WHO/CDS/CPE/SMT/2000.4
Part II

Diagnosis and management of severe falciparum malaria

Part II Tutor's Guide

Training Unit
Division of Control of Tropical Diseases
World Health Organization
Geneva
June 2000

The development of this training module was made possible by a grant from the World Bank

Contents

Planning the course

Adjust according to group

This Tutor's Guide is designed primarily to help those responsible for the training of those health personnel responsible for the diagnosis and management of severe *P. falciparum* malaria. Some parts of it should be useful even to the most experienced teacher. In case of self 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. After working through the picture quiz and the case studies, and discussing the suggested answers provided in the Tutor's Guide, the learner will have covered the main aspects of the diagnosis and management of severe and complicated malaria in adults and children. The tutor and facilitators provide guidance and do not in general perform supportive functions. If you are not familiar with this training system, read this introduction carefully.

For whom is this training module intended?

The module is intended for those who, in the course of their work, have to diagnose and treat patients with malaria. It will also be useful for those responsible for organizing, running and evaluating programmes for malaria control. It can be used alone for a special course or as one element of a more comprehensive course on disease control.

Educational level of learners

The training module is intended primarily for the training of physicians, nurses, medical students and other health personnel at the district hospital and intermediate levels of health care in malarious and non-endemic areas of the world.

Apart from educational qualifications, it is important that trainees:

- are able to read, comprehend and write English
- have had some experience in the diagnosis and management of severe malaria.

The complete module is designed to be accomplished in 28 hours (4 days). You will find the suggested timetable in one of the following paragraphs.

How is the training designed and what is its content?

The principal objectives of the training are listed in the Introduction to the Learner's Guide. Please stop and read these now. This module is conceived to stimulate active learning by working through a series of exercises. These exercises will be performed on the basis of the Learner's Guide preferably in small groups.

Learners are taught the salient clinical manifestations for the diagnosis and management of severe and complicated malaria. Common errors in the diagnosis and management of severe malaria are highlighted.

The learners acquire step by step all the knowledge and skills they need to recognize, diagnose and manage severe and and complicated malaria. This type of training is performance-based and is highly effective.

At the beginning of each Learning Unit of the Learner's Guide is a list of learning objectives. 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 yourselves that each learner has achieved the stated objectives before proceeding to the next Learning Unit. (Methods of evaluating progress are described later).

It is convenient to have all the learners working in small groups.

Who runs the course?

It is you who are responsible for organizing and running the course. The Learner's and Tutor's Guides 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, we stress the importance of using the Learner's Guide and the Tutor's Guide together as you proceed through the Learning Units.

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 overall manager of the training programme, you will be responsible for designing the timetable, explaining the learning tasks to the learners and facilitators, and giving learners and facilitators whatever help they need. Do not worry if the facilitators are not trained as teachers; their task is to explain or demonstrate a particular activity and to watch learners perform it. They 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 Guide 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, thus avoiding unnecessary note taking.

- 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 Learner's Guide, discussing and formulating ideas. This gives a greater opportunity to understand the subject, because there is no needs to take notes during the class.

- There is no chance of learners making errors in note-taking.

- After the course, each learner can take home a copy of the 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?

This subject is dealt with on pages 2 to 4 of the Learner's Guide. Please stop and read these now.

As stated in the Learner's Guide lectures should be kept to a minimum. The use of examples, group exercises and discussion groups are all much more effective ways of teaching.

How will you know whether it was a good course?

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 learners' performance as they work through the Learning Units and again at the end of the training, by evaluating the level of competence, and knowledge that learners have achieved in this subject. This may be done by the use of a pre-and post-tests and examples of questions that may be used are to be found in Annex 1. More details on evaluation are given later in this Tutor's Guide. A further evaluation of how well they have retained their knowledge and competence may be necessary 10-12 months later.

- **How did the learners view the 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. (A suitable questionnaire is provided in Annex 2). Frankness can be encouraged by allowing learners to make their responses anonymously.

Feedback provided during the course allows you to assess how well your training is being received and 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.

Whatever the government policy may be regarding the award of a certificate of competence, some record of attendance and level of competence reached by each learner should be kept so that details may be checked later.

Use of the Tutor's and Learner's Guides

The Tutor's and Learner's Guide and answer book may be used together for basic group training and for in-service training. The Learner's Guide alone may be used for refresher training, or by individuals for reference.

The way in which you and your facilitators should make use of the Guides and the audiovisual aids will become apparent as you work through the training module.

Learners will follow the group training activities using the Learner's Guide plus whatever other materials you provide them with. The Tutor's Guide could be handed to them at the end of the training (upon completion of this 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 improvise or to modify existing resources. Bear in mind that there may be long intervals between ordering supplies and getting them delivered, but do not delay training unnecessarily because you do not have the best equipment.

Ideally, one large room should be available for presentations and group discussions; pictures projected by the overhead and slide projectors will be seen more easily if the level of lighting can be controlled. Chairs and small tables or desks will be needed for this room. Whatever the conditions, do your best to ensure that the learners are as comfortable as is 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
- large 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)
- TV set and a video equipment.

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 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 session)
- 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 drawing during practical sessions
- pencil sharpener
- eraser
- ruler.

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 of the 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. For example, you will find that Learning Unit 1 "What you know about severe and complicated malaria in your country or place of work" will consist of a questionnaire. This unit involves individual work of participants as well as discussions by you with participants' most common misconceptions and errors. On the other hand, subsequent units can be dealt with in small group discussion of exercises, presentation of the results of each group's deliberations and general discussion involving the facilitators and yourself. Planning the course is made easier by the division of this module into a number of learning units or main topics.

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

- **Group discussion**

  Once 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 experience with the rest of the group and stimulate each other's thoughts on the subject in hand.

- **Clinical work and visits to wards**

  A number of these visits may be arranged for bed-side teaching activities. Their purpose is to give learners the opportunity to practise diagnostic principles and the management of severe diseases. The more cases they see the more competence they will acquire.

  Visits to health facilities for teaching purposes need to be well planned in advance to be sure that suitable cases are available, and the senior management and medical staff are agreable to and well informed about the visits. In addition you as the tutor should

caution the participants before each visit to conduct themselves in a professional manner and not to criticise procedures or discuss the patient's conditions while inside the facilities. All discussion and critical observations should be made back in the classroom.

- **Demonstrations, examples**

  These are designed to reinforce the learning process. Clear examples help to clarify concepts and establish principles of diagnosis and management of severe and complicated *P. falciparum* malaria.

Evaluation

Whether this module is used for group training or self learning, assessment of progress made by the learner in gaining knowledge 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. Guidance on writing multiple-choice questions and a few examples are provided in Annex 1. The post-test should be administered only after all the learning units have been completed.

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 de-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 and competence at the end of the training as revealed by the post-test.

To be valid the questions 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 retained (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.

We encourage the tutor to develop a bank of questions that can be used for pre- and post-testing in subsequent training sessions. The answers to the sample pre- and post-test questions are provided separately in the Tutor's Guide to enable you to easily reproduce the question papers. The answers are scored equally because all questions are considered, in the instance, to be of equal value.

Other evaluation instruments can be used to evaluate the training module itself, also by means of a comprehensive questionnaire completed by all learners at the end of each learning unit. Examples of such questionnaires can be obtained from the Training Unit, Division of Control of Tropical Diseases, WHO HQ, Geneva.

The timetable

Once you have calculated the amount of time that needs to be spent on each unit, all the various learning activities must be fitted into the framework of the training programme. The duration of the programme may be something over which you have little control; for instance, you may be told to limit the programme to 3 days because of shortage of funds, even though you have calculated that it should ideally be spread over 4 days. You and the facilitators will then need to spend time reorganizing the timetable so that all the learning activities can be fittted into the time available.

In planning the timetable, remember to allow time for evaluation both during and after the course, and for the hidden activities, such as getting settled into group work, delays in transportation to the training facility and so on.

A suggested timetable for a 4-day training course is shown in Table 1, but again is provided only as a guide. It is based on a 7-hour working day - four hours in the morning and three in the afternoon but this may not be suitable for your purposes and can be adapted approximately. A certain amount of time is unallocated especially in the morning sessions. As the course progresses you may feel that further discussion is necessary on some topics. These activities can be fitted into the "free" periods and a discussion session on the afternoon of the last day can also be used in a flexible manner.

Arrangement of the meeting room

Decide on the number of working groups ahead of time. Groups of four to eight are best. This will depend upon the number of learners and number of facilitators available. Try to arrange the room so that participants sit in groups in more or less a semi-circle. Make sure everybody will have a clear view of the blackboard and projector screen.

The group compositions can be changed occasionally if you wish or left the same throughout the course. But, for the pre- and post-test evaluations, participants must be seated apart from one another under examination conditions. However, the group activities can all take place in the same room and time is saved by not having to change places.

Introduction to the course

Your very first session with the learners in the meeting room should be preferably with the seating in a semicircular arrangement as indicated in the diagram. If the chairs do not have fixed supports for notebooks, it would be helpful to have small desks or tables available.

Introduce yourself first. Write your name on the board or flipchart and tell the learners a little about your background and your job. Then ask each of the facilitators to do the same thing.

The learners should introduce themselves next. It might be helpful to divide the learners into pairs and ask them to exchange names, information about jobs, home towns, etc. Each learner can then introduce his or her partner to the whole group. This method often has the effect of reducing tension, and a relaxed atmosphere is a good learning atmosphere.

The learners will have been given their copies of the Learner's Guide. Allow 10 minutes or so to read through its Introduction and then briefly, but carefully, deal with the various topics

covered. Explain, for instance, that working in small groups with facilitators should make learning easier. Stress that the course will involve a great deal of exercises, since this is the best way to acquire the necessary skills.

Go through the objectives of the various Learning Units so that the learners understand exactly what they should have achieved by the end of the course. Explain that the learners should keep these objectives in mind throughout the course and always ask for help if they feel uncertain of having achieved them. Each learner is likely to be more aware than the facilitators of how well he or she has understood a particular topic or has mastered a particular skill; it is the job of the facilitators to make the learning process as effective as possible.

There may be other subjects you want to raise at this time, but try also to encourage the learners to discuss the training programme - what they expect of it, what aspects of it are worring them, and so forth. Explain that you and the facilitators will welcome feedback throughout the course - constructive criticism from the learners may well help you to improve the training programme.

Finally, talk to the learners about evaluation. Explain that evaluation will be a continuous process throughout the training course. Stress that the pre- and post-tests should be enjoyed rather than feared; they are part of the learning experience. Their purpose is to allow you and the facilitators to assist the learners' starting level and to correct mistakes and clarify misunderstandings. Emphasize the importance of the learners reading all the questions (and any supplementary instructions) very carefully. Explain that everyone will learn at different speeds and that you and the facilitators will make as much allowance for this as possible.

Table 1. Suggested timetable

	Day 1	Day 2	Day 3	Day 4
AM				
LUNCH				
PM				

	Day 1	Day 2	Day 3	Day 4	Day 5
AM					
LUNCH					
PM					

LEARNING UNIT 1

What you know about the diagnosis and management of severe falciparum malaria in your country or place of work

Learning objective

The learning objectives for this Unit are for the learners to:

- understand the situation of severe falciparum malaria in their country or place of work, and how it is managed.

Learners should work in groups of 2-3, or singly. Emphasise that the result of this exercise will not be made public.

Make it clear to the participants that this Unit is **not** an examination but is designed to make the learners think about the situation of severe falciparum malaria in their own country or place of work. They will also have to think about how it is being managed and through this process and with your subsequent help as a tutor, they will understand and recognize the areas that need improvement. Encourage participants to answer the questions as precisely and briefly as possible and not more than 60 minutes should be allowed for this. In plenary session open a discussion between the participants regarding their experience in completing the questionnaire, paying particular attention to difficulties encountered and the reasons, and any missing information. Spend approximately one hour on this activity.

During lunch-time and at the end of the day, review the questionnaires and identify any specific areas which are the cause of common difficulties and which will need special emphasis in the Units that will follow.

