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Field guide for malaria epidemic assessment and reporting

DRAFT FOR FIELD TESTING

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Field guide for malaria epidemic assessment and reporting

Introduction

This small guide is written to *help field health staff at district and provincial levels to identify malaria epidemics as early as possible after their emergence, and to gather the appropriate information that will help to guide the response, and monitor its effectiveness; it will also be useful for a "post-mortem assessment" and future planning*.

It is specifically aimed at district health managers and others who have responsibility for public health and infectious disease control programmes.

In the whole spectrum of malaria epidemics from forecasting, early warning systems, alerts, response and review, this guide belongs in the area from alert to review, but does not detail the response. That information is found in other publications, as mentioned in the bilbiography.

The assessment guide is set out in 3 sections:

Section I: **What data to collect (Chapter 1)**

In the first section the basic information is requested. This information, when analysed and interpreted, will allow the field staff and those supporting them at district or (inter)national level, to decide whether an epidemic has indeed started, and what is the most appropriate response to this particular outbreak in this setting and with these resources.

Section II: **Why collect these data (Chapters 2–6)**

The second section follows the subject headings of the first, and tries to give sufficient information to enable the forms in the first section to be filled in with understanding and enthusiasm. There is a reason for all the questions asked – those reasons are set out in Section 2.

Section III: **How to analyse and interpret the data (Annexes 1–2)**

In the annexes in Section 3 there is detailed information on how to analyse the data, in terms of charts and graphs.

The reporting summary, at the very beginning of Section I, can be filled in when the data available have been collected and analysed, and forms the core of a report to the next level of the health structure where decisions on allocation of necessary additional resources are made.

No sophisticated equipment is needed to collect and analyse the data. Graph paper or plain squared paper and coloured pencils are all that is required. For some of the calculations, a calculator would be helpful, but the work can easily be done without sophisticated electronic equipment.

The bibliography at the end gives the references used in the development of this handbook, as well as useful further reading. Most of these references are available in full on an accompanying CD.

Situation report*

Country name: .....

Date:..... **Contact at country level:**.....

Situation declared as epidemic by national/regional/district authorities: ☐ yes ☐ no

If yes, is the district/region recognized as prone to malaria epidemics? ☐ yes ☐ no

If yes, when was the last epidemic?.....

Time frame	Date of onset? For reporting on past epidemics: end date of epidemic?	
First detection and notification	How? (national or international media reports, security services, health systems, …) When?	
Location and population at risk	*(Attach a map, GIS format, if possible)*	
Potential determinants (triggering factors)	**For example**: Unusual rainfall after prolonged drought, population movements, unusual rainfall, unusual temperature increase, numerous water pools after flooding, delayed or no control measures like IRS, others…	
Meteorological situation	Actual rainfall and temperature data	
Disease situation (available monthly or weekly data can be attached)	**For example**: Data from the four sentinel hospitals in the region shows a small increase in outpatient malaria cases in week 1, a situation that has been increasing consistently for the past four years. There is, however, a noticeable increase in malaria admissions in the paediatric ward, YYY Hospital, where December 2002 admissions were double that of December 2001. There has also been a noticeable increase in the reported malaria deaths in the paediatric ward of the XXX Hospital, which reported a 66% increase compared to 1999–2000 (26 deaths) in the month of November. *Data included in the national report*.	
Investigation	Investigated by whom? (MoH, NGOs, researchers, others...) **For example**: The national team, supported by the WHO country office, has undertaken a detailed investigation of the situation. Data available has also been reviewed, however data beyond week 1 of 2002 is currently unavailable	
Reports available	**For example**: MOH Situation Review on the recent reports of abnormal increase in malaria cases in YYY region dated *16 Jan 2002*, and a detailed assessment report dated *21 Jan 2002*.	
Response	**For example**: Resources are currently being mobilized to address the recommendations of the assessment report, particularly to support IRS and drug distribution. In the meantime, the response is underway and hospital treatment facilities have been expanded within the area (both in terms of capacity and staff). Press releases/interviews are underway to pass information to the affected areas through TV, radio and the press. Insecticides are being supplied to start the indoor spraying program.	
Requirements / Assistance	**Supplies:**	e.g.: Drugs (which ones?) and insecticide supplies reported as sufficient
	Funds:	e.g.: Request received by WHO country office, allocations being made through XXX funds allocated previously
	Technical support	e.g.: None currently requested
	Other:	e.g.: None currently requested
Other alerts increasing vulnerability	Please mention others events increasing vulnerability like prolonged drought season with shortage of crops and malnutrition, other epidemics such as cholera, complex situation created by overflooding…	
Potential evolution	A continuous increase expected ?	
Preparedness and response plan of action in place	Yes / No	
Immediate follow-up actions required (what is needed ?)	Activity	Completed
	1. MOH requests for support ? (WHO country or regional office, HQ to follow-up…)	
	2. National team for situation analysis and response (drugs, insecticide, monitoring & surveillance, etc.):	
	3. Control options selected:	
	4. Monitoring systems for assessing results in place:	
	5. Others:	
Other comments:		
Reported by (name, qualification and responsibility):		

*Form for onward reporting by national MoH to WHO, adapted from reporting form used by WHO/SAMC

SECTION I

Chapter 1. The outbreak report

Chapter 1. The outbreak report

1.1 Reporting summary of an unusual increase of malaria

Report to be sent to .....
Location (specify country, precise area affected and main surrounding towns)

.....

Species *P. falciparum* ☐ *P. vivax* ☐ not yet identified ☐
Date of onset .....

Estimated total ***population*** in currently affected area .....
Total reported and estimated ***cases*** over last 8 weeks .....
Total reported and estimated ***deaths*** over the last 8 weeks.....
Estimates based on .....

1. This report is in response to a registered epidemic alert ☐ yes ☐ no
   (specify source and date of alert) .....
2. This report is a new epidemic alert ☐ yes ☐ no

Summary of reasons for concern:

a. Case numbers have crossed the previously defined epidemic threshold ☐ yes ☐ no
b. There is no threshold value, but case numbers are very much higher than at the same time last year ☐ yes ☐ no
   If yes, by how many times? .....
c. There is no threshold value, but case numbers have risen very rapidly in the past few (2–4) weeks ☐ yes ☐ no
d. There is a high case-fatality rate from malaria-like illness ☐ yes ☐ no
e. There is a rising slide positivity rate in adults with symptoms of malaria ☐ yes ☐ no
f. There has been an unusually high consumption of antimalarial drugs in the past 2 weeks ☐ yes ☐ no
g. Malaria has been confirmed as the cause ☐ yes ☐ no

3. Trigger factors have been identified ☐ yes ☐ no
   If yes, list main trigger factors.....
4. Confounding factors have been identified ☐ yes ☐ no
   If yes, list main confounding factors .....
5. The area is known for the occurrence of falciparum malaria epidemics ☐ yes ☐ no

Response capacity

6. Human resources are adequate to deal with the outbreak ☐ yes ☐ no
7. There are enough supplies of effective medicines ☐ yes ☐ no
8. The cost of drugs is too high for affected population ☐ yes ☐ no
9. The laboratory service is overloaded ☐ yes ☐ no
10. Access to some affected areas is very difficult ☐ yes ☐ no
11. There is an opportunity for vector control ☐ yes ☐ no

Reported by .....
Position, contact details.....
Date, location .....

*Above **Reporting summary of an unusual increase of malaria** can be filled in when the data available have been collected and analysed, and forms the core of an emergency report to the next level of the health structure where decisions on allocation of necessary additional resources are made. Attach copies of the charts and graphs asked for in **Analysis of information.** Be sure to keep copies of all information locally.*

Analysis of information

A. Is this an epidemic?

Analysis of 5-year data for epidemic thresholds (see Annex 1) – *Source: Tables 1–2*
Attach a graph showing the epidemic threshold, with the current case numbers superimposed.

Where 5-year information is not readily available:

Bar chart of case numbers comparing this year and last year
(see chart 2.1, Annex 2) – *Source: Table 3*

Bar chart of case numbers, under-5 and 5 years and over for the past 8 (or more) weeks
(see chart 2.2, Annex 2) – *Source: Table 4*

B. Confirmation of malaria and proportion of suspected cases diagnosed

Bar chart of clinical cases and confirmed cases in children under 5
(see chart 2.3, Annex 2) – *Source: Table 4*

Bar chart of clinical cases and confirmed cases, 5 years and over
(see chart 2.4, Annex 2) – *Source: Table 4*

C. Case-fatality rates (overall vs malaria-specific)

Graph of the case-fatality rate in hospital; children under 5 years
(see graph 2.2, Annex 2) – *Source: Table 5*

Graph of the case-fatality rate in hospital; 5 years and over – *Source: Table 5*

D. For areas with presence of vivax malaria

Graph showing the comparative numbers of *Plasmodium falciparum* and *Plasmodium vivax* over time (past 16 weeks or more, if available) – *Source: Table 4*

E. Additional information

Are there confounding factors that may distort the data? – *See 2.6*
List possible confounding factors:.....
.....

If the cause of the epidemic is still uncertain, what else could it be besides malaria? – *See 2.5*
.....

Conclusion

Is this an epidemic of malaria? ☐ yes ☐ no ☐ uncertain

If yes, is there evidence that the epidemic curve is still rising? .....

1.2 Detailed assessment and analysis

1.2.1 Information for determination of epidemic threshold
(see Chapter 3 and Annex 1)

Table 1. Number of malaria cases reported monthly over the past 5 years

Source of data: Locality .....
Type of health service(s) included.....
Geographic relation to current outbreak .....
Are these the same clinic(s) where current epidemic was reported? ..... ☐ yes ☐ no
Case definition of cases included. .....

Month	5 years ago ( )	4 years ago ( )	3 years ago ( )	2 years ago ( )	last year ( )	this year ( )
January						
February						
March						
April						
May						
June						
July						
August						
September						
October						
November						
December						

Table 2. Number of malaria cases reported weekly over the past 5 years (if available)

Source of data: Locality .....

Type of health service(s) included .....

Geographic relation to current outbreak .....

Are these the same clinic(s) where current epidemic was reported? ..... ☐ yes ☐ no

Case definition of cases included. .....

