YES

State the national/local policy on prevention and control of malaria epidemics
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................

2. Is there an inventory of diseases of epidemic potential in the country/locality?

If YES

State which ones and their epidemic thresholds
........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................

MANAGEMENT SYSTEMS

3. Is there a unit within the local MOH responsible for prevention and control of epidemics/disasters?

.........................................................................................................................Y/N

If YES

What is it called and what is its location, composition and contact address
........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................
...........................................................................................................................................

4. Is other expertise outside MOH closely involved in the work of this unit (like meteorological services)?

.........................................................................................................................Y/N
If YES
Which outside expertise exactly, and what is the nature of the collaboration
with the MOH epidemics / disasters unit?
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..........................................................................................................................
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5. Has an emergency Task Force been established? Y/N
If YES
What are the criteria for the Task Force to be called together?
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List the Task Force members, their function and contact addresses
(1)....................................................................................................................
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(2)....................................................................................................................
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(3)....................................................................................................................
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(4)....................................................................................................................
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(5)....................................................................................................................
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(6)....................................................................................................................
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(8)....................................................................................................................
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(9)....................................................................................................................
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(10)...................................................................................................................
6. Has a retrospective analysis of previous malaria epidemics in the country/locality been done as part of the overall process of malaria stratification? .................................................................Y/N

If YES, attach the final document.

7. Has mapping of malaria epidemic prone areas been done as part of the overall process of malaria stratification? .................................................................Y/N

If YES, attach the most detailed and up-to-date maps.

Do the maps identify clearly the areas/villages and populations at highest risk, the years of the most recent epidemics, and the main risk factors? .................................................................Y/N

Do the maps identify and localize the specific curative and preventive services available to the population at risk? .................................................................Y/N

8. What is the estimated population at risk of malaria epidemics in the country/locality?
   Absolute number of people ............................................................................................................
   % of the total population in the country/locality ........................................................................

9. Has an early warning system been developed to predict malaria epidemics? .................................................................Y/N

   If YES
   What kind of system ........................................................................................................................

10. Early detection system of epidemics in place? .................................................................Y/N

    If YES
    What indicators / tools are being used ...........................................................................................

    At which level(s)
    ..................................................................................................................................................

    What is the most peripheral (health) unit involved ........................................................................

    Give a frank impression of its current functioning and possible bottle-necks
    ..................................................................................................................................................

..................................................................................................................................................
Which high risk areas are not covered by the early detection system
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..................................................................................................................................
..................................................................................................................................

11. Describe the notification chain for suspected epidemics
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12. Is an initial assessment and verification of a suspected epidemic always carried out in a systematic and timely manner following agreed guidelines? Y/N
If YES, attach the guidelines/reporting format and a recent report.

13. Have control options been defined for the different high risk areas and their cost-effective timing in relation to the onset of an epidemic? Y/N
If YES, attach an overview.

14. Are there national strategic plan/guidelines and training modules for prevention and control of malaria epidemics? Y/N
If YES, attach copies of each.

15. Has a preparedness plan of action been elaborated and shared with all parties involved in epidemic warning, detection and response? Y/N
If YES, attach mailing list of most recent preparedness plan of action.
SUPPORT SYSTEMS

16. Are trained human resources available for control of epidemics? .............................................................. Y/N

If YES, give overview of categories of staff, and number in each category.

(1) .....................................................................................................................................................
(2) .....................................................................................................................................................
(3) .....................................................................................................................................................
(4) .....................................................................................................................................................
(5) .....................................................................................................................................................
(6) .....................................................................................................................................................
(7) .....................................................................................................................................................

Is it sure that all these people are still in place? .......................................................... Y/N

17. Number of core trainers trained at national/district level in epidemic preparedness and control
..............................................................................................................................................................
..............................................................................................................................................................
..............................................................................................................................................................

Is it sure that all these people are still in place? .......................................................... Y/N

18. Are dedicated financial resources available? .................................................................................................. Y/N

If YES
At which level?
..............................................................................................................................................................

Amount?
..............................................................................................................................................................
% of the overall budget for malaria control activities?
........................................................................................................................................

19. Emergency stocks in place (give localities for each) of:

i) Antimalarial drugs for uncomplicated and for severe malaria (type, quantity)
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........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

iii) Laboratory supplies (type and quantity)
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

ii) Hospital supplies (type and quantity)
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........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

iv) Insecticides (type and quantity)
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........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

v) Vector control supplies and machinery (type and quantity)
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........................................................................................................................................
........................................................................................................................................
vi) ITNs (type and quantity)
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........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

20. Priority research needs for epidemic prevention and control
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........................................................................................................................................
........................................................................................................................................
........................................................................................................................................
........................................................................................................................................