LEARNING UNIT 2

Severe falciparum malaria

Learning objectives

The learning objectives for this Unit are for the learners to:

- define what is severe falciparum malaria
- identify the high risk groups likely to get severe falciparum malaria
- diagnose severe falciparum malaria
- appreciate the importance of early treatment.

The learner's guide lists the salient features of severe falciparum malaria. Stimulate discussion on each of these features and other possible diagnoses that may have to be considered.

Be particularly careful to explain why some people are at risk and others are not.

We strongly recommend that you prepare visual aids, such as overhead transparencies and slides,* in advance, and use them to demonstrate and reinforce the important features discussed.

* You may use the slides provided with this guide for teaching purposes.

LEARNING UNIT 3

Pathophysiology of severe falciparum malaria

Learning objectives

The learning objectives for this Unit are for the learners to:

- describe the mechanism believed to be responsible for the main complications of malaria
- show how an understanding of the mechanism of disease can help to determine correct treatment.

The Learner's Guide gives a succinct overview on pathophysiology of severe malaria. Make sure that all the learners have carefully read the Learning Unit, and stimulate the discussion.

Be particularly careful to explain that, in spite of the enormous amount of studies undergone on the topic, there are still some gaps in the understanding of the pathogenesis of malaria.

Use small groups and encourage discussion.

For those who wish to gain further insight into the pathophysiology of malaria refer to:

- *Severe falciparum malaria*, third edition, Transactions of the Royal Society of Tropical Medicine and Hygiene (available end of 1998).

LEARNING UNIT 4

Guidelines for diagnosis and assessment of severe falciparum malaria

Learning objectives

The learning objectives for this Unit are for the learners to:

- record a complete history from the patient
- conduct a physical examination of the patient looking for significant signs
- request the most urgent tests necessary for the correct diagnosis and management of severe falciparum malaria.

You should spend 10 minutes asking questions to the whole group to ascertain the overall understanding of the subject and to identify any serious misconceptions or gaps. Questions you may pose might be: What is the aim of taking a history? What are the elements of a history? What are the indications for alternative diagnosis? what are the indications for severity of malaria? what coma scales do they know and use? what important laboratory investigations should be carried out to confirm the diagnosis and assessment of the patient?

Based upon the outcome of the question and answer session, make a structured presentation of the subject using good quality overheads or slides* that you have prepared in advance. Go through the various elements carefully allowing plenty of time for discussion and feedback.

With regard to assessing the coma score it will be important to note that there are many scales of which two are proposed here, since they are the most widely used. These are the Glasgow coma scale for adults and the Blantyre coma scale for children.

There is no precise age at which one scale becomes more useful than the other. But as a rough guide we suggest that the Glasgow coma scale be generally used for people-aged > 12 years, and the Blantyre scale for children aged 9 months to 12 years.

With respect to laboratory investigations you as the tutor must decide beforehand what are the most practical and cost-effective tests that can be carried out in the local situation prevailing in your area. Of the investigations suggested in the Learner's Guide, some may be available and suitable for your setting whereas others will be appropriate for more advanced settings.

* You may use the slides provided with this guide for teaching purposes.

LEARNING UNIT 5

The Hospital Visit

Learning objectives

The learning objectives for this unit are:

- to put into practice the assessment of a patient with severe falciparum malaria
- to observe how the patient with severe falciparum malaria is managed in the health facility you will be visiting

It would be important to arrange well in advance a visit to a health facility with inpatients to allow the participants to have practice in history taking, eliciting physical signs and if possible assessing the level of consciousness. Remember that all the necessary health authorities should be alerted well in advance, and that you should caution the participants to act in a professional manner.

Following the visit to the health facility arrange a session in the classroom to allow a free discussion of the findings and possible problems encountered.

Advise the learners to get the whole picture of how the patient with severe falciparum malaria has used available health facilities.

LEARNING UNIT 6

Picture quiz

Learning objectives

The learning objectives for this Unit are for the learner to:

- interpret physical signs of severe disease in children and adults
- decide on differential diagnoses
- determine tests that need to be carried out.

You as the tutor should make this Learning Unit as enjoyable as possible.

Working in small groups, participants should answer each set of questions, then in plenary the group results of the group work can be compared and this can be done by projecting the pictures one by one and at the same time having a participant at the flip-chart noting the different answers of the groups. This should be followed by discussion and consensus regarding the correct interpretation.

As you use this module over time you may wish to build up a bank of pictures which could be used for a picture-quiz or as part of the pre- and post-test to evaluate the participants.

The children seen in Figures 1, 2 and 3 were all brought to a clinic in an area where *P. falciparum* is hyperendemic. Each child is unconscious and has a heavy *P. falciparum* parasitaemia. The children were 3 to 5 years old. They were febrile (38°C - 40°C). The children had been immunized against the communicable diseases of childhood through the EPI programme.

Question 1

What do the pictures show?

Answer: Opisthotonos. There is also posturing of the arms in various positions. These features indicate severe cerebral dysfunction.

Question 2

What is the differential diagnosis?

Answer: All these features may be due to cerebral malaria. The most important differential diagnosis is meningitis; you should also remember that any form of meningoencephalitis, including rabies, may present in a similar way: and hypoglycaemia due to any cause, one of which is malaria, may also present with this clinical picture. Kernicterus may also cause cerebral dysfunction.

Question 3

What tests would you do?

Answer: Blood glucose; lumbar puncture; other tests depend on the particular circumstances and response to treatment.

You should discuss with the learners about the additional tests that are (a) available and (b) appropriate in the management of this patient in the facilities in which they work.

Figure 1

Figure 2

Figure 3

The children seen in Figures 4 and 5 each have a short history of fever followed by progressive loss of consciousness. Both are in deep coma and have a heavy *P. falciparum* parasitaemia. They are 3 and 4 years old. Neither of them had been immunized against the common childhood diseases.

Question 4

What do the pictures show?

Answer: Conjugate deviation of the eyes to the left (Figure 4) or upwards (Figure 5). The patient in Figure 4 also has a sustained posture of the right arm, and the child in Figure 5 appears to have contraction of lower facial muscles, causing a grimace.

Question 5

What could be the explanation for this?

Answer: These features, like those of Figures 1 to 3 indicate a cerebral disorder. They may also be part of, or follow immediately after, a convulsion of any cause. All the conditions discussed under questions 2 and 3 should be considered in these patients, and the same tests should be done.

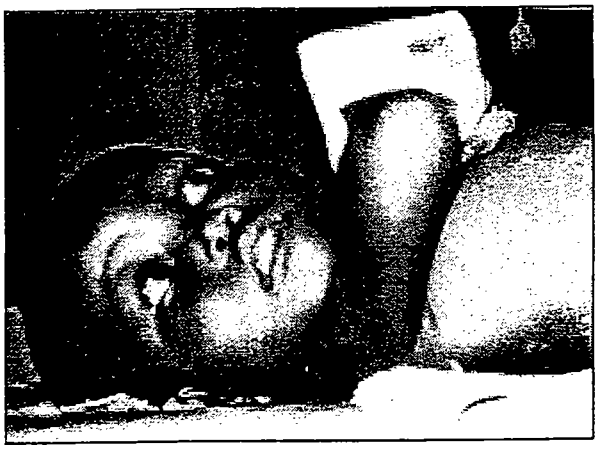


Figure 4

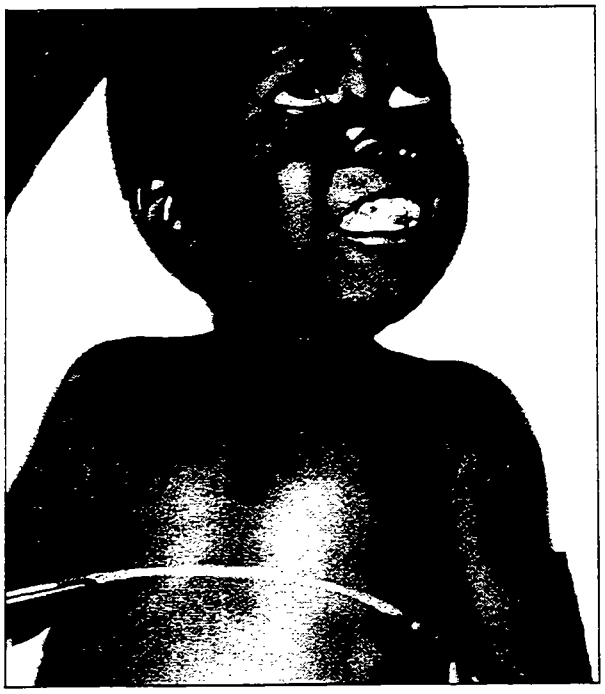


Figure 5

Figure 6

The patient seen in Figure 6 has severe *P. falciparum* malaria. She was admitted in coma, treated with quinine and recovered consciousness. Two days later she had a convulsion and collapsed into coma again.

Question 6

What are the possible causes of the convulsion and subsequent coma?

Answer:

a) Hypoglycaemia

b) May have a recrudescence of malaria because of not responding to quinine.

c) Meningitis.

Question 7

What investigations would you do to ascertain the cause?

Answer:

a) Blood glucose test, using a "stix" method if available.

b) Blood film (thick film)

c) Lumbar puncture.

d) Blood culture.

Question 8

How would you manage this patient?

- Antimalarials?
- The comatose patient should be given meticulous nursing care. The nurse should turn the patient every two hours or so. Allowing the patient to lie in a wet bed will promote bed sores.
- If hypoglycaemia is detected by blood testing or suspected on clinical grounds, give 50 ml of 50% dextrose by intravenous bolus injection.
- Follow with an intravenous infusion of 5% or 10% dextrose.
- Continue to monitor blood glucose level in order to regulate the dextrose infusion. Remember that hypoglycaemia may recur even after intravenous bolus of 50% dextrose.
- The patient should be treated with broad spectrum antibiotics without waiting for culture results. If the results of blood culture and sensitivity testing are available, give the appropriate antibiotics, if not continue with the broad spectrum antibiotics.
- Monitor and record the level of consciousness using the Glasgow coma scale, or for younger children the Blantyre scale, the temperature, respiratory rate, pulse and blood pressure.

Figure 7 shows the supportive treatment given to a patient with severe malaria.

Question 9

What exactly does the picture show?

Answer: Peritoneal dialysis in progress in a hospital in a rural location. A patient with acute tubular necrosis can be kept alive by peritoneal dialysis, until the kidneys recover, usually over a period of a few weeks.

Question 10

What is the most frequent complication in severe malaria that leads the physician to perform this procedure?

Answer: Renal failure. Dialysis is indicated if the patient remains oliguric after adequate rehydration and the blood urea and creatinine rise progressively and no possibilities for standard dialysis are available.

Question 11

What are the complications to be feared if this technique is applied in rural hospitals?

Answer: Peritoneal dialysis should not be undertaken lightly in a rural hospital setting. Bleeding and secondary infections are common complications and the mortality associated with the procedure is high. Early referral to a dialysis centre is usually preferable.

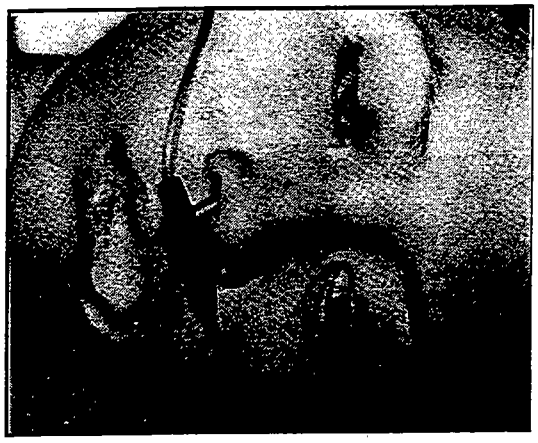


Figure 8

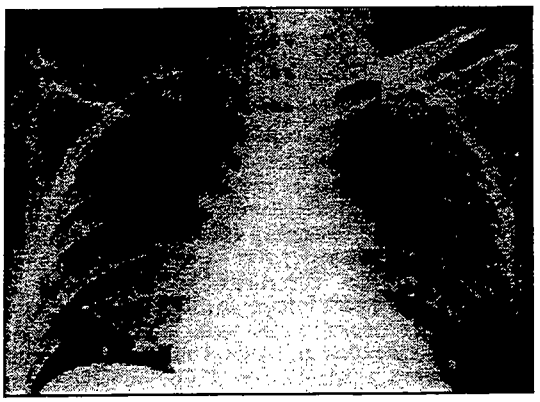


Figure 9

Figures 8 and 9 refer to the clinical and radiological presentation of a woman soon after labour.