		5 years ago ( )	4 years ago ( )	3 years ago ( )	2 years ago ( )	last year ( )	this year ( )
January	Week 1						
	Week 2						
	Week 3						
	Week 4						
	Week 5						
February	Week 6						
	Week 7						
	Week 8						
	Week 9						
March	Week 10						
	Week 11						
	Week 12						
	Week 13						
April	Week 14						
	Week 15						
	Week 16						
	Week 17						
	Week 18						
May	Week 19						
	Week 20						
	Week 21						
	Week 22						
June	Week 23						
	Week 24						
	Week 25						
	Week 26						
July	Week 27						
	Week 28						
	Week 29						
	Week 30						
August	Week 31						
	Week 32						
	Week 33						
	Week 34						
	Week 35						
September	Week 36						
	Week 37						
	Week 38						
	Week 39						
October	Week 40						
	Week 41						
	Week 42						
	Week 43						
November	Week 44						
	Week 45						
	Week 46						
	Week 47						
	Week 48						
December	Week 49						
	Week 50						
	Week 51						
	Week 52						

It is not common to have the complete information asked for in the previous pages, especially during an emergency. However, when you eventually find time it will be useful to start reviving this type of archived information, in order to construct a useful database for future reference.

For the moment, based on what you have been able to obtain in previous tables, complete as much of the following information as possible, realizing that the information in Table 3 will apply to the health services and case definition that you have identified in Tables 1 and 2.

1.2.2 Surveillance in the affected area (see 2.5)

Table 3. Case load over the past 6 months compared with previous year
The monthly total number of cases in the affected area during the past 6 months compared with the number of cases in the same months last year (identify the month and year)

	6 months ago ( )	5 months ago ( )	4 months ago ( )	3 months ago ( )	2 months ago ( )	last month ( )
this year						
last year						

Table 4. Number of cases of clinical malaria (fever cases treated for malaria) and laboratory confirmation at the individual health centres in the affected area in the past 8 weeks (add more tables if more health centre data available)

• **Table 4a Name of health centre/clinic/outpatient department (OPD)** .....
Availability of malaria diagnostic tests: none / microscope / rapid diagnostic tests

Identify the weeks by dates

	under 5 years of age*				5 years and over*			
	fever	test positive			fever	test positive		
dates		*P.f.*	*P.v.*	mix		*P.f.*	*P.v.*	mix
8 weeks ago (-)								
7 weeks ago (-)								
6 weeks ago (-)								
5 weeks ago (-)								
4 weeks ago (-)								
3 weeks ago (-)								
2 weeks ago (-)								
last week (-)								
Total								

N.B. *P.f.=Plasmodium falciparum; P.v.=Plasmodium vivax*

* In these and other tables: if available data are reported for age-groupings other than "under 5 years of age" vs "5 years and over", you can use the closest possible grouping, but be sure to mention this in your tables and analysis. Do this also if age groups are not separated at all.

• **Table 4b Name of health centre/clinic/OPD** .....
Availability of malaria diagnostic tests: none / microscope / rapid diagnostic tests

Identify the weeks by dates

	under 5 years of age				5 years and over			
	fever	test positive			fever	test positive		
dates		*P.f.*	*P.v.*	mix		*P.f.*	*P.v.*	mix
8 weeks ago (-)								
7 weeks ago (-)								
6 weeks ago (-)								
5 weeks ago (-)								
4 weeks ago (-)								
3 weeks ago (-)								
2 weeks ago (-)								
last week (-)								
Total								

N.B. *P.f.=Plasmodium falciparum; P.v.=Plasmodium vivax*

More information on the affected population
Is there reason to think that any particular group of people is especially affected (sick), or dying of the disease, e.g. farm workers, people working in the forest, schoolchildren, others? .....
.....

Reports from villages or remote areas
Location..... Transport distance to health service.....
Date of onset ..... Means of transportation .....
Time frame of reported data..... Person reporting.....
Size of population .....
Number of people sick with suspected malaria .....
Number of child deaths ..... Number of adult deaths in this period.....

Emergencies/new camps for displaced persons or refugees
Estimated population..... Number of deaths following fever .....
Deaths under 5 years ..... Deaths 5 years and over.....

1.2.3 Confounding factors (see 2.6)

Has there been improved access to the health facility as a result of
Reduced fees in the clinic? ☐ yes ☐ no
Period of increased income (e.g. harvest time)? ☐ yes ☐ no
Better roads or transport? ☐ yes ☐ no
Is there any other reason that more people come? ☐ yes ☐ no
If other reason, which?: .....

Comment: .....

1.2.4 Hospital data (inpatients) (see 2.7)

The number of patients treated for malaria hospitalized in the past 8 weeks and the deaths attributed to malaria

Table 5. Hospital data (inpatients)

	Under 5 years of age			5 years and over		
	Fever	Died	CFR[1]	Fever	Died	CFR
8 weeks ago						
7 weeks ago						
6 weeks ago						
5 weeks ago						
4 weeks ago						
3 weeks ago						
2 weeks ago						
last week						
Total						

Is there any other epidemic affecting the hospital? .....

Epidemic risk

Is the area known to be affected by epidemics of malaria? ☐ yes ☐ no
Is this an area of high malaria transmission all year round? ☐ yes ☐ no

Factors in the human (see 3.1)

Has a large group of people arrived recently? ☐ yes ☐ no
If yes: are these the people who are mainly affected by the epidemic? ☐ yes ☐ no
Was there malaria in their place of origin? ☐ yes ☐ no
Have they travelled through a malarial area? ☐ yes ☐ no

Increased vulnerability due to other (medical) conditions

Other health problems affecting the community more than usual
Hunger or malnutrition ☐ yes ☐ no
HIV/AIDS ☐ yes ☐ no
(Forced) migration ☐ yes ☐ no
Others .....

Comments .....
.....

Factors related to the vector (see 3.2)

Has the weather in the past few months been:
– unusual for this season? ☐ yes ☐ no
– wetter than usual for this season? ☐ yes ☐ no
– hotter than usual for this season? ☐ yes ☐ no
If yes: are meteorological trend data available? ☐ yes ☐ no

[1] Case-fatality rate (%) = number of patients dying from a disease divided by number of cases of the disease diagnosed in same period x 100

Are there any major environmental changes in the district that could have increased mosquito breeding sites (e.g. a new dam, or construction work, irrigation, rice-cultivation)?

.....

Is a new mosquito vector present in the region? ☐ yes ☐ no
Have mosquito vectors become resistant to insecticides? ☐ yes ☐ no
Has there been interruption of a malaria control programme in the past few years? ☐ yes ☐ no
Describe .....

Comments .....
.....

Table 6. Resistance to antimalarial drugs
Results of recent therapeutic efficacy studies[2] in the region

• **Table 6a. First-line drug** according to national protocol:.....

Year	Location	Investigators	Number studied	Number of days	ETF[3]	LCF[4]	LPF[5]	ACPR[6]

• **Table 6b. Second-line drug** according to national protocol: .....

Year	Location	Investigators	Number studied	Number of days	ETF	LCF	LPF	ACPR

• **Table 6c. Other antimalarial drug** commonly used in the area: .....

Year	Location	Investigators	Number studied	Number of days	ETF	LCF	LPF	ACPR

Comments .....
.....

[2] Specify whether the standard WHO protocol (see 3.3) was used, or an adapted protocol.
[3] Early treatment failure; specify whether number or percentage.
[4] Late clinical failure; specify whether number or percentage.
[5] Late parasitic failure; specify whether number or percentage.
[6] Adequate clinical and parasitological response; specify whether number or percentage.

1.3 Information needed for epidemic response

Population (see 4.1)
The total population in the affected area .....
The population in the whole district is .....
The number of recent newcomers is .....
What building materials are most commonly used for:
a) houses? .....
b) shelters for displaced persons? .....

Are there any cultural or other restrictions that could make it difficult for some people (e.g. women or religious or ethnic groups) to access the health facility? .....
.....

1.3.1 History of malaria in the region

Is malaria present at the same level all year round? ☐ yes ☐ no

or

Which months are known to be the peak malaria season? (tick the month)

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
P.f.												
P.v.												

or

Is malaria previously unknown in this region? ☐ yes ☐ no

1.3.2 Malaria prevention – vector control

Local *Anopheles* mosquito(es) known to be main malaria vector(s) 1 .....
2. .....
Are they known to rest indoors or outdoors? .....
Is there a malaria control programme in the region? ☐ yes ☐ no
Are houses sprayed indoors with insecticide? ☐ yes ☐ no
If yes, when were the houses last sprayed and what % coverage was achieved? .....
.....
Do people use insecticide-treated bednets? ☐ yes ☐ no
If yes, is there a system of regular re-impregnation with insecticide? ☐ yes ☐ no
What is the estimated current coverage of households/high risk groups with ITNs? .....
.....
Is there reason to suspect insecticide resistance? ☐ yes ☐ no
If yes, why? .....

1.3.3 Drug treatment of malaria

National policy
First-line treatment drug(s) .....
Second-line drug(s) .....
Drug(s) used for severe malaria .....
Drug(s) used for prevention of malaria in pregnancy .....
Other drugs that may be used in exceptional circumstances (e.g. an epidemic) .....
Are sufficient stocks of these drugs currently available? ☐ yes ☐ no

Drug(s) available locally from private doctors and/or drug sellers, NGOs, faith-based organizations
.....

1.3.4 Sketch map of health facilities in the district or affected area

Sketch a map of the health facilities in the district or affected area, showing:

- inpatient facilities; beds/staff/laboratory/cost of admission and treatment
- outpatient facilities/clinics; staff/laboratory/cost of consultation and treatment
- length of time for travel between clinics and hospital:
  - on foot
  - by commonly available transport
  - cost of transport
- distance/time taken to reach farthest villages/settlements:
  - on foot
  - by commonly available transport
  - cost of transport

Is HealthMapper[7] software in routine use for monitoring and evaluation in the area? ☐ yes ☐ no
If yes: attach latest available map of area indicating clinics, roads and location of outbreak.

1.3.5 Epidemic emergency preparedness plan of action

Is there a district epidemic management committee?	☐ yes ☐ no
Are contingency plans available (as part of an overall health emergency plan)?	☐ yes ☐ no
Have they been consulted?	☐ yes ☐ no
Are the recommended supplies available?	☐ yes ☐ no

If no epidemic emergency preparedness plan of action exists, the following activities and resources need to be considered:

- ***Personnel***

General: training – rest days

a)	*hospital/inpatient facility*	24-hour cover nurses per patient intensive care extra inpatient beds
b)	*outpatient facility*	hours of opening efficient patient flow waiting for laboratory results management of treatment follow-up
c)	*outreach*	new static or mobile clinics composition of teams distance travelled

- ***Referral services***

a) from periphery/outreach to health facility
b) from primary to secondary care

- ***Laboratory/diagnostics choices***

a)	*hospital level*	microscopy
b)	*primary level – with/without some inpatient beds*	rapid tests or microscopy
c)	*outreach facilities*	rapid tests are ideal
d)	at the height of the epidemic	clinical diagnosis, monitor with microscopy
e)	at different stages of the epidemic	monitor with microscopy

[7] HealthMapper is a user-friendly data management and mapping system, developed by WHO, customized specifically for public health users.