Conclusion:

Overall assessment satisfactory ? ..............................................................Y/N

IF YES : When is next assessment due ? ..............................................

IF NO : What steps will be taken to improve, by whom and when ?
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WHO priority support requested ?
..............................................................................................................Y/N
### Example of a malaria situation report – country

<table>
<thead>
<tr>
<th>Identification</th>
<th>How? (national or international media reports, security services, health systems, …)</th>
<th>When? Investigated by whom? (MOH, NGOs, Researchers, …)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contact: Names / E-mails / telephone numbers etc of people handling crisis</td>
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<td></td>
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</tbody>
</table>

| Location and Population at risk | E.g. Unusual rainfall after prolonged drought, population movements, unusual temperature increase, flooding, delayed or no control measures like IRS, others: |

| Trigger Factors (Nature of Event) | Rainfall to date, forecast, start of season, stop of season, temperature and possible cold spells |

| Meteorological Situation | **Example as follows**: Data from the four sentinel hospitals in the region shows a small increase in out-patient malaria cases in week one, a situation which has been increasing consistently for the last four years. There is however, a noticeable increase in malaria admissions in the Paediatric ward, YYY Hospital, where December 2001 admissions were double that of December 2002. There has also been a noticeable increase in the reported malaria deaths in the paediatric ward of the XXX Hospital, which reported a 66% increase compared to 1999 / 2000 (26 deaths) in the month of November. Data included in the national report. |

| Disease Situation (Attach Available data) | Type, densities, Susceptibility, Behaviour |

| Location and Population at risk | E.g. Unusual rainfall after prolonged drought, population movements, unusual temperature increase, flooding, delayed or no control measures like IRS, others: |

| Meteorological Situation | Rainfall to date, forecast, start of season, stop of season, temperature and possible cold spells |

| Disease Situation (Attach Available data) | **Example as follows**: Data from the four sentinel hospitals in the region shows a small increase in out-patient malaria cases in week one, a situation which has been increasing consistently for the last four years. There is however, a noticeable increase in malaria admissions in the Paediatric ward, YYY Hospital, where December 2001 admissions were double that of December 2002. There has also been a noticeable increase in the reported malaria deaths in the paediatric ward of the XXX Hospital, which reported a 66% increase compared to 1999 / 2000 (26 deaths) in the month of November. Data included in the national report. |

| Vector Situation | Type, densities, Susceptibility, Behaviour |

| Status of Preparedness | Is the area ready? Particularly Plans implemented, Guidelines, Checklist distributed, supplies, funds in place, people identified and trained |

| Investigation | **Example as follows**: The national team, supported by the WHO country office, has undertaken a detailed investigation of the situation. Data available has also been reviewed, however data beyond week 1 of 2002 is currently unavailable |

| Reports Available | **Example as follows**: MOH Situation Review on the recent reports of abnormal increase in malaria cases in YYY region dated 16 Jan 2002, and a detailed assessment report dated 21 Jan 2002. |

| Response | For example: Resources are currently being mobilized to address the recommendations of the assessment report, particularly to support IRS and drug distribution. In the meantime, the response is underway and hospital treatment facilities have been expanded within the area (both in terms of capacity and staff). Press releases / interviews are underway to pass information to the affected areas through TV, Radio and the press. Insecticides are being supplied to start the indoor spraying program. |

| Supplies: | Drugs (which ones?) And insecticide supplies reported as sufficient |
| Funds: | Request received by WHO country office, allocations being made through XXX funds allocated previously |
| People: | None currently requested |
| Other: | None currently requested |

| Requirements / Assistance | Please mention others events increasing vulnerability like prolonged drought season with shortage of crops and malnutrition, other epidemics such as cholera, complex emergency, flooding, etc. |

| Other Alerts That May Increase Risk | A continuous increase expected? |

<table>
<thead>
<tr>
<th>Potential Evolution</th>
<th><strong>Activity</strong></th>
<th>Completed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Immediate Follow-up Required</td>
<td>1. E.g. MOH requests for support? (WHO Country office, regional office, HQ to follow-up …)</td>
<td></td>
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<tr>
<td></td>
<td>2. E.g. National team for situation analysis and response (drugs, insecticide, monitoring &amp; surveillance, etc…)</td>
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<td>3. E.g. Control options selected:</td>
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<td></td>
<td>4. E.g. Monitoring systems for assessing results in place:</td>
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<tr>
<th>Date of Onset</th>
<th>Date of Detection</th>
<th>Date of Response</th>
</tr>
</thead>
</table>

| Other Comments: | Reported By: |

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Insert a map of the affected area
Annex 3

References

A. Public Health action in Emergencies caused by Epidemics
   A Practical Guide
   P Bres. WHO 1986 ISBN 92 4 154207 1
   It emphasizes on organization issues at national level and the same principles can
   be applied at district level or within camps for displaced population. Detailed
   description of planning outbreak investigation includes safety of personnel and
   organisation of teams.
   Specifically for vector control, there is a section on the logistics of insecticide
   spraying operations.
   There are formats for reporting and for a final report.
   The annexes contain useful explanations of epidemiological terms and examples
   of statistical analyses.