She has severe malaria with hyperparasitaemia and the condition shown in Figures 8 and 9 was preceded by difficulty in breathing with an increased respiratory rate.

Question 12

What is the condition shown in these pictures?

Answer: Acute pulmonary oedema that developed suddenly after delivery. The fluid balance of the woman was positive. Figure 9 is the radiographic appearance of acute pulmonary oedema.

Question 13

What is the differential diagnosis for this condition?

Answer: Aspiration bronchopneumonia and metabolic acidosis. Without good facilities for emergency radiography it may be difficult to differentiate acute pulmonary oedema from aspiration bronchopneumonia and metabolic acidosis although, in the latter, examination of the chest is usually normal.

LEARNING UNIT 7

The management of severe *falciparum* malaria

Learning objectives

The learning objectives for this Unit are for the learner to be able to:

- provide urgent treatment to a severely ill patient
- provide maintenance treatment throughout the period of illness
- arrange for regular monitoring and appropriate action as necessary.

You as the tutor should ascertain that the learners have understood that severe *P. falciparum* malaria is an emergency and urgent treatment is required. Discuss with the group the various steps to be followed and explain the reasons why each treatment is recommended.

Stress the importance of the maintenance treatment throughout the period of illness and related ancillary treatments.

Show an overhead transparency of the treatment/progress/observation chart highlighting the importance of its correct compilation. Note that the appropriate coma scale should be chosen for the admission assessment, and that the same scale should then be used for all observations on that patient.

A discussion in plenary should precede the presentation of the treatments which are not usually recommended or are contraindicated. This will allow you to clear misconceptions that the learners may have on this matter.

Finally remind the learners that the use of paracetamol is suggested as an antipyretic in preference to aspirin, since the use of the latter is controversial in that adverse effects, especially in children, have been observed, i.e. bleeding, Reye's syndrome. Nevertheless if aspirin is the only choice then it should be used unless clearly contra-indicated.

Provide copies of the treatment progress/observation charts to the learners, in order to allow working groups to discuss and familiarize themselves with the various sections.

LEARNING UNIT 8

Assessment of recovery

Learning objectives

The learning objectives for this Unit are for the learner to:

- assess the extent to which the patient has recovered
- record any residual sequelae
- arrange for follow up
- write a summary of the events and outcome.

This is an important unit, although it happens to be short. It would be appropriate to organize group work based on the outcome of the health facility visit (Learning Unit 5). The participants could be asked to write a summary of the events and outcome of cases seen.

A brief structured presentation and discussion session should highlight the importance of neurological sequelae in children and adequate follow-up. Ideally follow-up should continue until a child is completely well. Stress the importance of retesting PCV and Hb one month after discharge especially if the patient was anaemic. Sequelae and their frequency should be discussed.

Working in groups the participants should develop a form for entering the relevant information for review and synopsis of patients being discharged from a health facility. It will be important to use the outcome of this exercise to emphasize the elements of such a synopsis.

LEARNING UNIT 9

Exercises in the diagnosis and management of severe *falciparum* malaria

Learning objectives

The learning objectives for this Unit, after having worked through at least five of the case studies and having discussed the answers, are for the learner to have a very good knowledge of the :

- clinical features
- complications
- laboratory aspects
- chemotherapy
- management of severe *falciparum* malaria.

After having worked through at least five of the case studies and having discussed the answers, the learners should have a very good knowledge of the clinical features, complications, laboratory aspects, chemotherapy and management of severe *falciparum* malaria.

The tutor should be satisfied that each of the participants has a good grasp of each and everyone of the above objectives in particular the chemotherapy and management of severe *falciparum* malaria. Poor knowledge of the latter is often responsible for the unacceptably high mortality of hospitalized patients.

Working in no more than three groups the learners should discuss each case study and come to a consensus on the answers to the questions to be answered. No more than 30 minutes should be allowed for each case study.

In plenary each group should then present its findings for each case study in ten minutes, to be followed by a discussion of thirty minutes. This process is extremely important because of the problem solving approach on which this module is based.

Sufficient time should be allowed to accomplish this properly and the cases should be taken in the sequence that they occur in the Learner's Guide.

As the tutor, you should be fully satisfied that all participants understand the reasoning behind the answers to each question before proceeding to the next case study.

Time should be allotted for a final round table discussion giving the learners full opportunity to clarify any issue that they may not have fully understood. You may wish to stimulate their active participation by way of a revision of the subjects. This gives you the opportunity to make a clear synthesis of the subject as a whole, prior to the post-test evaluation.

The suggested answers to the case studies, which should help you in the discussion session following the presentation of the group work, are set out in the following pages. They can be photocopied and used as handouts after the case studies have been completed.

Case study: Patient A

The place: a country where *P. falciparum* malaria is transmitted in forested areas but not in the main cities.

A woman aged 25 years is brought to the outpatient department of the central hospital in the capital. She is a local resident, the wife of a business executive, and is in the seventh month (28 weeks) of her first pregnancy.

The patient became ill five days ago, with chills, sweating and headaches. An antibiotic was prescribed and her condition seemed to improve, but yesterday she developed rigors and persistent vomiting. A blood film at the local clinic revealed malaria parasites, and oral quinine (600 mg every 8 hours) was prescribed. She took two doses.

Today she has been referred to your hospital because of restlessness and increasing mental confusion. Examination reveals a semiconscious woman, who is unable to speak. She withdraws her hand from a painful stimulus but cannot localize a stimulus applied to the sternum or forehead. There is no neck stiffness, jaundice, pallor or rash. Axillary temperature is 39°C, pulse 90 beats/min., blood pressure 110/70 mmHg. The uterine fundus is palpable (26-28 weeks), and the foetal heart can be heard.

Question 1

What tests are urgently required?

Answer: **Blood glucose.** Pregnant women are susceptible to hypoglycaemia with any stress or infection, and they are particularly likely to develop hypoglycaemia (due to hyperinsulinaemia) during treatment with quinine. This patient is pregnant and has already received some quinine; she has altered consciousness. Hypoglycaemia is therefore a strong possibility and must be checked for urgently.

Haematocrit and parasite density; because she is pregnant she may already be anaemic due to iron or folate deficiency and increased plasma volume. Malaria may rapidly exacerbate anaemia. The risk of developing pulmonary oedema is increased in patients with severe anaemia.

Lumbar puncture, and **blood culture** if possible. Meningitis may co-exist with malaria and can be impossible to identify without examination of the cerebrospinal fluid. Septicaemia may complicate severe malaria. In pregnancy there is increased susceptibility to bacterial infections - e.g. pneumococcal - including septicaemia and meningitis.

Question 2

If the blood glucose is 1.2 mmol/l (22 mg/dl), what treatment will you give?

Answer: Intravenous dextrose. Remember, hypoglycaemia may be recurrent and severe in pregnancy; monitor the blood glucose level frequently.

Question 3

If the blood film shows *P. falciparum* rings "++++", and the cerebrospinal fluid is normal except for low glucose, then:

a) What antimalarial drug will you administer and by which route?

Answer: Quinine by intravenous infusion. An alternative route for quinine is intramuscular, but the intravenous route is preferable in a centre where a drip can be set up. In some countries, an acceptable alternative is a parenteral artemisinin - e.g. intravenous artesunate.

b) Would you prefer an alternative to quinine because the patient is pregnant?

Answer: Malaria is more dangerous for this patient than quinine; she should receive quinine where it is the best available antimalarial for severe malaria. Studies have shown little oxytocic effect of quinine in these circumstances. In other settings an artemisinin drug may be preferred

c) Would you give a loading dose of quinine?

Answer: A loading dose of quinine should not be given, because the patient has received quinine within the last 24 hours, and a loading dose may therefore lead to dangerously high blood levels of the drug.

d) What nursing procedures are important during this treatment?

Answer: An important nursing responsibility is to control the rate of infusion. If quinine is allowed to run too rapidly, hypotension and hypoglycaemia may develop and the patient may become dangerously overloaded with fluid. On the other hand, if the infusion is too slow, inadequate blood levels of the drug may be achieved, and the patient may become dehydrated. Meanwhile, care of the semiconscious patient is essential. As she is restless she must be protected from falling and from pulling out drip lines. Other important nursing procedures are discussed in the following sections.

e) If you were in a health unit without facilities for parenteral therapy, what alternative treatment could you consider?

Question 4

After six hours the patient becomes increasingly restless. The respiratory rate increases to 40/minute. The blood glucose level is normal. Under these conditions, what diagnostic steps would you take?

Answer: Look for evidence of pulmonary oedema, which may complicate *falciparum* malaria, especially in pregnancy.

Review the urinary volumes passed, the volumes of intravenous fluid (including dextrose) given, and the fluid balance. This emphasizes the need for precise monitoring and recording of fluid intake and output - another important responsibility of those who nurse the patient.

Assess the central venous pressure (clinically or, if possible, with the help of a central venous pressure line).

Examine carefully for gallop rhythm, basal crepitations and hepatic enlargement.

Question 5

A chest X-ray gives the picture shown (Fig. 10). What is the diagnosis and treatment?

Answer: This X-ray could suggest pulmonary oedema or acute respiratory distress syndrome (ARDS). The mechanisms of these two conditions are different, but the clinical and radiological pictures are similar. Both are grave complications. The most important treatment is to correct fluid overload if present, using intravenous diuretics, fluid restriction and even careful venesection. ARDS can only be diagnosed on the basis of arterial blood gas measurements. It requires assisted ventilation with careful attention to blood gases and even with these facilities the prognosis is poor.

Question 6

What other diagnostic steps are particularly important in this patient?

Answer: Foetal heart rate. Foetal distress is common in malaria, especially if there is high fever. Assisted vaginal delivery or even Caesarean section must be considered if foetal distress is severe.

Question 7

What other questions would you ask this patient's relatives?

Answer: Ask about travel - when had she visited parts of the country where transmission of malaria occurs? Had she received a blood transfusion in the recent past (an alternative source of malarial infection)?

Case study: Patient B

The place: a rural clinic in a hyperendemic P. *falciparum* area. Various antimalarial drugs are available, but intravenous infusions cannot be given.

A child aged 20 months became feverish two days ago and has vomited several times today. One hour ago the child had a convulsion, described by the mother as a repetitive twitching of limbs and mouth, followed by unresponsiveness for a few minutes. The child is now febrile (39.3°C), conscious, and able to localize and respond to a painful stimulus. A thick blood film shows P. *falciparum* rings "++++". The child repeatedly vomits any antimalarial drug given by mouth.

Question 1

a) Does the child have cerebral malaria?

Answer: The fact that the child is now fully conscious suggests that the convulsion was a "febrile convulsion" rather than a component of cerebral malaria. Convulsions occur in cerebral malaria but they are not usually followed by a rapid recovery of consciousness.

b) What should you do about the convulsions?

Answer: Make sure that the risk of a further convulsion is minimized by reducing the child's temperature (paracetamol, tepid sponging and fanning).

Question 2

The district hospital is 30 km away; the journey will probably take several hours by bus.

a) Should the patient be referred to hospital?

Answer: The decision to refer will depend on facilities at the health centre. This child needs antimalarial drugs and fluids, and should receive these at a centre able to give them and able to observe the child's progress carefully.

b) What treatment would you give in the meantime?