- ***Medication and supplies***

Hospital – extra supplies of:

– artemether injections and/or parenteral quinine
– 5%, 10% and 50% dextrose and 0.9% saline
– oral antimalarials for continuation of treatment
– paracetamol, oral and suppository
– diazepam, injectable and suppository
– furosemide injection
– water for injection
– syringes/needles/scalp vein sets/giving sets/adhesive tape
– thermometers and blood glucose monitors
– insecticide-impregnated bednets for all beds in the facility

Clinics and community outreach – extra supplies of:

– oral antimalarial drugs, first-line and second-line, designated for use during the epidemic (see flowchart for drug availability, 1.4a)
– rectal artesunate or intramuscular artemether for severe cases to cover transport to hospital
– paracetamol

- ***Access and communications***

a) free diagnostics and treatment for malaria
b) health education through outreach, local radio, etc.
c) information campaigns through press and public meetings

- ***Monitoring***

a) training in reinforced health information system (weekly data collection and analysis during epidemic)
b) district epidemiologist to manage data collection
c) sufficient registers, graph report forms and graph paper for each level
d) Where computers are already in daily use: (refresher) training in Excel and HealthMapper

- ***Vector control***

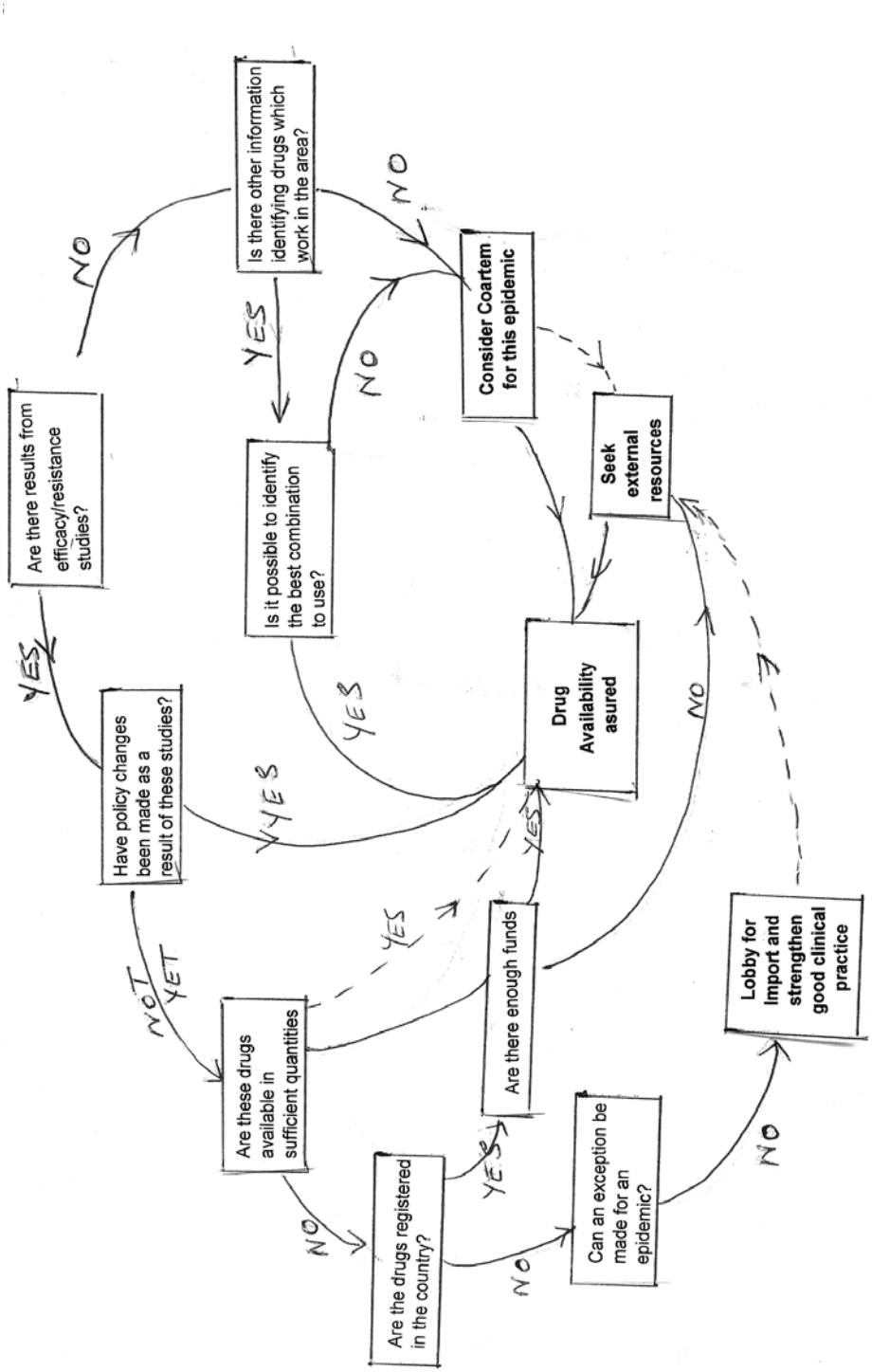
a) establish the efficacy of existing indoor residual spraying (IRS) programmes and insecticide used
b) district entomologist
c) trained teams for IRS
d) insecticide, equipment and logistics for IRS
e) insecticide, equipment and logistics for re-impregnation of existing bednets

- ***Outside help***

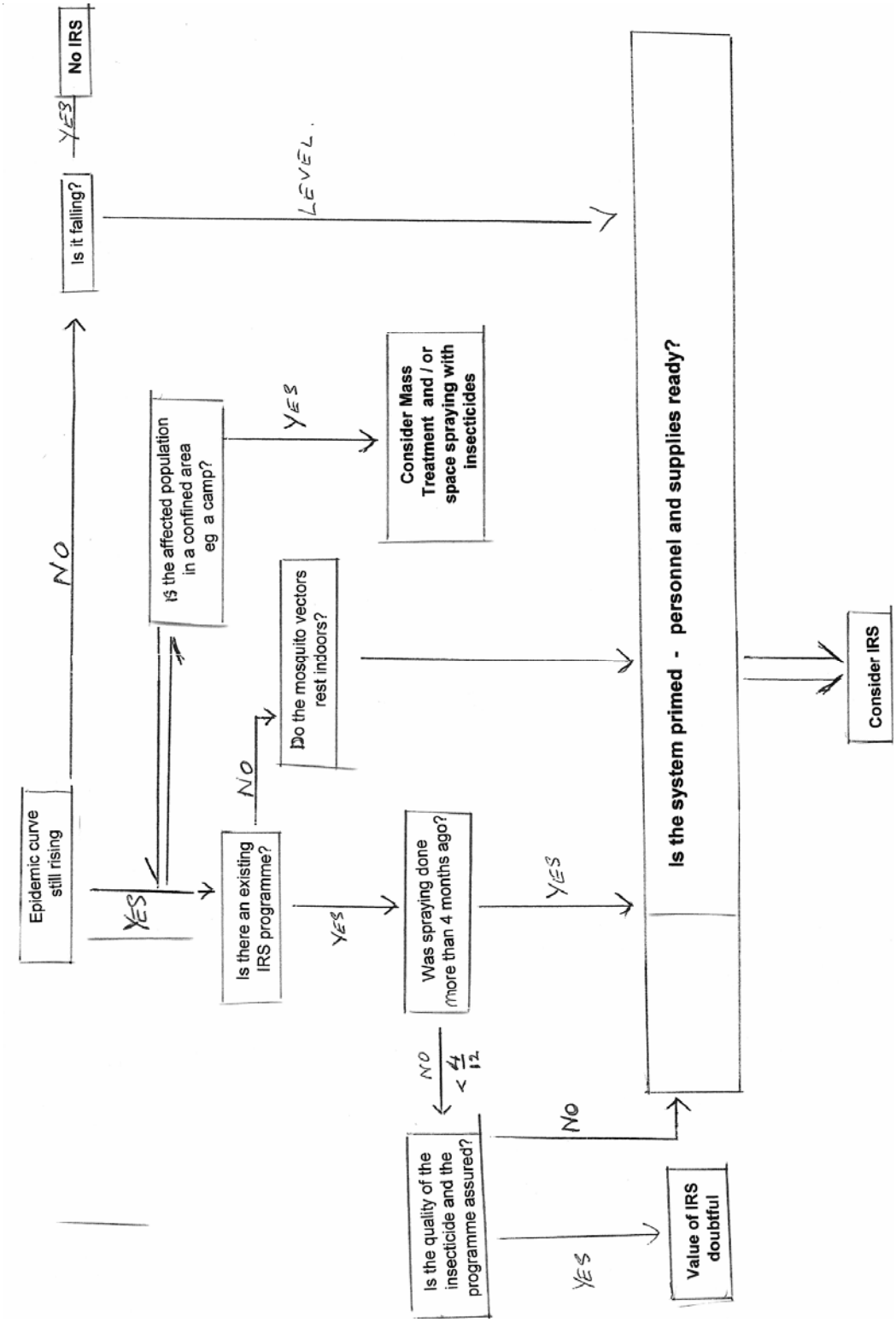
a) support from provincial/central government level (including national epidemic management committee), WHO, UNICEF
b) support from international NGOs

1.4 Flowcharts for decision-making

1.4a Flowchart on drug availability



1.4b Flowchart for assessing measures to interrupt transmission



1.5 Monitoring and evaluation

1.5.1 Monitoring the course of the epidemic

Form 1. Incidence of malaria at first-line health facilities
Form for daily or weekly monitoring of clinical cases, referred cases, and deaths in the community

Name of health post or clinic .....
Source of data: Locality .....
Type of health service(s) included .....
Geographical relation to current outbreak .....
Are these the same clinic(s) where current epidemic was reported? ..... ☐ yes ☐ no

Date(s)	Number of cases treated for malaria		Referral to 2nd line care		Deaths reported in the community	
	< 5 years of age	5 years and over	< 5 years of age	5 years and over	< 5 years of age	5 years and over

To analyse, make graphs or bar charts of the numbers of cases (total, under fives, 5 years and over).