WHO Expert Committee on Malaria. Twentieth report
WHO. 2000 ISBN 92 4 120892 9
   This publication concentrates on current concerns including early detection and
   containment or prevention of malaria epidemics. It also discusses epidemic risk,
   prediction of epidemics, development of early warning systems, the effect of drug
   resistance on epidemics, the role of epidemics in the spread of resistant and the
   place of mass chemotherapy.
   The increased risk of epidemics, the spread into urban areas and the re-emergence
   of malaria in areas where it was previously eradicated are described.
   Epidemic preparedness, including post-epidemic evaluation and review of
   planning are emphasized.

Manual for Indoor Residual Spraying. Application of Residual Sprays
   for Vector Control
WHO 2000
   This is a very practical manual which fully describes the available insecticides and
   their safe and effective application.

B. Malaria Vector Control
   Insecticides for Indoor Residual Spraying
   WHO 2001
   by Najera and Zaim
   This manual gives advice on the choice of insecticide in different situations, and
   how to purchase, store, use and dispose insecticides safely. It gives a detailed
   description of the various insecticides, their use and adverse effects.
C. Malaria Control among Refugees and Displaced populations
WHO 1996
Since refugees and displaced populations are at particular risk of malaria epidemics, this provides very useful information on how to assess the level of risk, preventative measures in camp situations, and the need for effective treatment taking into account the relative immunity of displaced population and the resistance of the parasite to antimalarials. It discusses the “epidemiological exchange” between the displaced and host populations.
It describes preventative measures during an emergency phase and when the camp is more settled. Consideration is given to the benefits and dangers of mass treatment and chemoprophylaxis.
The importance of information systems and their adaptation to different stages of the emergency is also emphasized.

D. Malaria Diagnosis New Perspectives
WHO 2000
This is a useful book in describing various rapid tests now being used for malaria diagnosis. It compares the sensitivity, specificity and performance of tests. Comparison is made between the advantages and disadvantages of using rapid tests as compared to microscopy and there is discussion on further research needs.

E. Malaria Epidemics Detection and Control Forecasting and Prevention
WHO 1998
This is a very informative book that starts with a historical overview and gives many examples of epidemics of malaria in more recent years, with good graphical illustrations of their evolution. The major determinants of epidemics are discussed in detail.
The chapter on early detection and control of epidemics describes the early outbreak investigation and identification of resource capacity. Various aspects of disease management and control of transmission are described, with the possibilities and constraints of early transmission control by mass drug administration and space spraying with insecticides.
The third part of the book covers surveillance and forecasting.

The African Summit on Roll Back malaria
This report summarizes the Plan of Action agreed to by the head of African States that participated in the summit. It includes the development of early warning systems and emergency preparation and response for malaria epidemics.
It also includes the indicators to achieve control of malaria epidemics through detecting and properly controlling within 2 weeks of onset.

Prevention and Control of Malaria Epidemics; 3rd meeting of the RBM Technical Support Network
WHO 2002
A report on the progress to date and definition of further needs. There is emphasis on surveillance and communication, and the need for decision-making guidelines. There is a clear definition of an epidemic. The importance of Epidemic preparedness and response plans is also emphasized.
Monitoring Antimalarial Drug resistance
WHO 2002
This is a report of an informal consultation which was conducted in December 2001 to review and update the WHO protocols for assessing therapeutic efficacy. It should be read in conjunction with the existing protocols of 1996 and 1998. There are significant changes on the classification of therapeutic response and recommendations about analytical and statistical procedures. The place of in vitro tests and molecular markers is also discussed.

In vitro micro-test (markIII) for the assessment of the response of Plasmodium Falciparum to chloroquine, mefloquine, quinine, amodiaquine, sulphadoxine/ pyrimethamine and artemisinin.
1997

Malaria Early Warning Systems Concepts, Indicators and Partners
A framework for Field research in Africa.
WHO 2001
This book mainly discusses the development of Malaria Early Warning Systems, with the possibility of epidemic prevention. Much of this is concerned with climatic data, but also with the importance of the regular collection and interpretation of clinical data. Ways of identifying epidemic thresholds are also discussed.