Answer: Because the child is persistently vomiting, the first dose of antimalarial drug should be given parenterally. Ideally, this should be by slow intravenous infusion, but since this is not possible in this case, it may be given by intramuscular injection:

quinine (10 mg salt/kg) or, if most local parasites are known to be chloroquine sensitive, chloroquine (2.5 mg/kg intramuscularly).

Recent studies suggest that a loading dose of quinine (20 mg salt/kg) can safely be given by the intramuscular route, **as long as the patient has not received quinine or quinidine in the preceding 24 hours or mefloquine in the preceding 3 days.**

A reasonable approach is to give quinine 10 mg/kg intramuscular immediately, then 10 mg/kg intramuscular (the remainder of the loading dose) after 4 hours).

Because of the history of a febrile convulsion, make sure the mother continues to give her child tepid sponging and fanning to reduce the risk of further convulsions.

This child may cease to vomit soon after the injection, especially if the temperature has been successfully lowered. It may then be possible to continue treatment by mouth, without referral to a larger centre.

If, however, the child is referred to a larger centre, make sure that the child is given dextrose by mouth or nasogastric tube during the period of travel. Studies are now in progress to determine the value of artesunate suppositories in these circumstances.

Question 3

The child successfully took the second and third doses of quinine by mouth and was brought back to the clinic the next day; there had been little change; the child was still febrile, and the parasitaemia was similar to the previous day.

Does this suggest that the child has drug-resistant malaria?

Answer: No. Fever commonly persists, and the degree of parasitaemia may remain similar for up to 24 hours after the start of treatment, even if the parasite is fully sensitive to the drug being given. By 48 hours, however, the density of parasitaemia should be greatly reduced and the patient should be considerably better. You should nevertheless look for other possible causes of fever.

Question 4

The child was well and aparasitaemic on the third day, and went on to complete a seven-day course of oral quinine. At the end of that time a further blood test showed gametocytes "+".

What should be done about the gametocytes present in the blood after treatment?

Answer: Gametocytes are commonly found in the blood for several days or even weeks after successful treatment of *falciparum* malaria; they do not indicate failure of treatment, and no action is required.

Treatment to remove gametocytes from blood circulation has been used in some settings with the aim of reducing the transmission of malaria. This is inappropriate in a hyperendemic area because most transmission occurs from the large number of people with asymptomatic malaria.

Case study: Patient C

The place: a country where P. *falciparum* is hyperendemic.

The patient, a 28-year-old male economist, was born and brought up locally, but attended university in Northern Europe for five years. He returned home last month.

One week ago he developed fever. He decided this could not be malaria because he had grown up in a malarious area and believed he was therefore immune. Two days ago he became confused, especially at night. He stayed in bed and was attended by a servant who today called the doctor because the patient was increasingly confused. The last urine he had passed was a small volume of very dark fluid 24 hours ago.

On examination, the patient was a well nourished adult man. He was afebrile (rectal temperature 36.5°C). He was restless but could give brief appropriate answers to questions, and could localize the site of a painful stimulus. He was jaundiced and his mucous membranes were pale. There was some bleeding from the gums, and there were a few retinal haemorrhages in each eye.

Question 1

a) What is the differential diagnosis?

Answer: Consider all diseases that may progress to encephalopathy with jaundice: fulminant hepatitis, yellow fever, other viral fevers, relapsing fever, septicaemia, lobar pneumonia (which is commonly accompanied by jaundice), leptospirosis, alcohol excess, sickle crisis, trypanosomiasis, etc.

Nevertheless, in the circumstances of this patient, in particular the failure to pass urine, severe *falciparum* malaria must be the most likely diagnosis.

Retinal haemorrhages are common in severe malaria, and do not on their own indicate the presence of abnormal bleeding tendency.

b) Was the patient right to think he was immune to malaria?

Answer: No. Immunity to malaria is partial, and may be almost completely lost after an absence of a few years from the endemic area.

Question 2

The thick blood film shows *P. falciparum* "++++" and the thin blood film shows that 26% of red cells are parasitized.

a) What else would you look for in the thin blood film?

Answer: Platelets. Thrombocytopenia is usual in *falciparum* malaria, but may be particularly severe in this patient who has signs of a bleeding tendency. Severe thrombocytopenia may be evident on a thin blood film.

b) What other tests would you do to investigate the bleeding tendency?

Answer: Platelets count and prothrombin time. In addition a bedside test that might be positive in the presence of a low platelet count is Hess's test. If possible it would be interesting to know the levels of plasma fibrinogen and fibrin degradation products (FDPs). If the platelet count and plasma fibrinogen are very low in a patient with spontaneous bleeding, the bleeding can be attributed to disseminated intravascular coagulation (DIC). However, if only the thin blood film can be done, scantiness of platelets in the presence of bleeding in a patient with malaria suggests DIC: Hess's test may or may not be positive. The best bedside test for the presence of abnormal bleeding due to DIC is the bleeding time (described in Learner's Guide, page 34). In this patient this is likely to be prolonged, since there is abnormal bleeding spontaneously from the gums. A record of bleeding time would be useful in order to monitor progress in response to treatment.

c) What treatment is needed for the bleeding?

Answer: Fresh blood transfusion (HIV negative). If facilities allow, alternative treatment should be based on laboratory tests. If in the patient with spontaneous bleeding, thrombocytopenia is the only abnormality give platelet concentrates; if laboratory results show DIC give platelet-rich plasma or fresh frozen plasma with additional platelets. Vitamin K is not helpful since the bleeding is not due to vitamin K deficiency. Since this patient may also need blood transfusion for malarial anaemia, it would be wise to prepare urgently as many safe units of whole fresh blood as possible. It is assumed that specific treatment for malaria has already been given.

Question 3

The patient has not passed urine for 24 hours. What kind of investigations and actions are appropriate?

Answer: Palpate the abdomen to see if the bladder is distended. Try to get the patient to pass urine. If he cannot, catheterize with **full sterile** procedure, in order to record urine volumes carefully. Test the urine (if any) by all routine methods and if possible, for sodium concentration and specific gravity. The management needed is then that of any patient with suspected acute tubular necrosis - i.e. attempt to correct any underhydration by careful saline infusion (urine specific gravity >1.015 and sodium <20 mmol/l suggests dehydration). Some authorities use drugs such as frusemide (furosemide) and low dose dopamine in the attempt to achieve flow of urine. The efficacy of these treatments remain unconfirmed. Measure plasma urea, creatinine and electrolytes if possible; an electrocardiograph helps to demonstrate hyperkalaemia.

If acute tubular necrosis becomes established, intensive care is required, with peritoneal dialysis or haemodialysis if necessary.

Question 4

15 ml of dark brown urine was obtained by catheter. The urine 'stix' tests revealed albumin "++", blood "++++", bilirubin "++", urobilinogen "++". Microscopy of the urine showed no cells and a few casts

How do you interpret the results of the urine test?

Answer: The presence of "blood" in the urine (i.e. haemoglobin) in the absence of red blood cells indicates that there is free haemoglobin in the urine, as a result of intravascular haemolysis, a complication of severe *falciparum* malaria. Bilirubinuria indicates that there is some increase in the conjugated bilirubin in the plasma, as a result of hepatic involvement in malaria. Urobilinogen appears in the urine when there is unconjugated hyperbilirubinaemia, as in haemolysis. Proteinuria is usual in the presence of acute tubular necrosis, which is the commonest form of renal failure to complicate *falciparum* malaria.

Question 5

Acute renal failure is confirmed. Is it possible that the kidneys may recover?

Answer: Yes. In acute tubular necrosis, recovery commonly takes place within a period of a few weeks. It is therefore important to keep the patient alive, if possible, by dialysis (if necessary peritoneal dialysis) -

because full recovery is then likely, without the need for continued long-term dialysis.

How should quinine therapy be given to this patient with acute renal failure?

Answer: If acute renal failure is confirmed, the first dose of quinine should be the same as in any patient with severe malaria, but if acute renal failure becomes established, doses should be reduced by 50% from the third day onwards.

NOTE: peritoneal dialysis can be life-saving and is achievable without excessively expensive equipment. However, it requires experience and competence. Guidelines for indications and methods of peritoneal dialysis are available and should be taught to hospital staff who may be responsible for management of patients with severe malaria. Fortunately, acute renal failure is very rare in African children with severe malaria.

Case study: Patient D

The place: a country with hyperendemic P. *falciparum* malaria in low-lying areas but no malaria transmission on the high central plateau.

A nineteen-year old woman was brought to a clinic in the malaria-endemic area. The medical officer recorded that the patient gave a history of fever for the past three days with rigors and vomiting. On examination she was febrile (axillary temperature 39.1° C) and slightly jaundiced. She was fully conscious. Because she had never been out of the country, the doctor considered it unlikely that she was suffering from *P. falciparum* malaria, but nevertheless checked a thin blood film. No malaria parasites were seen on the film so he diagnosed hepatitis and advised rest and a fat-free diet.

Question 1

Do you think the medical officer was right to decide that this patient did not have malaria? (Justify your answer.)

No ! Because the doctor did not take into consideration the history and investigations.

Could the doctor have done better with

a) the history?

Answer: Poor knowledge of the epidemiology of malaria in the country. The medical officer considered malaria unlikely because the patient had not been out of the country. He/she should have enquired about the patient's travel history: if the patient had lived all her life in the highlands, she would be highly susceptible to malaria when visiting the lowlands. The possibility of blood transfusion and contact with jaundiced persons should also be enquired.

b) the investigations?

Answer: Inadequate knowledge of procedures for laboratory malaria diagnosis. A diagnosis of malaria was dismissed because there were no malaria parasites on the thin film. It is much easier to identify a scanty parasitaemia on a thick film than a thin film. A thick film should have been done. Even if that was negative for malaria parasites, the doctor should have been prepared to consider a diagnosis of malaria and repeat the film after a few hours. If facilities allowed, liver enzymes could be measured to help diagnose acute hepatitis.

Question 2

Two days later the patient was brought back to the clinic by anxious relatives. She had become drowsy and was not answering questions properly. On examination the patient was afebrile, slightly jaundiced and confused. She could not answer questions but could withdraw her hand from a painful stimulus. The possible diagnoses considered were fulminant hepatitis, sickle cells crisis, relapsing fever and cholecystitis. Malaria was ruled out because she was apyrexial. Treatment was started urgently with tetracycline intravenously and enemas to empty the large bowel. She remained unconscious and her temperature rose to $38^{oC;}$ a blood film now revealed scanty *P. falciparum* parasitaemia. This was considered 'probably incidental' because low-grade parasitaemia was common among young adults in the area, but "to cover malaria", chloroquine was prescribed: 600 mg intravenously, to be followed by 300 mg intravenously every eight hours.

What errors were made:

a) in clinical judgement?

Answer: First, malaria was ruled out because she was apyrexial. Malarial fever is variable and a single measurement is never sufficient to indicate the absence of malaria. Occasional patients with severe malaria remain afebrile for long periods despite being severely ill.

Second, the low-grade parasitaemia was considered unimportant. Patients with severe malaria usually do have heavy parasitaemia, but some patients have low-grade peripheral parasitaemia despite having severe malaria. This is because of withdrawal of trophozoites and sequestration of parasites in the capillaries of the internal organs.

b) in the treatment of the patient?

Answer: First, a young woman should not be treated with tetracycline unless she is definitely known to be non-pregnant. No mention is made of any attempt to discover whether she is pregnant. Tetracycline is also likely to be harmful in viral hepatitis, thus this disease should be excluded.

Second, intravenous chloroquine was prescribed. Since the patient was ill enough to require parenteral treatment, intravenous quinine would have been preferable.

Question 3

The next day the patient was increasingly febrile and the parasitaemia had increased, so quinine 20 mg base/kg was given to run intravenously over one hour in normal saline, to be repeated 8-hourly. Twenty-four hours later the patient became increasingly breathless. There were no signs in the chest but pneumonia was diagnosed and treated with penicillin. After a further twelve hours the patient was still breathless and suddenly had a convulsion. Her level of consciousness deteriorated and she died ten hours later.

a) What errors were made in administration of quinine?