Form 2. Confirmation of diagnosis
Form for daily or weekly monitoring of confirmation of diagnosis (slide/test positivity rate)

Name of health centre .....
Source of data: Locality .....
Type of health service(s) included .....
Geographical relation to current outbreak .....
Is this the same health centre where the current epidemic was reported? ..... ☐ yes ☐ no

Date(s)	< 5 years of age			5 years and over		
	Number tested	Number confirmed	% positive	Number tested	Number confirmed	% positive

To analyse, make bar chart showing numbers tested, numbers confirmed and slide positivity rate.

Form 3. Hospital admissions and case fatality rates
Form for daily or weekly monitoring of inpatients and hospital deaths

Name of hospital.....
Source of data: Locality .....
Type of health service(s) included.....
Geographical relation to current outbreak .....
Is this the same hospital where the current epidemic was reported? ..... ☐ yes ☐ no

Date(s)	Number of patients admitted for malaria						Hospital deaths attributed to malaria*					
	< 5 years of age			5 years and over			< 5 years of age		5 years and over		Total	
	treated for malaria	lab. tests done	lab. test positive	treated for malaria	lab. tests done	lab. test positive	no.	%	no.	%	no.	%

* In this table, the percentage of deaths (CFR) = number of patients dying from malaria in the hospital divided by number of patients admitted and treated for malaria in that age group in the same period x 100. It therefore includes all malaria patients, whether diagnosed clinically or with laboratory confirmation.

To analyse, make chart showing numbers admitted, tested, and CFRs by age groupings and total.

1.5.2 Monitoring and evaluating the response to the epidemic

1. Process indicators

Access to health care
During each week of the epidemic:
a) All villages within the epidemic area are within 2 hours travel of skilled and adequately equipped health care.
b) Mobile clinics set up and running according to planned schedule.
c) Arrangements for referral implemented for 90% of cases.
d) No rupture of stock of drugs designated for use in the epidemic.
e) Malaria diagnosis and treatment free of charge.

Vector control
a) Planned IRS activities achieved within the time frame (i.e. while epidemic curve is still rising).
b) Planned distribution/re-impregnation of insecticide-treated nets (ITNs) achieved within the time frame (i.e. during the onset of the epidemic).

2. Outcome indicators

Indicators of good case management

a) Time from onset of symptoms to presentation for treatment < 24 hours.
b) Percentage of patients developing severe disease shows a downward trend.
c) Hospital CFR for all admitted cases < 1% (see Form 3).
d) CFR for severe falciparum malaria (according to WHO definition[8]) < 20%.

Indicators of interruption of transmission

a) The incidence curve flattens or falls (see Form 1).
b) The slide/test positivity rate flattens or falls (see Form 2).

3. Indicators of epidemic preparedness and response

a) Emergency preparedness plan of action available and reviewed within 24 hours of alert.
b) Outbreak investigation initiated within 48 hours of alert.
c) Plans made and extra resources requested within 48 hours of completion of outbreak investigation.
d) Necessary resources (including additional requested resources) deployed within 2 weeks of epidemic alert.
e) Emergency meetings with partners to coordinate response.

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[8] A patient with severe falciparum malaria may present with confusion, or drowsiness with extreme weakness (prostration). In addition, the following may develop:

- cerebral malaria, defined as unrousable coma not attributable to any other cause in a patient with falciparum malaria
- generalized convulsions
- severe normocytic anaemia
- hypoglycaemia
- metabolic acidosis with respiratory distress
- fluid and electrolyte disturbances
- acute renal failure
- acute pulmonary oedema and adult respiratory distress syndrome (ARDS)
- circulatory collapse, shock, septicaemia ("algid malaria")
- abnormal bleeding
- jaundice
- haemoglobinuria
- high fever
- hyperparasitaemia

These severe manifestations can occur singly or, more commonly, in combination in the same patient. Source: *Management of severe malaria – a practical handbook*, 2nd ed. Geneva, World Health Organization, 2000.

SECTION II

Chapter 2. When is it an epidemic of malaria?

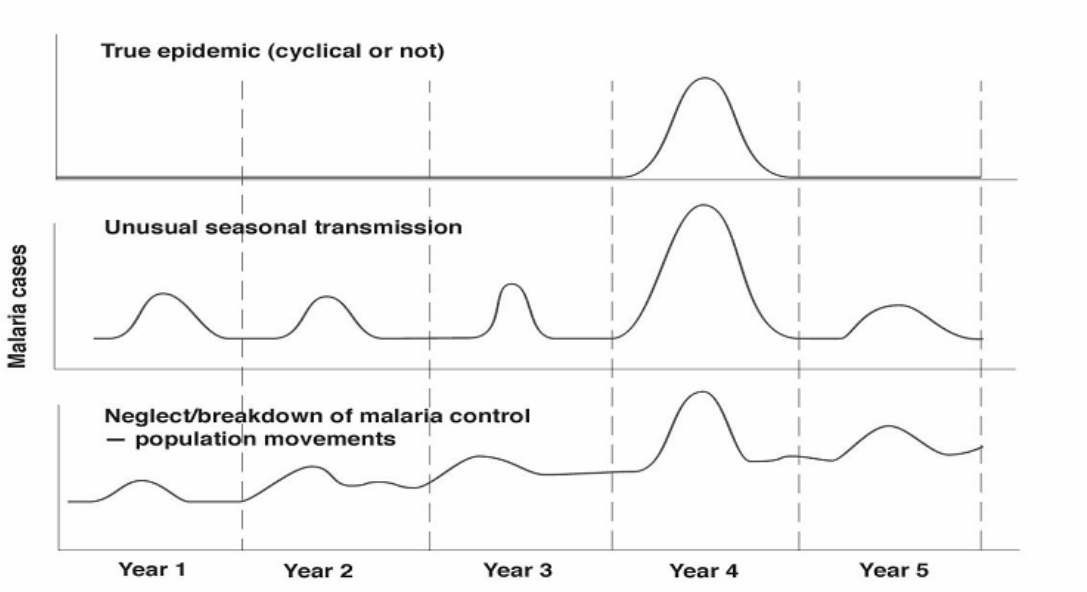
The information you have recorded in "Reporting summary" and "Analysis of information" is needed to find out whether the problems are severe enough to be classified as an epidemic, and whether malaria is the most likely cause of the epidemic. The following background information will help you to understand the need for the data.

2.1 Features of an epidemic

- An increase in morbidity (cases) clearly beyond what is normal for the area.
- Excessive case-fatality rates in falciparum malaria (> 1% for all cases and >20% for severe cases fulfilling WHO definition, see 1.5.2).

2.2 Types of malaria epidemic patterns

Figure 1. Classification of major epidemic types



(Source: WHO, 2002)

- **Explosive epidemic in non-immune populations**

True epidemics: infrequent/cyclical outbreaks in relatively non-immune populations related to climatic anomalies. They occur mainly in arid and semi-arid zones with little or no seasonal fluctuation where infection is normally rare.

- **Exaggerated seasonal variation**

Strongly seasonal transmission: variable but relatively predictable transmission influenced by normal climatic variations.

- **Complex emergencies**

Malaria transmission exacerbated by population movements and country political instability. The pattern can be either explosive or exaggerated seasonal variation.

- **Yearly increase towards endemicity**

Neglect/breakdown of control: a general upward trend in endemicity and transmission in areas where malaria has re-emerged as a result of neglected control activities (not necessarily linked to a complex emergency situation).

Vivax and falciparum epidemic curves

Epidemics grow in a series of steps representative of the incubation interval,[9] which is about 20 days for *P. vivax* and 35 days for *P. falciparum*. The incubation interval and the reproduction rate determine how fast the epidemic curve can rise, which is much faster in vivax epidemics than in falciparum epidemics. In places where both vivax and falciparum are present, vivax cases will thus usually be more abundant earlier in the malaria season, followed by the cases of falciparum. There will be considerable overlap. If the conditions exist for a big seasonal increase in vivax, it can be expected that the same may be true for falciparum, with more serious consequences.

2.3 Defining and declaring a malaria epidemic

The practical importance of defining and declaring an epidemic is the level of support that may be triggered. Declaring an epidemic too late will lead to avoidable and unnecessary morbidity and mortality, and to wastage of resources if control options are implemented too late in relation to natural development of the epidemic curve. Declaring an epidemic prematurely may lead to over-reaction at the expense of scarce resources and may distort the reality of the situation.

Definitions

- *An epidemic*

An epidemic is an acute exacerbation of disease out of proportion to the normal to which the community is subject.[10]

- *A malaria epidemic*

There is no universal definition of a malaria epidemic. It is generally accepted that a sharp increase in malarial incidence among populations in which the disease is rare or a seasonal increase in clinical malaria in areas of low to moderate transmission constitute a malaria epidemic.[11] However, the definition of "normal" occurrence can be defined only for a particular population in a specific area and time. Therefore, malaria epidemics can generally be considered as a disturbance of a previously existing epidemiological equilibrium.[12] An alternative definition of an epidemic is the malaria caseload exceeding the capacity of the existing health care facilities to handle it.

[9] The incubation interval is the period between the occurrence of infective gametocytes in the primary patient and their reappearance in a secondary patient.
[10] Macdonald G. *The epidemiology and control of malaria*. London, Oxford University Press, 1957.
[11] Bruce-Chwatt, 1993.
[12] Nájera, 1999.

2.4 Epidemic thresholds (see Annexes 1 and 2)

Attempts have been made to identify thresholds that clearly define an epidemic in terms of the previous experience of the disease. Such thresholds can be worked out in areas where data have existed for some years and the population has remained stable.[13] In these circumstances the declaration of an epidemic is very straightforward.

However, many epidemics occur in situations where previous data are either unavailable or irrelevant due to significant contextual changes. In these circumstances, precise thresholds will not be possible, and an epidemic situation is more practically defined by the rapid increase in numbers, a high case-fatality rate and the fact that the existing health services are overwhelmed.

2.5 Surveillance in the community or district/affected area

- *Malaria surveillance*

In areas where malaria is endemic year-round, it is usual to keep monthly data in health facilities. However, this time interval is too long to be sensitive to early detection of malaria outbreaks. In districts where malaria epidemics have occurred before, and in complex emergencies, you should **try to keep weekly data on malaria cases and malaria deaths, particularly before and during the expected epidemic season**. In epidemic-prone places, you can keep a running graph of malaria cases and update it weekly, either on squared paper or using a computer if you have access to one (which is especially useful at district level where data are compiled and analysed).