The Use of Artemisinin and its Derivatives as Anti-Malarial Drugs
WHO 1998
The meeting reviewed the research and use of artemisinin derivatives and the recommendations and availability at that time
The clinical use, especially combination therapy, and the need for ongoing research is described.

The Use of Antimalarial Drugs
WHO 2001
Report of a WHO Informal Consultation Nov 2000
A useful overview of the individual antimalarials currently in use, and programmatic considerations.

Antimalarial Drug Combination Therapy
WHO 2001
Report of a WHO Technical Consultation April 2001
An update and overview of available and potential combinations, with clear recommendations for their use to replace monotherapy. Their use needs to be accompanied by careful monitoring.

Management of Severe Malaria
A practical handbook
WHO 2000 ISBN 92 4 154523 2
All you need to know about the clinical presentation and management of severe malaria is clearly discussed in this handbook.
Assessment of the safety of Artemisinin Compounds in Pregnancy
WHO 2003
This report gives the position of WHO and recommendations on the current use of artemisinin derivatives in pregnancy based on the current evidence. WHO/CDS/MAL/2003.1094

Essential Malariology 4th edition
Warrell and Gilles 2002 ISBN 0 340 74064 7
A comprehensive textbook brought up to date. It includes the history and epidemiology of malaria. There are chapters on parasites, vectors and malaria control, and on clinical presentations and treatment.

Framework for Monitoring Progress and Evaluating Outcomes and Impact
Roll Back Malaria 2000
It gives the framework of malaria programmes in country, and the indicators to monitor the progress, outcomes and impact of programmes

Scaling-up insecticide-treated netting programmes in Africa
RBM 2002
A framework for national ITN programmes

Specifications for Netting Materials
WHO 2000
It describes technical details with clear explanations of the need for particular materials and requirements for nets.

Entomological field techniques for malaria control
WHO 1992
It is A manual, divided into learning units, taking a student through the practical entomological techniques related to malaria vector

The Malaria Control programme of Namibia
Report of a WHO mission 1990
The report analyses the epidemics of malaria in 1989 and 1990 including the background for these epidemics and makes recommendations on malaria control and epidemic preparedness.

Clinical epidemiology of malaria in the Highlands of Western Kenya and Defining and Detecting malaria Epidemics in the Highlands of Western Kenya.
Hay et al. Emerging Infectious Diseases. Vol 8 no 6 June 2002
A retrospective analysis of the incidence of malaria in this region over 2 decades, with discussion about the application of different methods of defining epidemics.
Intersectoral response to the 2002 malaria outbreak in the highlands of western Kenya
Hay for UNICEF 2002
A retrospective analysis of the epidemic of the same year is given, applying the different methodologies for defining an epidemic. Recommendations are given for tightening up surveillance and using available information for early warning systems. The triggers for the epidemic are discussed, and many practical recommendations are made to address those issues and improve the detection and management of future outbreaks.

Malaria Epidemics: Preparedness: Early Warning Systems
WHO 2002
By JA Najera
This book is largely concerned with early warning systems and risk factors. Early detection based on epidemiological surveillance systems is also addressed, and illustrated with many tables and graphs.

The Health Management Information System Manual
WHO
The surveillance system used in many countries, is clearly set out in this manual.

Test procedures for Insecticide Resistance Monitoring in Malaria Vectors, Bio-efficacy and Persistence of insecticides on treated surfaces
WHO 1998
The report has results from a number of studies and updated recommendations.

Space spray application of insecticides for vector and public health pest control. A practitioner's guide.
WHO 2003
This guide provides information and recommendations on how to control flying insect pests and vectors of diseases by applying space insecticides sprays.
WHO/CDS/WHOPES/GCDPP/2003.5

Communicable Disease Control in Emergencies
WHO 2002
It includes general principles of data collection for communicable diseases, and sources of data. The chapter on malaria deals with diagnosis and treatment, and information required to investigate a suspected malaria outbreak. There are useful annexes with case definitions, indicators and standards for use in emergency cases and sampling forms.

A clinical-symptoms-based early warning system for the timely detection of malaria epidemics
Delacollette C. unpublished document, 1998
Using the 1990 malaria epidemic in Burundi, this paper discusses the use of routinely collected clinical data for the early detection of malaria epidemics. The system is based on monthly data collection.
A Guideline for malaria epidemic prediction, prevention, detection and control in Africa.
WHO 2003 (in preparation)

Interagency Handbook for Malaria Control in Complex Emergencies
It covers initial Assessment Planning and survey methods.
(in preparation)

Malaria Control Achievements problems and Strategies
WHO 1999
By JA Najera
It gives an overview of the history of the efforts to control and even eradicate malaria and the current global strategy. There is a section on control and prevention of malaria epidemics indices for early warning and practical use of clinical data.

Vector control
By Jan Roozendaal