Answer: Quinine 20 mg **base**/kg. This dose is too high; the correct loading dose is 20 mg of quinine dihydrochloride **salt** (16.7 mg base)/kg. One hour is too quick for an intravenous infusion (especially of a loading dose) of quinine; three or four hours is preferable.

b) What errors were made in diagnosis of clinical complications?

Answer: When the patient became breathless a diagnosis of pulmonary oedema, or of adult respiratory distress syndrome (ARDS), should have been considered, especially in this patient with severe malaria who has been on a saline infusion: the venous pressure should have been assessed, fluid balance reviewed and, if possible, a chest X-ray should have been done.

When a patient on a quinine infusion has a convulsion or becomes more deeply unconscious - especially if she is or may be pregnant - the blood should be tested for glucose concentration. Hypoglycaemia often accompanies quinine use and requires immediate correction.

Case study: Patient E

A four-year-old girl is brought to the outpatients department of your hospital by her mother, late in the evening.

The child was well until yesterday morning (36 hours ago), when she began to have fever. Yesterday she took meals but seemed indifferent; today she has refused food, but has drunk a little. The mother says the child had a "fit" this morning; she regained consciousness immediately. For the past few hours the child has been increasingly drowsy, and for the last hour has been unconscious.

At the examination the child is well-nourished, unconscious, and not dehydrated. The axillary temperature is 40.2°C; pulse 120/beats/min, regular; blood pressure 90/70 mmHg. No neck stiffness. Pupils are equal; a few retinal haemorrhages seen; no papilloedema. Some yellowish sticky fluid is seen filling the left external auditory meatus. Reflexes are normal. No rash.

Question 1

If facilities are limited which laboratory tests are essential for this child as a guide for immediate action?

Answer:

a) Blood films for malaria parasites.

b) Blood glucose.

c) Lumbar puncture.

d) Haematocrit and/or haemoglobin concentration.

These tests should be possible in any centre seeing ill patients. Whether other tests are done may depend on the results of the above tests, and on available facilities - blood culture, chest X-ray, biochemical studies. They are less likely to add substantially to the value of careful clinical assessment in the planning of immediate treatment.

Question 2

a) Why does the blood glucose test have the priority in this case?

Answer: Hypoglycaemia may complicate any childhood fever, including malaria. Hypoglycaemia cannot be easily recognized clinically, so must be tested for; immediate correction can reverse coma and prevent cerebral damage.

b) Should you wait for the result of the blood glucose test if it will take 2 hours?

Answer: In this patient 2 ml venous blood was taken into a fluoride oxalate sample tube and sent to the laboratory to determine the blood glucose. However, two hours is too long to wait. If the child is hypoglycaemic this should be corrected at once.

c) If not, what should you do?

Answer: either do a bedside test for blood glucose (finger-prick and test "stix") or, if that is not possible give intravenous dextrose (see Learner's Guide, page xxx). Note: If it is not possible to give dextrose intravenously, either dextrose or a sugar solution should be given by nasogastric tube.

Question 3

In this child a "stix" test on finger-prick capillary blood revealed a glucose level of 1.0 mmol/1(18 mg/dl). 50% dextrose was given intravenously, but the child remained unconscious.

What does this suggest?

Answer: There is another cause of coma in addition to hypoglycaemia. (Alternative possibilities are: that insufficient dextrose has been given; or that hypoglycaemia has already been prolonged enough to cause brain damage). However, in this case it is likely that continuing coma is due to malaria itself.

Question 4

Figure 11 xxx is the thick and thin blood film from this patient as seen under the high power microscope (magnification x700).

a) What does the blood film show?

Answer: Malaria: all parasites are at the "ring" stage, and the infection is extremely heavy ("++++").

b) What species of parasite is present?

Answer: For these reasons it is almost certainly *P. falciparum.* This patient needs urgent treatment; an accurate count of the parasitaemia can wait until treatment is started.

c) How heavy is the infection?

Answer: It is very important to have a rough idea of how heavy the parasitaemia is because children with heavy parasitaemia are at greater risk of death. A patient with heavy parasitaemia may have a large drop in haemoglobin level over the next few hours; knowing the approximate degree of parasitaemia can help predict the need for blood transfusion in good time.

d) How could you quantify it more accurately?

Answer: Methods of quantifying parasitaemia are discussed in Appendix 1.

Question 5

This child has *P. falciparum* parasitaemia "++++" with hypoglycaemia:

a) Does this exclude a diagnosis of meningitis?

Answer: In highly endemic areas the children may have heavy parasitaemia without severe illness. The fever and coma in this child may be due to something else and meningitis is a possibility.

b) Neck stiffness was absent in this patient. Is it still necessary to do the lumbar puncture?

Answer: The absence of neck stiffness does not exclude meningitis, since young children with meningitis may have no neck stiffness especially if deeply unconscious, sedated or post-ictal. Therefore, lumbar puncture is still indicated.

c) Does clear colourless fluid exclude meningitis?

Answer: Not quite, but it makes it less likely. A child as ill as this from meningitis would be highly likely to have cloudy cerebrospinal fluid. But remember, you need 400 cells/mm3 in cerebrospinal fluid to make it visibly cloudy, so a fluid containing 300 cells/mm^3 might be clear. Microscopy of the fluid should therefore be carried out if possible.

Question 6

If in this patient microscopy of the cerebrospinal fluid revealed 3 wbc/mm^3 (normal) and 7 rbc/mm^3 (normal).

a) Could the ear discharge be important in this patient?

Answer: If the child has chronic middle ear disease, a cholesteatoma may have developed and infection could have spread to the brain or meninges. Intracerebral, subdural or extradural abscess - or meningitis - could result. The normal C.S.F. findings exclude meningitis, but the other complications of middle ear disease remain a possibility.

b) What should be done about it?

Answer: The external meatus should be mopped out carefully so that the ear drum can be examined. In this child remnants of an insect were found in the external auditory meatus; after gentle mopping with cotton-wool on a stick, the drum was seen to be normal. If chronic middle ear disease had been found, antibiotics would have been indicated.

Question 7

What is your decision on how to proceed with antimalarial treatment?

a) Which drugs to use?

Answer: The decision may be guided by a national or regional policy. Otherwise consider: known local parasite drug-sensitivities; drug availability.

b) By which route?

c) *Answer:* Choice between i.v., i.m., or nasogastric tube depends on available skills and staffing, drugs used, patient's condition. What is the correct dosage schedule?

Answer: For dosage, see Appendix xxx

Question 8

Apart from antimalarial drug(s), is any other drug therapy indicated for this patient?

Answer: Consider specific treatment for:

- **Fever.** Paracetamol is an effective antipyretic, which can be given by suppository. While waiting for this to have an effect (or if it is unavailable), apply tepid-sponging and fanning - the child's mother (or father) may help with this. Fever is only dangerous if very high, moderate fever (<39°C) may have some beneficial effects on host response and some anti-parasitic action.

- **Convulsions.** Observe this child very carefully for convulsions (including subtle convulsions, (see p. xxx), and treat accordingly (p. xxx). Remember in children with convulsions due to high fever or hypoglycaemia, correcting these abnormalities may be sufficient to prevent further convulsions.

- **Complicating infection.** Septicaemia occasionally complicates severe malaria. Other potential bacterial infections include aspiration pneumonia, and urinary tract infection if the patient is catheterized. These complications should be looked for and only treated if they develop.

Question 9

How should fluid replacement be given?

Answer: Assess each individual's requirements. Pay special attention to:

- Prevention or correction of hypovolaemia, because the patient with severe malaria is at risk of developing acute renal insufficiency.

- Prevention or correction of fluid overload, especially if renal failure has developed; pulmonary oedema may result from fluid overload, and may also be a direct complication of severe malaria.

- Prevention of hypoglycaemia. Children who are fasting are liable to develop hypoglycaemia, especially during a febrile illness; furthermore, quinine promotes pancreatic insulin secretion. The likelihood of hypoglycaemia developing can be reduced by maintaining a continuous 10% dextrose infusion (e.g. 80 ml/kg/24hr).

Question 10

The patient's haematocrit is 19%. What are the implications of the levels of parasitaemia and haematocrit in this patient?

Answer: Blood transfusion may be life-saving, but because of its dangers should only be used if strongly indicated. Do not apply rules of thumb (e.g. a haematocrit level) but assess the individual. In this case, the degree of parasitaemia will help with the decision. A count on the thin film indicates 29% of red cells are parasitized.

a) Would you transfuse?

Answer: Many of this child's red cells will soon be destroyed:

- Because of the high parasitaemia
- Because non-parasitized RBCs may also be destroyed.
- Because the total body parasitaemia may be considerably higher than 29%, with many parasitized RBCs being sequestered in deep tissues.

You can therefore predict a large fall of haematocrit. Transfusion is therefore indicated.

b) If blood transfusion is or becomes necessary, how would you give the blood?

Answer: The need in this child will be for red cells, not blood volume or plasma factors; packed cells should therefore be infused.

Question 11

What clinical observations would you make during the course of treatment in this patient?

Answer: Important physical signs to record include:

- Vital signs (temperature, pulse, respiratory rate, blood pressure).
- Level of consciousness (we suggest Balantyre coma scale - see Learner's Guide).
- Occurrence of any convulsions or other clinical events.
- Urine output.
- Signs of dehydration or overhydration (skin, jugular venous pressure, heart, lung bases, liver size).

Question 12

What laboratory tests would you repeat (and when) during treatment?

Answer:

- Haematocrit and/or haemoglobin level at least 12 hourly.
- Parasite count 12 hourly until negative.

- Blood glucose level - frequency depends on condition. Repeat immediately with any convulsion or deterioration of consciousness.

- Creatinine, electrolytes if urine output impaired.

- Blood culture if fever and coma fail to resolve or if state of shock develops.

Question 13

What should be followed up for after the child has recovered?

Answer: Assess neurological recovery. Sequelae may occur, especially in children who have been hypoglycaemic or have had repeated convulsions. Neurological sequelae include blindness, deafness, motor impairments and disorders of behaviour and intellect. There is often considerable recovery over time.

Case study: Patient F

The place: a country with hyperendemic *P. falciparum* malaria.

A sixteen-year old man was brought to a clinic in a malaria-endemic area. His friend told the doctor that the patient had a history of fever for the past 7 days. Two days before admission, the patient went to a private clinic and was diagnosed with influenza. He was given some medication but the patient did not feel improved. On examination the patient was febrile and jaundiced. He was stuporous. Blood smear showed *P. vivax* malaria.

Question 1

Do you think that cerebral malaria could be the cause of the patient's stupor?

Answer: Yes, it might be. In this case, the patient may have mixed infection with *P. vivax* and *P. falciparum* malaria. The reason that *P. falciparum* malaria was not found may be due to a low *P. falciparum* parasitaemia or to partial treatment with some medication from a private clinic.

Question 2

What will you investigate in this patient?

Answer: In this case, the causes of unconsciousness should be explained. Lumbar puncture, blood glucose, and repeated blood smear for malaria should be carried out in order to exclude other causes of unconsciousness such as meningitis, meningoencephalitis and hypoglycaemia.

Question 3

How would you manage theis patient if repeated blood smears show only *P. vivax* malaria while blood glucose and lumbar puncture are normal?

Answer: The cause of unconsciousness in this patient is unlikely to be due to *P. vivax* malaria. It is quite possible for *P. falciparum* to cause coma in a non-immune patient while the density of parasitaemia is too low to be detected by microscopy in the peripheral blood. The patient should therefore be treated as severe *P. falciparum* malaria infection. This treatment also removes *P. vivax* infection. Although the patient is only stuporous, not comatose, the treatment should be started as for severe disease.

Question 4

If the patient had a haematocrit of 18%, what would you do?

Answer: The rate of development and degree of anaemia in malaria depends on the severity and duration of parasitaemia. Severe anaemia may develop rapidly in association with hyperparasitaemia. In this case the parasite density is not high, therefore the cause of anaemia in this patient may not be only due to malaria infection. Use clinical criteria to decide whether blood transfusion will be necessary for this patient.