- *Be alert to increased case-loads and/or mortality*

Not all malaria epidemics occur in places or situations where they can be anticipated. If you have the impression that there are substantially increased numbers of fever cases in primary care or an unusual number of deaths from malaria, especially in adults or older children, you should carefully review the figures and strengthen surveillance.

- *How to strengthen surveillance for an outbreak*

If an outbreak or epidemic is suspected, all facilities in the prone region should start to keep weekly figures for malaria. These could be added to the existing epidemic surveillance report form or recorded separately. In either case, it is important in reporting malaria that distinction is made for both morbidity and mortality between under- and over-5 years. In emergencies, complex or otherwise, it is normal to keep weekly figures of morbidity.

- *More adults with malaria*

In an epidemic situation where immunity is not high, you may see a steady increase in the number of adults presenting with malaria. This is particularly significant if you can be sure, through microscopy or rapid diagnostic tests, that an increasing proportion of adults with clinical malaria are slide- or test-positive.

- *Need for laboratory diagnosis*

At the same time as moving to weekly data collection, it is important to be sure of the diagnosis and of the type of malaria. If there is no laboratory in the district capable of doing this, send slides taken from all fever cases to the nearest facility that can make the diagnosis. Alternatively, you could use rapid diagnostic tests that will identify *Plasmodium falciparum.* For areas where *Plasmodium vivax* is common, there are also tests that will identify both *Plasmodium falciparum* and non-falciparum malaria (see Section 3.8 and WHO, *Malaria diagnosis new perspectives*)

[13] For example: Cullen JR et al. An epidemiological early warning system for malaria control in northern Thailand. *Bulletin of the World Health Organization*, 1984, 62(1):107-114.

- *Deaths in the community*

In places where malaria is not well known, reports of increased deaths in the community following a feverish illness may not be immediately attributed to malaria. Health workers may not be familiar with the presentation, and malaria outbreaks have been mistaken for dengue, typhoid, meningitis or other diseases associated with fever. On the other hand, once a malaria epidemic has been declared, "verbal autopsies" to assess the cause of deaths will be influenced by the community's preoccupation with the ongoing epidemic, resulting in an overestimate of deaths due to malaria.

- *Deaths in camps for the displaced or work camps*

The same may be true for displaced populations, for whom malaria may be a new illness with which they are not familiar. Health workers may be unused to seeing severe malaria in otherwise healthy adults, and may therefore assume another cause of the illness.

2.6 Confounding factors that might explain increased numbers

Increased numbers of people presenting at a health centre can be due to causes unrelated to illness or to epidemics. For example, a new road may have been built, or a new bus service started, which makes it easier for people to reach the health centre. Sometimes more people will come because the service has become cheaper or even free of charge for malaria, or they have heard that there are more qualified staff, or a neighbouring clinic has closed.

2.7 Hospital data collection

Hospital data can be very valuable in giving more information about the diagnosis and case-fatality rate, which are often not so clear in the community. The hospital may also be able to alert the peripheral facilities to other diseases or outbreaks that be confused with malaria.

2.8 Laboratory tests

- *Microscopy*

Microscopy is still the best way of detecting malaria, particularly in epidemic-prone regions. Apart from making a precise diagnosis according to type, it is possible to see whether the parasitaemia in an individual patient has declined after treatment.

- *Rapid diagnostic tests*

Rapid diagnostic tests detect antigens from the malaria parasite. One type detects histidine-rich protein II (HRP-II) which is produced by *P. falciparum*. Another type detects parasite lactate dehydrogenase (pLDH) from all four species, and some kits combine detection of the HRP-II antigen of *P. falciparum* together with that of an as-yet unspecified "pan-malarial" antigen of the other species. The latter two tests can distinguish *P. falciparum* from the non-falciparum species, but cannot distinguish between *P. vivax, P. ovale* and *P. malariae*. Some of the kits that detect all four species mention in their brand name or their marketing material only two species (e.g. "PF/PV"), which is confusing. The tests are available as dipsticks or test strips.

Rapid tests can be very useful where microscopy is not available or is overwhelmed by increased case-load. However, they are not quantitative, and those based on detection of HRP-II remain positive for up to 2 weeks after the patient is cured and has no parasites.

Table 7. The pros and cons of microscopy and rapid diagnostic tests for malaria

	Microscopy	Rapid diagnostic tests
Detection threshold	5–10 parasites/µl theoretically, but in a normal laboratory, often only 100 parasites /µl	40–100 parasites/µl
Species	all identified	most detect only *P.f.*; some detect *P.f.* and non-*P.f.*
Parasite load	yes	no
Differentiation between sexual and asexual stage	yes	no
Detection of sequestered parasites	no	yes
Useful for monitoring response to treatment	yes	no
Time to result	60 minutes	15–20 minutes
Personnel	skilled	minimally trained
Cost	high capital costs; reagent costs low	now approx US$ 0.5 per test for the HRP-II tests
Logistics	storage of microscope and supply of reagents can be difficult	easily carried and stored, although sensitive to extremes of heat and humidity

Chapter 3. What causes an epidemic of malaria?

This chapter describes the factors that can give rise to an epidemic of malaria. Understanding what may have caused the particular epidemic you are concerned with may help to identify particularly vulnerable groups of people or to indicate whether vector control is important now or to prevent future epidemics. The discussion on specific trigger factors is not meant to be complete. We hope this chapter stimulates you to collect and interpret local information, trying to identify what may have caused the particular epidemic in your area.

General principles

Epidemics occur as a result of disturbances in the existing equilibrium between the rate of infection and the herd immunity[14] of a population in a given area. Malaria epidemics do not generally occur in high-transmission areas (other than when there is migration of non-immune persons into these areas) because the populations of these areas develop partial immunity to the disease. It has been shown that continuous exposure to malaria infection provides immunity in people after a certain age but this immunity is transient. People who remain uninfected over a short period (less than one year) become newly susceptible to the disease. Therefore, those living in areas of seasonal or low transmission do not develop adequate immunity and are vulnerable to the disease every season. Furthermore, since epidemics occur in areas where populations have inadequate immunity, malaria can explode in the presence of factors that lead to increases in transmission, with very high rates of morbidity and mortality.

3.1 Factors in the human

- *Relative immunity*

Immunity to malaria develops slowly over a period of years. Only in areas of high transmission do older children and adults display this immunity. In areas of unstable or seasonal transmission, immunity even in adults remains limited, and there is potential for an epidemic. Immunity may decrease after a succession of years in which there is low transmission, e.g. because of drought. People who have developed immunity in a high-transmission area and then leave that area also lose their immunity – something they may not appreciate until they become very sick again on return to the high-transmission area.

Trigger factors for an epidemic

- *Migration*

If a community has lived in a non-malarial area, or an area with low and seasonal transmission, and moves into an area with high transmission, all age groups will be very vulnerable to disease and there is a potential for a serious outbreak. Movement of people carrying malaria into an area that is free of malaria but where the vector is present may lead to an outbreak in the non-immune host population.

- Population movement in search of labour
- Displacement of people due to man-made (civil war, conflict, etc.) and natural disasters
- Resettlement of non-immunes in malaria-endemic region
- Movement of infective persons into a receptive[15] environment

[14] Herd immunity: if enough people in a community have partial immunity against malaria, the spread of malaria among members of that community becomes more difficult.

[15] Receptivity refers to the abundant presence of anopheline vectors or the existence of other ecological and climatic factors favoring malaria transmission.

- *Vulnerability due to other factors*

The severity of the public health impact of an epidemic is influenced by the vulnerability of the people. Severe malaria epidemics typically occur after an unusually long dry season with crop failure and increasing malnutrition, because people in a poor state of health or nutrition are more vulnerable to malaria. There is evidence that malnourished children are more likely to develop malaria and are more likely to die from it. New evidence is emerging that people who are HIV-positive are more likely to have parasitaemia, to be symptomatic and to have higher parasitaemia than people who are HIV-negative. The effect of this on transmission has yet to be assessed.

3.2 Factors related to the vector

- *Increased breeding possibilities*

A change in weather patterns is the most important and common reason for an unusual increase in the vector population. Abnormally heavy rains, or flooding downstream caused by those rains, may be the trigger factor for an epidemic, especially following a particularly dry year. Members of the *Anopheles gambiae* complex, the principal vectors of malaria in Africa, are often associated with malaria epidemics. These vectors mainly breed in temporary rain pools close to human dwellings. Hence, in many parts of Africa where malaria is of the epidemic type, rainfall is a critical factor for vector proliferation and is often followed by increased seasonal malaria transmission. Rainfall also increases humidity, which contributes to longevity of vectors. Unusually high temperatures can enhance larval development, increase the feeding frequency of adults and shorten the incubation period of the parasite in the mosquito. Particularly in highland areas, the combination of increased rainfall and higher temperatures contributes to malaria epidemics.

Changing agricultural practices, especially irrigation, can also lead to an increase in vector breeding sites. Small dams and other civil engineering projects, even extensive fish ponds, can sometimes give rise to temporary or longer-term new water collections that are suitable for mosquito breeding.

- *New and more efficient vectors*

Occasionally a malaria epidemic has been triggered by the arrival in an area of a new and more efficient vector.

- *Vector control broken down*

When control measures in an area weaken or break down, for whatever reason (including a lack of quality control), there may be a gradual, year-by-year return to the pre-control endemicity. This may result in seasonal peaks increasing year by year, sometimes to levels that surpass the epidemic threshold.

- *Insecticide resistance*

Results of insecticide resistance studies in the region in the last few years will give useful information that may help to identify the cause of the epidemic and will also inform the choice of insecticides to be used to combat it. Testing for insecticide resistance is a specialized task (see also Bibliography).

3.3 Factors in the parasite

- *Resistance to antimalarial drugs*

The widespread and high-level resistance to chloroquine is well known, and that to sulfadoxine/ pyrimethamine (SP) is following rapidly. Continued use of these drugs allows replication of resistant parasites and, in the case of SP, an increase in gametocytes. These factors increase transmission in the long term and markedly increase the case-fatality rate and thus the severity of the epidemic.

- *Results of efficacy/resistance studies*

Results of therapeutic efficacy studies and drug resistance studies in the region in the past few years will give useful information that may help to identify the cause of the epidemic and will also inform the choice of drugs to be used to combat it. Table 8 gives the WHO criteria for classification of therapeutic efficacy study results.

Therapeutic efficacy studies should usually follow patients for a minimum of 14 days. Studies that last 28 days or longer need polymerase chain reaction analysis to differentiate recrudescence[16] from reinfection. The end result at 14 days *always* underestimates the level of resistance.