Question 5

If the patient had G-6-PD deficiency, when would you give him primaquine?

Answer: Primaquine administration is not emergency treatment for *P. vivax* malaria. Usually primaquine can be given when the patient improves, i.e. when fever subsides. Primaquine may cause more haemolysis if the drug is given during acute illness when fever is high.

Question 6

What further antimalarial treatment will this patient require?

Question 7

What precautions would you take for this treatment?

In patients with mixed *P. falciparum* and *vivax* malaria infection, drugs which are effective against asexual forms of *P. falciparum* are also effective against asexual forms of *P. vivax*. Primaquine may be used for treatment of *P. vivax* hypnozoites in a later stage.

Blood and urine should be examined periodically for evidence of haemolysis. Patients should be warned to stop treatment and report immediately to a doctor if they have abdominal pain and become weak or pale, or notice darkening of the urine.

Case Study : Patient G

The place : a city where there is no *P. falciparum* malaria transmission.

The patient, a 24-year-old woman, who made a 2-month visit to a part of the country where malaria is endemic. For malaria prophylaxis she took mefloquine (250 mg weekly), but discontinued this on return to the city. Twelve days later she felt tired and had a mild headache. The following evening she became febrile and began to vomit. Her general practitioner referred her to hospital. On examination, she was well but febrile (temperature 39.5°C). There were no other abnormalities. Thick and thin blood films showed *P. falciparum* trophozoites with 20% parasitized erythrocytes. Quinine was immediately started by intravenous route (loading dose of quinine 20 mg salt/kg given in 4 hours, followed by 10 mg salt/kg every 8 hours for a total of 10 days) to attempt a rapid reduction of the parasitaemia. During the second infusion a nurse reported that the patient could not communicate with them. On examination, she was conscious with open eyes but unable to speak. Although there was no spontaneous movement of the limbs, the reflexes were normal and the plantar responses flexor. There was no neck stiffness or retinal haemorrhage.

Question 1

What is the neurologial lesion?

Answer: The patient appeared to be awake but unable to communicate: this state is referred to either as "coma vigil" or "akinetic mutism", and results from midbrain dysfunction due to sequestered parasitized erythrocytes.

Question 2

What important investigations should be carried out immediately?

Answer: Blood glucose should be checked because hypoglycaemia, which may cause cerebral or other neurological sequelae, may occur after quinine infusion, especially as the parasitaemia is declining; it occurs especially in severe malaria and most commonly during pregnancy. Lumbar puncture should also be performed to exclude other infectious causes of cerebral dysfunction.

Question 3

Is it possible that any person who has mefloquine prophylaxis may get malaria?

Answer: It is possible because there is no absolute chemoprophylaxis for malaria. It should be remembered that anyone may get malaria when visiting a malaria endemic area, even after taking malarial chemoprophylaxis. If a patient complains of headache, malaise, or fever, a blood smear for malaria should be carried out. Repeated checks of blood smears for malaria are necessary if the patient still has symptoms. A small number of parasites in the blood may be difficult to detect, hence the need for repeated blood smear examinations. The patient stopped prophylaxis too soon which probably allowed an hepatic form of the parasite to emerge.

Question 4

Will you use dexamethasone in this patient?

Answer: No. Dexamethasone and other corticosteroids should never be used in cerebral malaria, they do not improve overall prognosis, and furthermore, serious complications are significantly more frequent when they are used.

Case study: Patient H

The place: a country where *P. falciparum* malaria is transmitted in forested areas but not in the main cities

A man aged 30 years is brought to hospital due to stupor. One month before admission he had a holiday in the forest. The patient became ill seven days ago, with chills, sweating and headache. He went to a private clinic and was diagnosed with upper respiratory tract infection. He was prescribed an antibiotic and his condition seemed to improve, but yesterday he developed rigors and persistent vomiting. A blood film at the private clinic, revealed *P. falciparum* malaria with 10% parasitaemia, and oral quinine (600 mg every 8 hours) was prescribed. He took 3 doses. Today he is referred to your hospital because of stupor. His temperature is 39° C, pulse 100/min, and blood pressure 120/80 mmHg.

Question 1

What tests are urgently required?

Answer: Blood glucose and lumbar puncture to exclude other causes of stupor. If both tests are normal, the cause of stupor in this patient may be due to cerebral malaria.

Question 2

Blood glucose was 30 mg/dl, then the doctor gave him 50 ml of 50% dextrose. After dextrose infusion, the patient became alert. Would you give him a loading dose of quinine?

Answer: No. This patient took quinine in the last 24 hours. Quinine can be given in normal dose (10 mg salt/kg).

Question 3

If the patient had renal failure and was not given quinine before admission, will you give him a loading dose of quinine?

Answer: Yes. The aim of loading dose quinine administration is to raise the blood quinine level to minimum inhibitory concentration (MIC). Quinine will rise to MIC level after loading dose administration in 4 hours.

Question 4

If the patient had jaundice and renal failure, how would you adjust the dose of quinine?

Answer: Quinine doses should be reduced by one third to one half on the third day of treatment if there is no improvement in the overall condition, or if acute renal failure develops. For example, 10 ml/kg at 8-hourly intervals should be reduced to 7 mg/kg at 8-hourly intervals after 48 hours of treatment. Quinine is biotransformed in the liver (80%) and is excreted by the kidneys (20%). If dosage is not adjusted to accommodate renal insufficiency, the level of quinine may rise to toxic levels.

Question 5

If the patient's consciousness does not improve after dextrose infusion and he has convulsions, what will you do?

Answer: The patient may have cerebral malaria. Treat convulsions with diazepam or paraldahyde. A slow intravenous injection of diazepam (0.15mg/kg of body weight, maximum 10 mg for adults) or intramuscular injection of paraldehyde (0.1ml/kg of body weight), will usually control convulsions. Diazepam can also be given intrarectally (0.5-1.0 mg/kg of body weight) if injection is not possible. (Note: paraldehyde should, if possible, be given from a sterile glass syringe; a disposible plastic syringe may be used provided the injection is given immediately the paraldehyde is drawn up, and that the syringe is never reused.)

Case study: patient I

The place: A country where *P. falciparum* malaria is hyperendemic.

A patient, a 30-year-old woman was admitted to the local hospital due to high fever with dyspnea. Twenty days before admission, she had fever which did not subside after taking paracetamol. Today she developed dyspnea and came to the hospital. On examination, her temperature was 38°C, pulse rate 120/min, respiratory rate 28/min, and blood pressure 130/88 mmHg. Chest film showed increased interstitial shadowing and a normal heart size compatible with noncardiogenic pulmonary oedema. Blood smear revealed *P. falciparum* malaria.

Question 1

What is the possible cause of tachypnoea in this patient?

Answer: Although the patient had pulmonary oedema, the other possible causes of tachypnoea in this patient may be due to metabolic acidosis and hypoglycaemia. Therefore arterial blood gas and blood glucose level should be undertaken if facilities allow.

Question 2

The patient was given furosemide (30 mg) and oxygen therapy via nasal canula (with oxygen flow 5 l/min). Half an hour later, the patient was not improved and arterial blood gas revealed PaO_2 48 torr. What should you do?

Answer: The patient has developed respiratory failure, mechanical ventilation should be started.

Question 3

When will you start positive-end expiratory pressure (PEEP) assisted ventilation for the patient?

PEEP should be used when the patient has low PaO_2 (PaO_2 <70 torr) using a ventilator with $\underline{FiO_2}$ >50%. Failing that, the patient may develop ARDS.

Question 4

If central venous pressure (CVP) is measured to evaluate the patient's volume status, what level of CVP should be maintained?

Answer: CVP should be maintained between 0 and 5 cm H_2O

Question 5

What are other manifestations or complications of severe malaria that are often associated with pulmonary oedema?

Answer: Hyperparasitaemia, renal failure, hypoglycaemia, and metabolic acidosis are often associated with pulmonary oedema.

Selected further reading

Basic Malaria Microscopy. Part I: Learner's Guide. Part II: Tutor's Guide. Geneva, World Health Organization, 1991.

Bench aids for the diagnosis of malaria. Plates No. 1-8, Geneva, World Health Organization. xxx

International travel and health. Vaccination requirements and health advice. Geneva, World Health Organization (updated annually).

WHO model prescribing information: drugs used in parasitic diseases, second edition, Geneva, WHO, 1995.

WHO Technical Report Series, No 805, 1990 (*Practical chemotherapy of malaria*: report of a WHO Scientific Group).

Management of severe falciparum malaria: A practical handbook, second edition, Geneva, World Health Organization, 1998.

Severe falciparum malaria, third edition. Transactions of the royal Society of Medicine and Hygiene (available end of 1998).

Appendix 1

Enumeration of malaria parasites

In addition to definitive diagnosis of malaria and differential diagnosis of the species of malaria parasites, microscopical examination also enables their number in a unit volume of blood to be determined. Knowledge of the degree of parasitaemia may be of diagnostic and prognostic value in the case of severe *P. falciparum* malaria infection and also helps in following up the changes produced by treatment.

Methods of counting malaria parasites in thin blood films

To count parasites as a percentage of red cells on the thin film, use two tally counters, one for red cells and the other for parasites. Count all the red cells in an oil immersion field, then all the parasites in the same field. Repeat the exercise until 500 red cells have been counted. Percentage parasitaemia is then the total number of parasites x 100 divided by the total number of red cells counted.

$$\text{Percentage of parasitaemia} = \frac{\text{No. of parasites counted (total) x 100}}{\text{No. of red blood cells counted (total)}}$$

Methods of counting malaria parasites in thick blood films

I. Parasites per µl

The following is a practical method of adequate accuracy. It is based on the number of parasites per µl of blood in a thick film, these being counted in relation to a predetermined number of leukocytes. An average of 8000 leukocytes per µl is taken as the standard. Despite inaccuracies due to variations in the number of leukocytes between individuals in normal health and greater variations in ill health, this standard allows for reasonable comparisons. Before counting begins, the equivalent of 0.25 µl of blood (about 100 fields, using a 7 x ocular and a 100 x oil-immersion objective) should be examined in the thick film to determine the parasite species and stages that may be present. When this has been established, a suitable counting method for positive blood films is:

1. To count parasites and leukocytes separately using two tally counters.

2. (a) If, after 200 leukocytes have been counted, 10 or more parasites have been identified, record the results in the record form, showing parasites per 200 leukocytes;

(b) If, after 200 leukocytes have been counted, 9 or less parasites have been counted, continue counting until 500 leukocytes have been counted and record the parasites per 500 leukocytes.

3. In each case, the parasite count in relation to the leukocyte count can be converted to parasites per µl by the simple mathematical formula:

$$\frac{\text{No. of parasites counted} \times 8000}{\text{No. of leukocytes counted}} = \text{parasites per } \mu l$$

This means that if 200 leukocytes are counted, the parasites are multiplied by 40, and if 500 leukocytes are counted the parasites are multiplied by 16.

4. It is normal practice to count all the species present and to include both sexual and asexual parasites together. Occasionally a separate count is made of the gametocytes of *Plasmodium falciparum* but when this is done, they should still be included in the general parasite count. It is rarely possible to separate the gametocytes of *P. vivax* or *P. malariae* from the asexual parasites with sufficient accuracy to justify a gametocyte count.

II. The Plus System

A more simplified method of enumerating parasites in thick blood films is to use the plus system. This indicates the relative parasite count and entails using a code of from one to four pluses, as follows:

+	=1-10 parasites per **100 thick film** fields	(4-40 parasites per mm^3)
++	=11-100 parasites per **100 thick film** fields	(40-400 parasites per mm^3)
+++	=1-10 parasites per **one thick film** field	(400-4000 parasites per mm^3)
++++	=more than 10 parasites per **one thick film** field	(4000-40000 parasites per mm^3

This system should be used only when it is not possible to undertake the more acceptable parasite count per µl of blood.

Appendix 2

*Antimalarial Chemotherapy of Severe Falciparum Malaria in Adults and Children**

Chloroquine-resistant malaria or sensitivity not known	Chloroquine-sensitive malaria
Quinine (adults): 20 mg dihydrochloride salt/kg of body weight (loading dose)[a] diluted in 10 ml isotonic fluid/kg by iv infusion over 4 hours; then 8 hours after the start of the loading dose, give a maintenance dose of quinine, 10 mg salt/kg over 4 hours. This maintenance dose should be repeated every 8 hours, calculated from the beginning of the previous infusion, until the patient can swallow, then quinine tablets, 10 mg salt/kg 8-hourly to complete a 7-day course of treatment, or a single dose of 25 mg/kg sulfadoxine and 1.25 mg/kg pyrimethamine (maximum 1500 mg sulfadoxine - 75 mg pyrimethamine). *Quinine (children)*: 20 mg dihydrochloride salt/kg of body weight (loading dose)[a] diluted in 10 ml isotonic fluid/kg by iv infusion over 4 hours; then 12 hours after the start of the loading dose, give a maintenance dose of quinine 10 mg salt/kg, over 2 hours. This maintenance should be repeated every 12 hours, calculated from the beginning of the previous infusion, until the patient can swallow, then quinine tablets, 10 mg salt/kg, 8-hourly to complete a 7-day course of treatment or a single dose of 25 mg/kg sulfadoxine and 1.25 mg/kg pyrimethamine. **or** If iv infusion is not possible, *quinine* can be given IM. If for some reason quinine cannot be administered by infusion, quinine dihydrochloride can be given in the same dosages by IM injection in the anterior thigh (*not* in the buttock). The dose of quinine should be divided between two sites – half the dose in each anterior thigh. If possible, for IM use, quinine should be diluted in normal saline to a concentration of 60-100 mg salt/ml. Alternatively, consider artemisinin/artesunate suppositories. **or** *Artesunate*[c] 2.4 mg/kg (loading dose) iv followed by 1.2	*Chloroquine*: 10 mg base/kg in isotonic fluid by constant-rate iv infusion over 8 hours, followed by 15 mg/kg given over the next 24 hours. **or** *Chloroquine*: 5 mg base/kg in isotonic fluid by constant-rate iv infusion over 6 hours, every 6 hours, for a total of 5 doses (i.e. 25 mg base/kg continuously over 30 hours) **or** (If iv infusion is not possible) *chloroquine* 3.5 mg base/kg, every 6 hours im or sc[b] **or** *Quinine or artemisinin derivative* (see opposite)

* From: Management of Severe Malaria. A Practical Handbook, 2nd edition, WHO, Geneva, 1999.

[a] Alternatively, the loading dose can be administered as 7 mg salt/kg by iv infusion (or pump) over 30 minutes, followed immediately by 10 mg salt/kg diluted in 10 ml isotonic fluid /kg by iv infusion over 4 hours.

[b] Total dose 25 mg base/kg; change to oral therapy when the patient can swallow.

Chloroquine-resistant malaria or sensitivity not known	Chloroquine-sensitive malaria
mg/kg at 12 and 24 hours, then 1.2 mg/kg daily for 6 days. If the patient is able to swallow the daily dose can be given orally. **or** *Artemether*: 3.2 mg/kg (loading dose) im followed by 1.6 mg/kg daily for 6 days. If the patient is able to swallow, the daily dose can be given orally. If parenteral administration is not possible then suppositories of artemisinin or artesunate may be given. *Artemisinin suppositories*: 40 mg/kg (loading dose) intrarectally, then 20 mg/kg 24, 48 and 72 hours later, followed by an oral antimalarial drug.[d] **or** *Artesunate suppositories*: 200 mg intrarectally at 0, 12, 24, 36, 48 and 60 hours, may prove to be highly effective and are in trials. A loading dose of 4 mg/kg intrarectally followed by 2mg/kg at 4, 12, 48 and 72 hours has been used in Viet Nam. This treatment should be followed by an oral anitmalarial drug.[d] **or** If parenteral quinine, artemether or artesunate is not available, *Quinidine*: 15 mg base/kg (loading dose) by iv infusion over 4 hours, then 8 hours after the start of the loading dose, give 7.5 mg base/kg over 4 hours, 8-hourly, until the patient can swallow, then quinine tablets (dosage as above for adults and children) to complete a 7-day course of treatment, or a single dose of 25 mg/kg sulfadoxine and 1.25 pyrimethamine.	

[c] Artesunic acid, 60 mg per ampoule is dissolved in 0.6 ml of 5% sodium bicarbonate diluted to 3.5 ml with 5% dextrose and given immediately by iv bolus ("push") injection.

[d] For example, mefloquine 25 mg/kg in two divided doses 8-24 hours apart.

Some important points to note in relation to the Table

In areas where a seven day course of quinine is not curative (e.g. Thailand) add an **oral** course of tetracycline 4 mg/kg four times daily or doxycycline 3 mg/kg once daily, for 3-7 days, as soon as the patient can swallow, except for children under 8 years and pregnant women; or clindamycin 10 mg/kg twice a day, for 3-7 days, as soon as the patient can swallow.

In patients requiring more than 48 hours of parenteral therapy, reduce the quinine or quinidine maintenance dose by one-third to one-half (i.e. 5-7mg **salt**/kg of body weight every 8 hours).

Total daily doses of intravenous quinine are as follows:

Adults:
day 0 (first day of treatment): 30-40 mg **salt**/kg of body weight
day 1: 30 mg **salt**/kg of body weight
day 2 and subsequent days: 15 mg **salt**/kg of body weight

Children:
day 0 (first day of treatment): 20-25 mg **salt**/kg body weight
day 1: 20 mg **salt**/kg body weight
day 2 and subsequent days: 10 mg **salt**/kg of body weight

It is unusual to have to continue intravenous infusions of quinine for more than 4-5 days. If it is more convenient, quinine may be given by continuous infusion. (Infusion rates should not exceed 5 mg **salt**/kg of body weight/hour.)

If for some reason quinine cannot be administered by infusion, quinine dihydrochloride can be given in the same dosage by intramuscular injection in the anterior thigh. The dose of quinine should be divided between two sites - half the dose in each anterior thigh. If possible, for intramuscular use, quinine should be diluted in normal saline to a concentration of 60 mg/ml.

When quinine is not available but quinidine is, the latter drug may be used. Because of the possible cardiotoxic effect of quinidine this drug should be used only if the cardiac function can be monitored.

Quinine : Salt-Base Equivalents

	Salt (mg)	Base (mg)
Quinine bisulphate	508	300
Quinine dihydrochloride	366	300
Quinine ethylcarbonate	366	300
Quinine hydrobromide	366	300
Quinine hydrochloride	405	300
Quinine sulphate	363	300

Quinimax™, which is often prescribed by health services in French-speaking Africa, contains only 59.3 mg of quinine base in a tablet of 100 mg. Other quinquina compounds can be found in Quinimax such as quinidine, cinchonine and cinchonidine but at a very low dosage (2.4 mg base for the three compounds in a tablet of 100 mg).

Appendix 3

Setting up an intra-osseous infusion

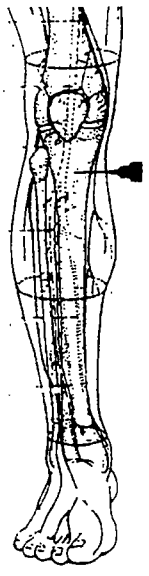
When it is impossible to set up an intravenous infusion e.g. in a shocked patient, or one in whom accessible veins have already been used - an intra-osseous infusion can be lifesaving.

An intra-osseous infusion can be used to administer anything that would otherwise be given intravenously, i.e. fluids, whole blood, packed cells, drugs.

Equipment

- alcohol swabs
- a small syringe and fine needle for giving local anaesthetic
- an 18-gauge needle with trochar (special needles are made for intra-osseous infusion; alternatively a bone-marrow aspiration needle, or even a standard 17-21 g disposable needle can be used, with care)
- i.-v. bottle and drip-set, or 50 ml syringe containing fluid for infusion

Procedure (with full sterile precautions)



- Choose a point for insertion of the infusion needle, in the middle of the wide flat part of the tibia, about 2 cm below the line of the knee joint (see diagram).
- Do not use a site where there is a fracture or where there is any overlying skin sepsis.
- If the patient is conscious, anaesthetize the skin and underlying periosteum at the chosen point.
- With the needle vertical to the skin, press firmly with a slight twisting motion until the needle enters the marrow cavity with a sudden "give".
- Attach a 5 ml syringe, aspirate to confirm that the position is correct. The aspirate can be used for blood films, blood culture, and blood glucose measurement.

Possible complications

Sepsis. Do not leave an intra-osseous line in one site for more than 6-8 hours - after that time, sepsis is increasingly likely to develop.

Compartment syndrome. If the needle is allowed to pass entirely through the tibia, fluid may be infused into the posterior compartment of the leg causing swelling and eventually impairing circulation. Check the circulation in the distal leg at regular intervals.

Notes

- You can place an infusion in each leg, either simultaneously or in sequence, if necessary.
- An alternative site for an intra-osseous infusion is the antero-lateral surface of the femur, 2-3 cm above the lateral condyle.
- An infusion allowed to drip through the needle in the usual way (by gravity) may go very slowly. For urgent administration use a 50 ml syringe to push in the required fluid as a bolus.

Appendix 4

Prevalence rate

The total number of cases or events or conditions at a particular point in time divided by the total population at risk at the same point in time.

The prevalence rate (P) for a disease is calculated as follows:

$$P = \frac{\text{Number of cases or events or conditions at the specified time}}{\text{total population at risk at the specified time}}$$

Incidence rate

The total number of new cases or events or conditions in a population in time divided by the average total population at risk in the same area in time.

Incidence rate (I) is calculated as follows:

$$I = \frac{\text{Number of people who get a disease in a specified period}}{\text{Average total population at risk in the same area in time}}$$

Malaria specific mortality rate

The number of malaria deaths in a given period, usually one year, in a given population, usually 100 000.

Malaria case fatality rate (CFR)

The number of malaria deaths in a time period, divided by the number of malaria cases in the same period. The ratio is usually multiplied by 100, to express CFR as a percentage.

ANNEX 1

Example of multiple-choice type question

Evaluation by the use of multiple choice type questions has the advantage of some form of standardization of the monitoring, is less time-consuming for both learner and tutor and is beneficial for those who have difficulty in expressing themselves in the language being used or even in their mother tongue. It has the disadvantage of not being able to express alternative scenarios and this is a draw back especially in medicine where variations are rife. It is therefore a compromise that it is suggested, that the evaluation of the trainees' progress be measured by means of a series of multiple choice questions.

However, it must be said that in order to validate the questions they must be properly written, meaningful and as much as possible problem solving rather than recall of memory. Further, to be really valid they should not be designed in such a way as to offer a set choice. That is to say if the questions say which two of the following are correct then without knowing anything about the subject, you can achieve the correct answer in 20% of cases. To eliminate the bias and distinguish more clearly those who really know the subject and those who are guessing right, one would not indicate how many of the five might be correct but then negative marking will have to be introduced otherwise by checking all five total marks could be obtained. Negative marking however makes it much harder and is more complex to apply. It is suggested that for each wrong answer 0.5 of a mark or less be deducted and fore each correct answer 1 mark be given.

Two other issues arise. The first is that if equal marking is to be used then the question and answer must have equal difficulty. The second is that to measure progress the pre- and post-test must be of equal difficulty. This can be achieved by offering the same questions in the pre- and the post-test by rearranging the proposed answers and questions in a different sequence.

If certain rules are adhered to, then writing multiple-choice questions is greatly facilitated although still a difficult task. The following are some suggestions:

- The body of each questions should be a complete statement (not just a single word) and the answer should not be dependent on the answer to any other questions on the page.

- Do not overburden the question with unrelated details and avoid negative statements, but if unavoidable then highlight them to draw them to the attention of the trainees.