Table 8: Therapeutic efficacy studies: classification of results[17]

Early Treatment Failure (ETF)

- development of danger signs or severe malaria on Day 1, Day 2 or Day 3, in the presence of parasitaemia
- parasitaemia on Day 2 higher than Day 0 count irrespective of axillary temperature
- parsitaemia on Day 3 with axillary temperature $\geq$ 37.5 ºC
- parasitaemia on Day 3 $\geq$ 25% of count on Day 0

Late Clinical Failure (LCF)

- development of danger signs or severe malaria after Day 3 in the presence of parasitaemia without previously meeting any of the criteria of early treatment failure
- presence of parasitaemia and axillary temperature $\geq$ 37.5 ºC on any day from Day 4 to Day 14, without previously meeting any of the criteria of early treatment failure

Late Parasitological Failure (LPF)

- presence of parasitaemia on Day 14, and axillary temperature $\leq$ 37.5 ºC, without previously meeting any of the criteria of ETF or LCF *(areas of intense transmission)*
- presence of parasitaemia on any day from Day 7 to Day 28 and axillary temperature $\leq$ 37.5 ºC, without previously meeting any of the criteria of ETF or LCF *(areas of low to moderate transmission)*

Adequate Clinical and Parasitological Response (ACPR)

- absence of parasitaemia on Day 14 (or Day 28 in areas of low to moderate transmission) irrespective of axillary temperature without previously meeting any of the criteria of ETF, LCF or LPF.

[16] Recrudescence: renewed manifestation of infection due to survival of blood stage forms despite treatment

[17] *Monitoring antimalarial drug resistance. Report of a WHO consultation, Geneva, Switzerland 3–5 December 2001*. Geneva, World Health Organization, 2002 (WHO/CDS/RBM/2002.39).

Chapter 4. Are the resources available to address the epidemic?

This chapter explains the information needed to respond adequately to an epidemic of malaria.

4.1 Population affected

You need to make an estimate of the number of people currently affected and of the number who might become affected based on the local epidemiological situation. You can use available government census data, UNHCR information on local refugee populations, etc. for this estimate. Mention in your reporting summary the basis of your population estimate, also whether it is just an informed guess. If it is difficult for some groups to access a health facility, services will have to be adapted to reach them (mobile clinics or trained outreach workers).

4.2 History of malaria in the region – seasonality

Some of the information about the peak malaria season may already be available from the previous pages. However, in an emergency these numbers may not be known, and local knowledge about the peak malaria season will be valuable.

4.3 Vector control

The most important measures for malaria control in an epidemic are:
a) early diagnosis and treatment (see next section);
b) vector control measures, if applied early enough in the epidemic (vector control measures can also be used to prevent epidemics).

There are a great many varieties of the anopheles mosquito, which transmits malaria. They have different habits as regards breeding sites, resting in- or outdoors, times of biting and whether they prefer humans to animals. Knowledge of the type of mosquito in the affected area is used to determine control measures.

The effectiveness of an existing IRS programme depends on:
a) the level of resistance of the mosquito to the insecticide;
b) knowledge of the resting habits of the mosquito;
c) the timing of IRS in relation to the peak season;
d) the coverage of the programme in each village or district.

The flowchart on Interruption of Transmission (1.4b) will help in the assessment of the likely effectiveness of an IRS component of the epidemic response, in relation to the stage of the epidemic.

The effectiveness of an ITN programme depends on:
a) a good level of knowledge locally about the use of ITNs;
b) use by the most vulnerable members of the family (usually young children and pregnant women, but also all HIV-positive people);
c) reimpregnation of the net with insecticide before the malaria season, or every 6 months in places with year-round transmission;
d) coverage >80%.

4.4 Drug treatment of malaria

In a malaria epidemic, early diagnosis and treatment are essential for good case management and can contribute to interruption of transmission (with the use of artemisinin-based combination therapy for *P. falciparum* and of primaquine for *P. vivax*). Good treatment and an effect on transmission can be achieved only by the use of drug regimens known to be highly effective in this locality.

It is often necessary to introduce different drugs to treat an epidemic, because:

a) the people affected by epidemic malaria have little or no immunity, which may result in excessively high case-fatality rates if first-line drugs are not 100% effective;
b) case numbers are very high, leaving health workers overloaded and with no time to follow up first-line treatment failures with more effective second-line drugs: effective first-line treatment must be used;
c) resistance emerging to some commonly used first-line drugs (especially SP) increases the gametocyte carrier rate and thus the potential for transmission; in an epidemic it is particularly important to reduce transmission.

- *First-line treatment of falciparum malaria in epidemics*

The WHO recommendation for first-line treatment of falciparum malaria is artemisinin-based combination therapy (ACT).[18] Based on available safety and efficacy data, the following therapeutic options are available and have potential for deployment (in prioritized order) if cost is not an issue:

(1) artemether–lumefantrine co-formulation (Coartem®)
(2) artesunate (AS) plus amodiaquine (AQ) in areas where AD efficacy is high
(3) artesunate (AS) plus sulfadoxine/pyrimethamine in areas where SP efficacy is high
(4) artesunate (AS) plus mefloquine (MQ) (this option is not recommended in highly endemic settings because of the long half-life of mefloquine)

The use of artemisinin derivatives is particularly important in an epidemic because of the very rapid reduction of parasitaemia and clinical recovery with limited side-effects and once-a-day dosing schedules, the effect on reduction of gametocyte carrier rates, and the availability of rectal suppositories for people unable to take oral drugs. Data on the use and safety of artemisinins in the first trimester of pregnancy are still limited.

Ideally you will be able to make your choice of drugs on the basis of results of efficacy/resistance studies from the affected area or surrounding areas. A drug that shows high parasitological failure rates at day 14 is not a good choice for an epidemic: patients who still have parasites although they are not clinically ill will still be contributing to the transmission of malaria. Where no formal resistance studies are available, health workers are often aware of poor response to one or other (or both) of the first-line drugs. If drugs are freely available on the private market, it is likely that a substantial degree of resistance already exists to those drugs. To date, no resistance to artemisinin derivatives has been recorded. Where no data on resistance are available, artemether–lumefantrine is the drug treatment of choice, at least until further information becomes available. As yet it cannot be used in pregnancy, during breastfeeding and in infants under 10 kg (who should be treated with SP or an alternative antimalarial) – and it is expensive, often necessitating external financial support.

- *Drugs for transfer of severely ill patients*

Rectal artesunate can be given in the community so that treatment of severe malaria can begin at once, while transfer to hospital is being arranged.

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[18] *Antimalarial drug combination therapy. Report of a WHO technical consultation, 4–5 April 2001*. Geneva, World Health Organization, 2001 (WHO/CDS/RBM/2001.35).

- *Hospital inpatient care*

Quinine remains an effective drug for severe and complicated malaria in most parts of the world except south-east Asia. Its disadvantage is that it has to be administered intavenously in 5% or 10% dextrose, and still risks hypoglycaemia. Its proper administration every 8 hours requires a high level of nursing care. Artemether has the great advantage of being administered once a day intramuscularly, and is therefore the drug of choice to manage severe malaria in complex emergencies. Artemether also does not increase the risk of hypoglycaemia, making it the drug of choice in all settings for management of severe malaria during the second and third trimesters of pregnancy. The efficacy of quinine and artemether is equally good. In an inpatient situation with a high workload, artemether has obvious advantages. Quinine should in principle still be used for women in the first trimester of pregnancy.

- *Vivax malaria*

Almost all drugs used for treatment of *P. falciparum* can also be used for treatment of *P. vivax*. The exception is SP, which is not suitable for treatment of *P. vivax*.

Chapter 5. Monitoring the course of the epidemic

5.1 Morbidity

The numbers of people presenting at each health centre, mobile clinic or outreach health post give an indication of whether the epidemic is still increasing. In a big epidemic, it is often easier and more informative if the numbers are collected and graphed daily. Weekly reporting is a minimum.

5.2 Diagnosis

During a big epidemic it is not usually possible to test each individual patient by microscopy, or even with a rapid diagnostic test. Also, later in the epidemic, the rapid test will not be so helpful, because many people will be positive as a result of recent infection; a positive test does not necessarily imply a current infection. It is therefore necessary to make a clear (clinical) case definition for the particular area in which you are working.[19]

Since clinical diagnosis is notoriously inaccurate, it is necessary to monitor the percentage of clinical diagnoses that are proven malaria cases by regularly sampling a given number of clinical cases for parasitaemia. Depending on the numbers presenting and the resources available, a suggested sample is 50 adults and 50 children each week. These percentages can also be graphed. It may be that the percentage of positives begins to go down before the numbers presenting go down; during an epidemic, people are more likely to present with minor symptoms because of fear of more serious disease, and also because they have been encouraged to attend early for rapid treatment.

5.3 Case-fatality rates

It is to be hoped and expected that most severe cases will be referred to hospital, but where that has not happened, deaths in the community should be recorded. This figure will not be accurate as it will not be certain that the death was due to malaria. Nevertheless, a crude death rate during an epidemic will reflect the deaths due to malaria.

Hospital admissions and death rates reflect the numbers of severe cases. In hospital it should be possible to make a definitive diagnosis of each case, but even here, numbers may overwhelm the resources, and clinical case definitions will be needed.

[19] For model case definitions, see section 9.1.1 of *WHO Expert Committee on Malaria. Twentieth report*. Geneva, World Health Organization, 2000 (WHO Technical report Series, No. 892).

Chapter 6. Evaluating the response to the epidemic

Indicators will help you to monitor the success of the intervention. Two kinds of indicators are needed: process indicators and outcome indicators.

6.1 Process indicators

Process indicators will help you to see whether your intervention is going according to plan. The indicators in the assessment form (see 1.5) may not be right for your location but are given as an example of what things to look for. Each one implies a number of aspects of the intervention that will need to be in place to reach this indicator. For example, in order to have skilled health care accessible within 2 hours of each village, it may be necessary to:

a) employ extra staff,
b) train the staff in diagnosis and treatment,
c) supply the outlying clinics,
d) negotiate with the villages about hospitality for the health worker.

These and other similar details will be in your plan of action.

6.2 Outcome indicators

Outcome indicators will help you to see whether your intervention is achieving the aims of reduced morbidity and especially mortality, and of reduction in transmission.

- *Time to treatment*

Patients who present early are more likely to respond well to treatment. To measure this you will have to record the time of presentation and of onset of symptoms in the registration book. The average time to presentation can be measured daily or weekly. This figure gives an indication of how successful your awareness-raising has been, and of the confidence that the people have in the health workers.