- Use plausible or logical distractors in the possible answers, and each distractor must appear to have something to do with the question otherwise it looks nonsensical.

- Ensure that the distractors and the correct response are fairly similar in content or in the total number of words.

- Avoid clues that may suggest the correct answer and be cautious about the use of "some of the above" as a distractor or correct answer. This is especially important if you use the same question for the pre- and post- tests but then rearrange the sequence of possible answers.

- If it is not possible to obtain more than three plausible responses, do not waste time trying to invent others.

- Items that have numerical answers should have them arranged in order from large to small or vice-versa.

- Review the test paper as a whole and ensure that no letter or number corresponding to the correct answer appears more frequently than some other letter.

The following are some example types of multiple-choice questions. It is good practice to mix several different types in one examination paper.

One "best" response type

Question 1

Careful programmatic planning and replanning are essential for effective malaria control and involves a series of coordinated activities. Which of the following does planning involve?

A. Setting priorities ☐
B. Selecting tactical variants ☐
C. Deploying field personnel ☐
D. Conducting field research ☐
E. Arranging meetings ☐

Multiple type response

Question 2

An implementation plan should include certain sections. Five suggested sections are listed below (A - E). Select the sections which should be included in an implementation plan and indicate your answer in the boxes provided.

A. The stratification process
B. A description of strata
C. The objectives set in each stratum
D. The approaches formulated to achieve the objectives
E. The operational targets

(i) only A and B are correct ☐
(ii) only B and C are correct ☐
(iii) only B,C, and D are correct ☐
(iv) only B,C; D and E, are correct ☐
(v) all are correct ☐

The "matching" type

These are more difficult to construct but in doing so remember to:

- Limit the number of entries to 10 or less
- Do not break items at the bottom of a page
- Have a longer list of questions than of possible answers but state in the directions that they may be used more than once

Questions 3 - 8

The group of questions (3-8) below, consist of numbered items and a list of lettered components of a definition for each numbered item. Select the one element of a definition that is most clearly associated with it and mark that letter in the answer column against the numbered item. Each letter heading may be selected once, more than once, or not at all.

3.	Planning environment	c
4.	Planning process	b
5.	Analysis of the malaria situation	d
6.	Stratification process	e
7.	Criterion for selecting malaria control measures	a
8.	Implementation plan	b

a) Safety to people and environment
b) Objectives
c) Lack of data
d) Past malaria control activities
e) Interpretation of data

The comparison type

The comparison type questions permit one to compare and contrast situations or events.

Each set of letter headings below is followed by a list of number words or phrases. Mark the answer column against each numbered word or phrases the following:

a) If the item is associated with (a) only
b) If the item is associated with (b) only
c) If the item is associated with both (a) and (b)
d) If the item is associated with neither (a) nor (b)

Questions 9 – 12

a) Planning and replanning
b) Description of strata
c) Both
d) Neither

9.	Evaluation	(a)
10.	Implementation plan	(b)
11.	Analysis of malaria situation	(c)
12.	Operational research	(d)

True-false type questions should not be used and have never been included here. Where possible for the planning examination try to pose a problem situation, based on your own experience for instance, and then ask searching questions about what would you do and suggest the answers. The question can be of any of the types noted above.

ANNEX 2

Questionnaire for evaluation of training

Instructions for completion of questionnaire

Use the following code to indicate the extent to which you agree or disagree with each of the statements made in the questionnaire:

1 Disagree strongly

2 Disagree

4 Agree

5 Agree strongly

These numbers are printed alongside each question. You should circle the number that corresponds most closely to your opinion.

The difference between options 1 and 2 and between options 4 and 5 is one of degree only. To oblige you to express a definite opinion, no code 3 has been included (except for question 12); this allows a "satisfaction index" to be calculated for each question.

Take your time over completing the questionnaire. You do not have to put your name on it if you would rather not, but please answer the questions as frankly as possible.

Section I. Overall assessment of the training activity

1. Overall the organization of the training programme was satisfactory. 1 2 4 5

2. The training programme covered all the subject matter in adequate detail. (If you disagree with this, state which subjects should have been given greater coverage.) 1 2 4 5

Comments:

_____

_____

_____

3. The tutors and facilitators for this training course had sufficient knowledge and teaching ability to provide you with the necessary skills and competence . 1 2 4

Comments:

4. The time allocated to each part of the training was adequate relative to the total time available. (If you disagree with this, state which particular topic should have been allotted more or less time.) 1 2 4

Comments:

Section II. Relevance and usefulness of the different teaching methods

5. Overall, the teaching methods used in this training course were effective . 1 2

6. The use of the various teaching methods listed below was quite appropriate.

Large group presentations 1 2

Comments:

Practical demonstrations (laboratory) 1 2 4 5

Comments:

Laboratory work and facilities (including equipment) 1 2 4 5

Comments:

Field work 1 2 4 5

Comments:

Small group discussions 1 2 4

Comments:

Self-study 1 2 4

Comments:

Quizzes, tests and other evaluation exercises 1 2

Comments:

Section III. Assessment of teaching materials

7. The audio-visual materials (slides, overhead projection transparencies) used in the training were very helpful . 1 2 4 5

Suggestions for improvement:

8. The teaching materials provided were satisfactory in all respects . 1 2 4 5

Suggestions for improvement:

Section IV. Implementation of training; attitude of tutor and facilitators

9. The general atmosphere of the training course made this a good learning experience . 1 2 4 5

Comments:

10. Every effort was made to help you achieve the learning objectives . 1 2 4

Comments:

11. You were able to achieve all the learning objectives of the training programme 1 2 4

Comments:

Section V. Overall evaluation of the training

12. What overall rating would you give to this training programme? (Circle your response)

1 2 4 5

Lowest Highest

13. With regard to this training experience, state the following giving actual examples):

(a) the three aspects that impressed *you most favourably*

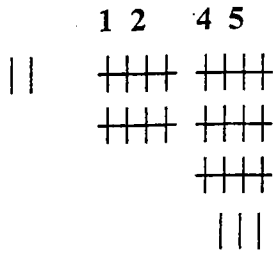
(b) the three aspects that impressed *you least favourably*

14. Do you have any additional comments regarding any aspect of the training programme? If so, please make them below.

Analysing response to the questionnaire.

The following method will allow you to analyse the responses to the questionnaire quite simply and quickly. Take a fresh (uncompleted) copy of the questionnaire; against each question, mark the learners' responses. For example:

5. Overall, the teaching methods used in this training course were effective.



This shows that two learners considered the teaching methods were not effective while 28 agreed that they were effective.

Now multiply the number of answers by the corresponding coefficient:

$(2 \times 2) + (10 \times 4) + (18 \times 5) = 4 + 10 + 40 + 90 = \mathbf{134}$

The "satisfactory index" is calculated as a percentage. For the above example, the number 134 is multiplied by 20 (i.e. 100 divided by the maximum coefficient, 5) and divided by 30 (the number of learners):

$$\frac{134 \times 20}{30} = 89.3\%$$

Since the satisfaction index is calculated in such a way that 60% represents "average" satisfaction, you should make a note of any questions for which the index is below 60% (if there is none, identify the five questions for which the index is lowest and the five for which it is highest). Let the learners know the results of this questionnaire at the final evaluation session on the last day of the training programme.

❖ ❖ ❖

ANNEX 3

Commonly used methods of teaching and their objectives

Teaching method	Purposes
Audio tapes May be used with large or small groups of learners or by the individual learner.	• To guide practical work. • As a variation in the method of presentation of material. • For the acquisition of new knowledge.
"Brainstorming" Intensive discussion focusing on a single problem. Participants are asked to develop as many solutions as possible to a problem within a limited time - generally not more than 10 minutes. No critical evaluation of solutions is offered.	• For developing new and creative ideas. • As a prelude to detailed, in-depth problem-solving.
"Buzz-groups" Groups of 2-4 people discuss a particular topic for a short time - generally no more than 5 minutes - within the context of a large-group lecture.	• To encourage all learners to participate. • To develop group cohesion and encourage learners to help one another. • To "rehearse" understanding and thus consolidate factual learning. • To stimulate creative thinking.
Case discussion Real or hypothetical problems are analysed in detail. Learners are encourage to find solutions and make decisions.	• To help in understanding the facts underlying the problems and to eliminate misconceptions. • To show how various principles are applied to real problems.

Controlled discussion Under the control of the tutor, learners are encourage to ask questions, raise problems and make comments following a lecture.	• To provide further consideration of factual learning. • To bring together and synthesize the contents of a lecture and provide feedback to tutor and learners.
Demonstrations Certain procedures are performed by the tutor to demonstrate skills that must be acquired by learners.	• To help develop learners' power of observation. • To provide knowledge of principles as a prelude to learners practising the skills for themselves.
Video tapes	• For development of skills in interviewing, counselling, etc. • To allow learners to see themselves "in action". • To provide learners with direct feedback.
Free group discussion Discussion in which the content and direction are principally under the learners' control. The role of the tutor is that of an observer.	• To develop effective small-group functioning. • To help learners establish the practice of self-learning. • To allow the tutor to observe developments in the learners' problem-solving skills.
Group tutorial Tutorial with 12-15 learners. The subject and direction are usually, but not invariably, under the control of the tutor.	• To facilitate understanding of particular topics, and bring together ideas. • To develop group-functioning skills.
Projects Varied in format and content, but generally submitted as a written exercise by a small group of learners or by individuals.	• To develop skills in gathering organizing, applying and illustrating information in the context of a particular problem. • To provide practice in the presentation of data.

Private reading	• To assist in acquiring and understanding new information. • To assist the development of critical thinking skills. • To develop an ability to select and retrieve relevant information.
Role-playing Learners are assigned or select certain roles (e.g. village leader, mosquito collector), then create and act out typical situations. It is essential that the content of the role-play is discussed at length by participants and observers; without this, the exercise has little value.	• To develop "self-awareness", i.e. to help the learner appreciate the effect that his or her attitudes have on other people. • To improve attitudes and behaviour by encouraging the learner to "get into the skin" of another person.
Seminar Presentation of material by one learner to a group of fellow learners, followed by critical analysis and discussion. It is not essential that the tutor be present.	• To present new information. • To help with understanding of new material.
Individual tasks The type of task assigned to the individual learner may vary, but it will generally be a problem to be solved within or outside the classroom situation.	• To foster active, direct learning. • To develop problem-solving skills. • To provide a context in which the tutor can help learners to remedy particular weaknesses.
Lecture The "classical" lecture is an uninterrupted talk by the tutor to a group of learners, generally lasting about 1 hour. The form may be modified and used in conjunction with "buzz groups", syndicate groups, etc. into a coherent whole.	• To transmit information. • To impart general background knowledge of a particular subject. • To synthesize a wide variety of information
Practical classes Learners perform experiments, write up their results, and draw appropriate conclusions.	• To develop powers of observation. • To develop familiarity with equipment and skill in its use. • To develop problem-solving through collection, analysis and evaluation of data.

Problem-centred groups Problem solving in the classroom situation by groups of 4-8 learners, partly under the direction of the tutor.	• To develop skills in analysing and solving problems and in decision-making. • For practice in applying theoretical knowledge to "real" problems.
Step-by-step lecture A lecture format linked to an organized around, for example, a set of 35-mm slides or a number of multiple-choice question.	• To impart new information and reinforce its understanding.
Step-by-step discussion Working with a small group (8-10) of learners, the tutor directs a discussion centred on a particular issue or a set of pre-prepared questions. The intention is to draw out from the learners the required information.	• To present a new factual material. • To help learners in the process of scientific and deductive reasoning and of drawing appropriate conclusions.
Syndicate group The class is divided into groups of 4-6 people; all groups work on the same, or closely related, problems, with occasional teacher contact. Each group prepares a report, which is presented to the rest of the class. The syndicate group technique can be used in conjunction with tutorials.	• To develop skills in seeking out, organizing and presenting information. • To foster cooperation between learners in planning, writing and presenting a report.

❖ ❖ ❖