- *Percentage of patients developing severe disease*

The number of cases of severe malaria, or more specifically "cerebral" malaria, is a good indicator for indirect measurement of the effectiveness of first-line treatment of uncomplicated malaria.

- *Case-fatality rate*

This indicates the quality of hospital care, but the CFR can be high because of late presentation or late referral from primary care.

- *Flattening or falling epidemic curve*

If the epidemic has been identified early, or at least before its peak, it should be possible to see whether your measures have prevented the expected increase in case numbers. Unchecked epidemics will normally continue to increase until 50% of the population at risk have been infected, or until weather conditions (especially cooler temperatures) start to limit transmission.

6.3 Indicators of the epidemic response

These indicators feed into the overall indicator of success from the Abuja statement that "malaria epidemics should be detected within 2 weeks of onset, and properly controlled within 2 weeks of detection".

SECTION III

Annex 1

Making graphs and thresholds for epidemic detection when previous 5 years' data are available

Several "malaria epidemic detection" methods have been suggested and their performance in the acutely seasonal malaria transmission environments of the western highlands of Kenya has undergone a provisional evaluation.[20] Most epidemic surveillance techniques aim to identify those points in a disease time-series that occur outside the 95% confidence intervals of a normal distribution determined from the history of cases at that location.

The normal expected level of disease should preferably be calculated from historical data that cover a period of relative stability, excluding obvious epidemic years. If population size differs markedly over the years, calculate the reported cases per unit of population (for instance per 1000) instead of the total numbers.

Three methods for calculating a monthly epidemic threshold level are described below, using respectively: (1) the monthly mean for the past 5 years (n=5) plus 2 times the standard deviation SD, (2) the 3rd quartile, which is the second highest value noted for the month over the past 5 years; and (3) the C-SUM, which is the mean calculated over the combined previous, current and following months' data for the past 5 years (n=15). The latter can be refined by adding a 95% confidence interval (1.96 SD).

Ideally these methods should be used with weekly data to allow early detection and control.

The choice of method for calculating an epidemic threshold depends in practice on the electronic equipment available to you, and on how accurate the epidemic alerts should be. No calculator or computer is required for the 3rd quartile and C-SUM methods, but these methods are also less specific (raising more "false" alarms). If you have a historical dataset and a calculator or computer we would encourage you to experiment with all three methods to see which one would be most suitable for your area, taking into account sensitivity, specificity and predictive value.

The authors welcome feedback on experiences with malaria epidemic threshold methods (christa.hook@amsterdam.msf.org; rietvelda@who.int).

[20] Hay S et al. Clinical epidemiology of malaria in the highlands of western Kenya *and* Defining and detecting malaria epidemics in the highlands of western Kenya. *Emerging Infectious Diseases*, 2002, 8(6): 543-548 and 555-562.

Method 1. Threshold at the monthly mean plus 2 standard deviations (SD) – calculated from previous 5 years' data

Minimum equipment required: electronic calculator capable of calculating square roots.

A method proposed by Cullen et al.[21] uses the previous 5 years' data to construct an admissions profile for an average year at that location. The alert threshold for each month is then determined as the mean plus 2 times the standard deviation. Strictly the arithmetic mean plus 1.96 times the standard deviation should capture 95% of cases in normally distributed data.[22] This technique is reported to have been successfully applied to cases of *Plasmodium vivax* malaria in northern Thailand during the 1980s.[23] It has also been used as a basis for raising alerts of possible *P. falciparum* epidemics in the highlands of Madagascar.[24]

Method 2. Threshold at the upper 3rd quartile of 5 years' retrospective data

Minimum equipment required: none.

WHO has advocated the use of a method that triggers an alert when current cases exceed the upper 3rd quartile or the "upper normal limit", determined from 5 years of retrospective monthly case data.[25] For 5 years of observations, quartile 0 is the minimum, quartile 1 the second lowest, quartile 2 the median, quartile 3 the second highest and quartile 4 the maximum value of the series for any given month. If the current month's cases exceed quartile 3, an alarm is triggered. This method has been implemented for the detection of highland malaria epidemics in Ethiopia[26] and Uganda.[27]

Method 3. Threshold at the 3-months' moving average over past 5 years (C-SUM)

Minimum equipment required for C-SUM: none, but a calculator would be useful.
Minimum equipment required for C-SUM + 1.96 SD: calculator with square root function

The cumulative sum (C-SUM) method for epidemic detection is based on the construction of an average or base year by calculating the expected number of cases using the average for that month (and the previous and following month) during the past 5 years.[28] For example the expected number of cases for March 2002 would be derived from the average of February, March and April admissions from 1997 to 2001 inclusive (n=15). When a scientific calculator or computer is available the method can be refined by adding the 95% confidence interval (1.96 times the standard deviation) for each value of the base year. An advantage of the C-SUM method is that it smoothes out artificial variations in monthly reported data that are due to late reporting and other errors inherent to the surveillance system. The C-SUM method still needs validation for malaria epidemic control.

A practical example of how to work out the thresholds using these techniques is given below, using a set of real data. In this dataset from Sudan possible epidemic years have not yet been excluded. The large year-to-year differences in this dataset particularly affect the sensitivity of methods 1 (Mean + 2 SD) and 3 (C-SUM + 1.96 SD), giving a very wide 95% confidence interval and high threshold level.

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[21] Cullen JR et al. An epidemiological early warning system for malaria control in northern Thailand, *Bulletin of the World Health Organization*, 1984, 62(1):107–14.
[22] Kirkwood, 1988
[23] Cullen et al., 1984
[24] Albonico M et al. Control of epidemic malaria on the highlands of Madagascar, *Parassitologia,* 1999 41(1–3):373–376.
[25] Nájera et al., 1998; WHO, 2001
[26] Abose et al., 1999
[27] Cox et al., 1999
[28] CDC, 1986; Deparis et al., 1995

Practical example: Method 1 using the mean plus 2 standard deviations

Malaria cases reported from El Obeid (Sudan)												
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1994	1609	2235	2035	1597	4927	2442	2857	5159	9245	1490	1299	2267
1995	1214	1322	1784	1880	1863	1958	398	2815	4761	5845	2588	ND
1996	1198	1099	2010	1411	1449	2018	1737	1902	1939	1842	2332	2321
1997	2597	2219	2988	2977	5276	3534	2822	4028	3188	3395	2269	2223
1998	2941	2449	2619	2462	2973	2200	2612	2424	8658	10158	4274	2944

Calculating the standard deviation involves the following steps:[29]

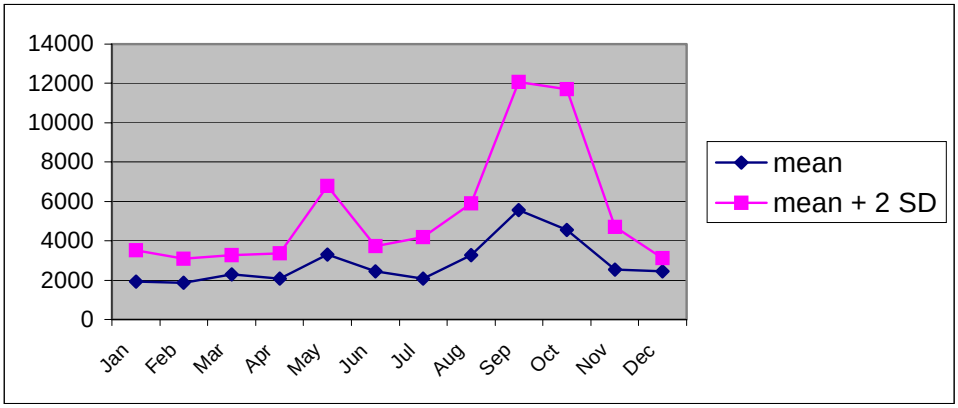
1. calculate the mean over the last 5 years' data
2. substract the 5-year mean from each monthly value to get the monthly deviation
3. square each deviation
4. sum the squares of the deviations
5. divide the total by one less than the number of values in the dataset (in this case: 5–1 = 4. Note exception for December)
6. take the square root √

To take the example of March, the mean value is (2035+1784+2010+2988+2619) divided by 5 = 2287 (step 1). The monthly deviation for March 1994 is 2035–2287 = –252 (step 2), and its square is (–252)x(–252)=63 504 (step 3). Applying this to March 1994–1997 data and summing them all up gives a total of 994 867 (step 4). Dividing the total by 4 (=5–1) gives 248 717 (step 5), of which the square root √ is 499 (step 6). The mean plus two standard deviations for March is then 2287+(2x499)=3285. This is the March alert threshold.

Applying this to all 12 months of the year gives the following:

1994–1998	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
mean + 2 SD	3529	3083	3285	3358	6783	3721	4179	5899	12081	11698	4712	3117

Using graph paper or simple squared paper you can construct a graph of the mean and the mean + 2 SD (the 95% confidence interval). It should look like this:

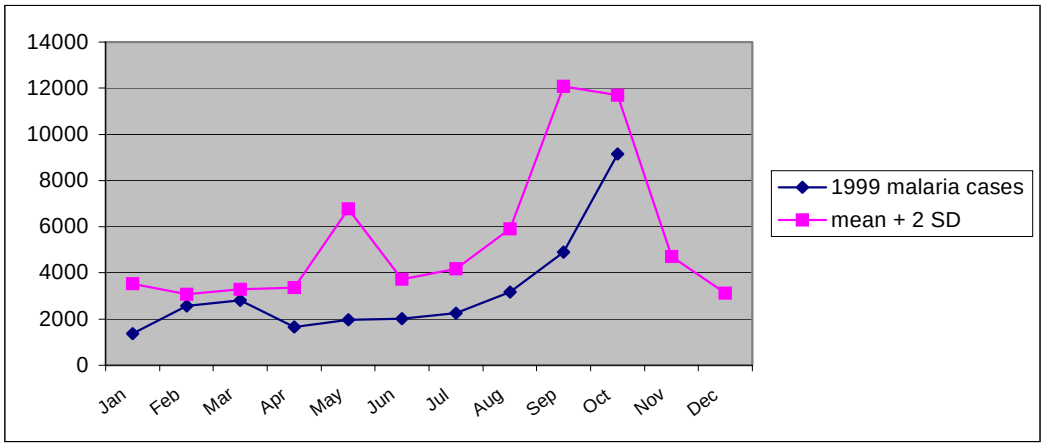


[29] Elston RC, Johnson WD. *Essentials of biostatistics*. Philadelphia, F.A. Davis, 1987.

Now take the figures for the year you are monitoring:

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1999	1364	2560	2817	1656	1958	2021	2255	3169	4897	9158		

and add them to the graph of the mean + 2 SD. This is how it looks:



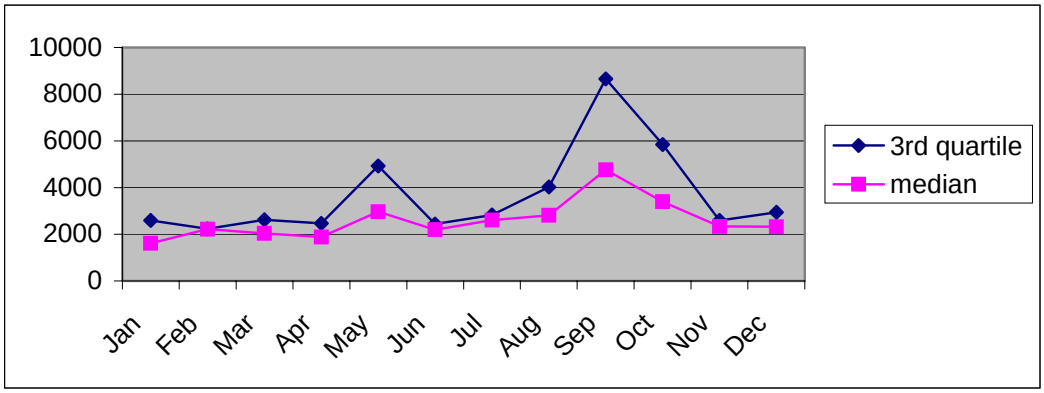
Practical example: Method 2 using quartiles

Malaria cases reported from El Obeid (Sudan)												
Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1994	1609	2235	2035	1597	4927	2442	2857	5159	9245	1490	1299	2267
1995	1214	1322	1784	1880	1863	1958	398	2815	4761	5845	2588	
1996	1198	1099	2010	1411	1449	2018	1737	1902	1939	1842	2332	2321
1997	2597	2219	2988	2977	5276	3534	2822	4028	3188	3395	2269	2223
1998	2941	2449	2619	2462	2973	2200	2612	2424	8658	10158	4274	2944

In order to determine the median and quartiles the data need to be rearranged in ascending order for each month:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
	1198	1099	1784	1411	1449	1958	398	1902	1939	1490	1299	2223
1st quartile	1214	1322	2010	1597	1863	2018	1737	2424	3188	1842	2269	2267
median	1609	2219	2035	1880	2973	2200	2612	2815	4761	3395	2332	2321
3rd quartile	2597	2235	2619	2462	4927	2442	2822	4028	8658	5845	2588	2944
	2941	2449	2988	2977	5276	3534	2857	5159	9245	10158	4274	

Using graph paper or simple squared paper you can construct a graph of the median and the 3rd quartile, indicating a level above which you should consider the possibility of an epidemic. It should look like this:

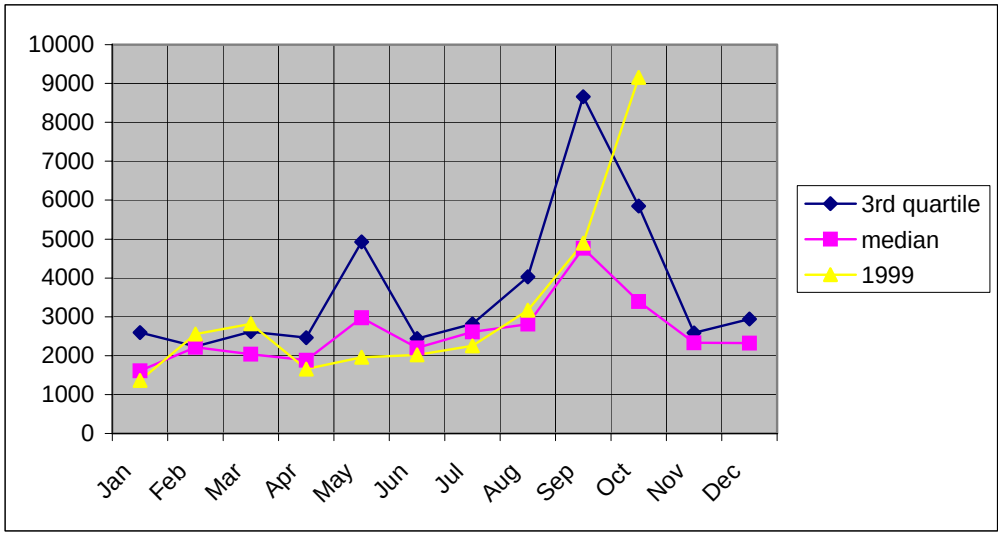


Now take the figures for the year you are monitoring:

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1999	1364	2560	2817	1656	1958	2021	2255	3169	4897	9158		

and add them to this graph.

This is how it looks:



The October figure is rising steeply above the 3rd quartile, signalling an epidemic.

Practical example: Method 3 using C-SUM

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

The table shows the same data set as before, with the sum total of each month added:

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
1994	1609	2235	2035	1597	4927	2442	2857	5159	9245	1490	1299	2267
1995	1214	1322	1784	1880	1863	1958	398	2815	4761	5845	2588	
1996	1198	1099	2010	1411	1449	2018	1737	1902	1939	1842	2332	2321
1997	2597	2219	2988	2977	5276	3534	2822	4028	3188	3395	2269	2223
1998	2941	2449	2619	2462	2973	2200	2612	2424	8658	10158	4274	2944
sum	9559	9324	11436	10327	16488	12152	10426	16328	27791	22730	12762	9755

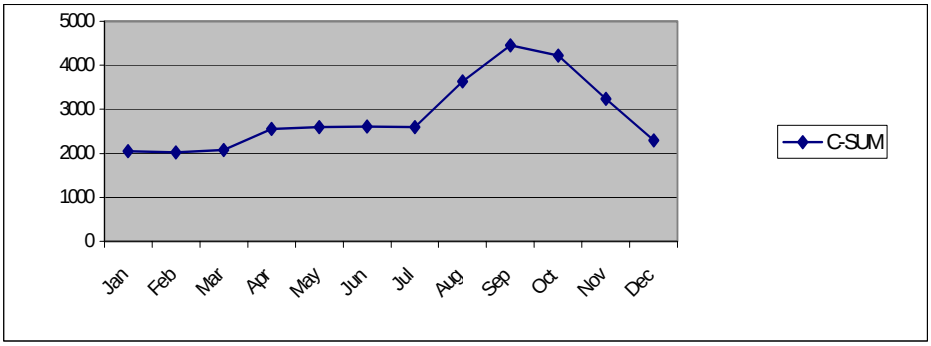
To calculate the C-SUM for February add the sums for January, February and March, and divide the total by 15. Similarly the C-SUM for November is calculated by adding the sums of October, November and December and dividing by 14 (in this example, December 1995 data are missing).

In our example, to calculate the C-SUM for January you should in principle use December data for 1993–1997 and January and February data for 1994–1998. However, the Sudan dataset does not provide December 1993 figures, and we have used December 1998 data instead.

The C-SUMs for each month are then:

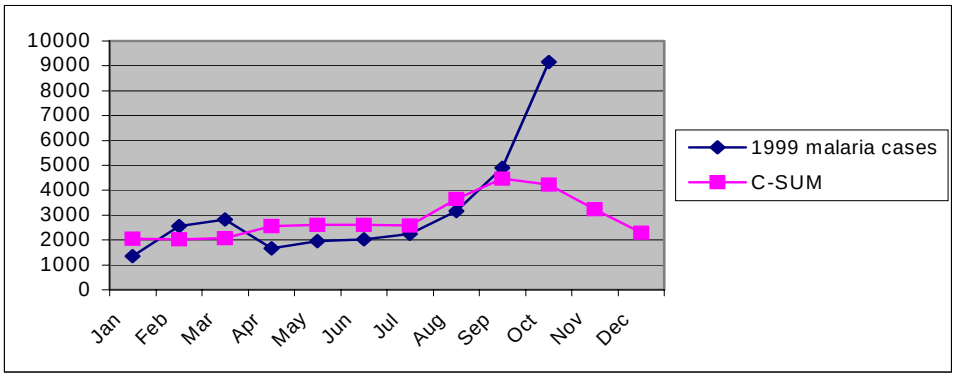
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
C-SUM	2046	2021	2072	2550	2598	2604	2594	3636	4457	4219	3232	2291

which can be shown on a graph:



This line can be used as the threshold above which an epidemic alert is triggered.

If you then add the figures for 1999, the graph looks like this:



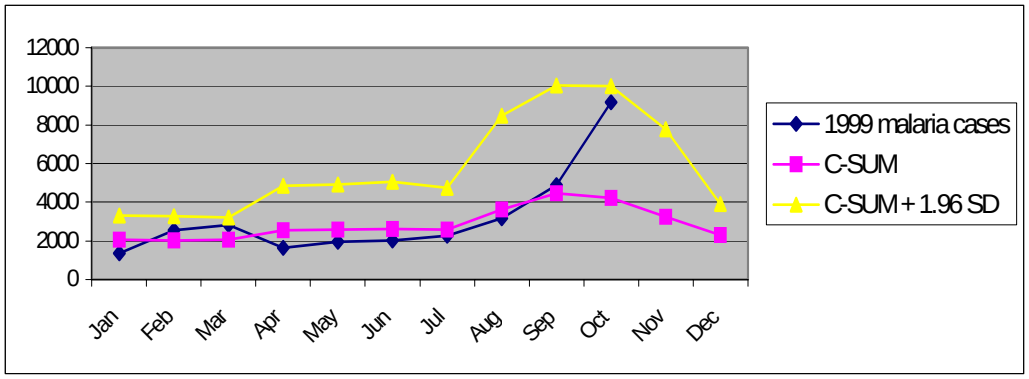
It is easily seen that the numbers for October are far above the threshold signalling an epidemic.

When a scientific calculator or computer is available the C-SUM method can be refined by adding the 95% confidence interval (1.96 times the standard deviation) for each month of the threshold. To do this you should calculate the mean and standard deviation as described under method 1, using 15 data points per calculated month instead of 5.

The C-SUM + 1.96 SD for each month are then:

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.
C-SUM + 1.96 SD	3299	3264	3196	4841	4910	5067	4732	8468	10046	9999	7768	3901

Which can be shown on a graph:



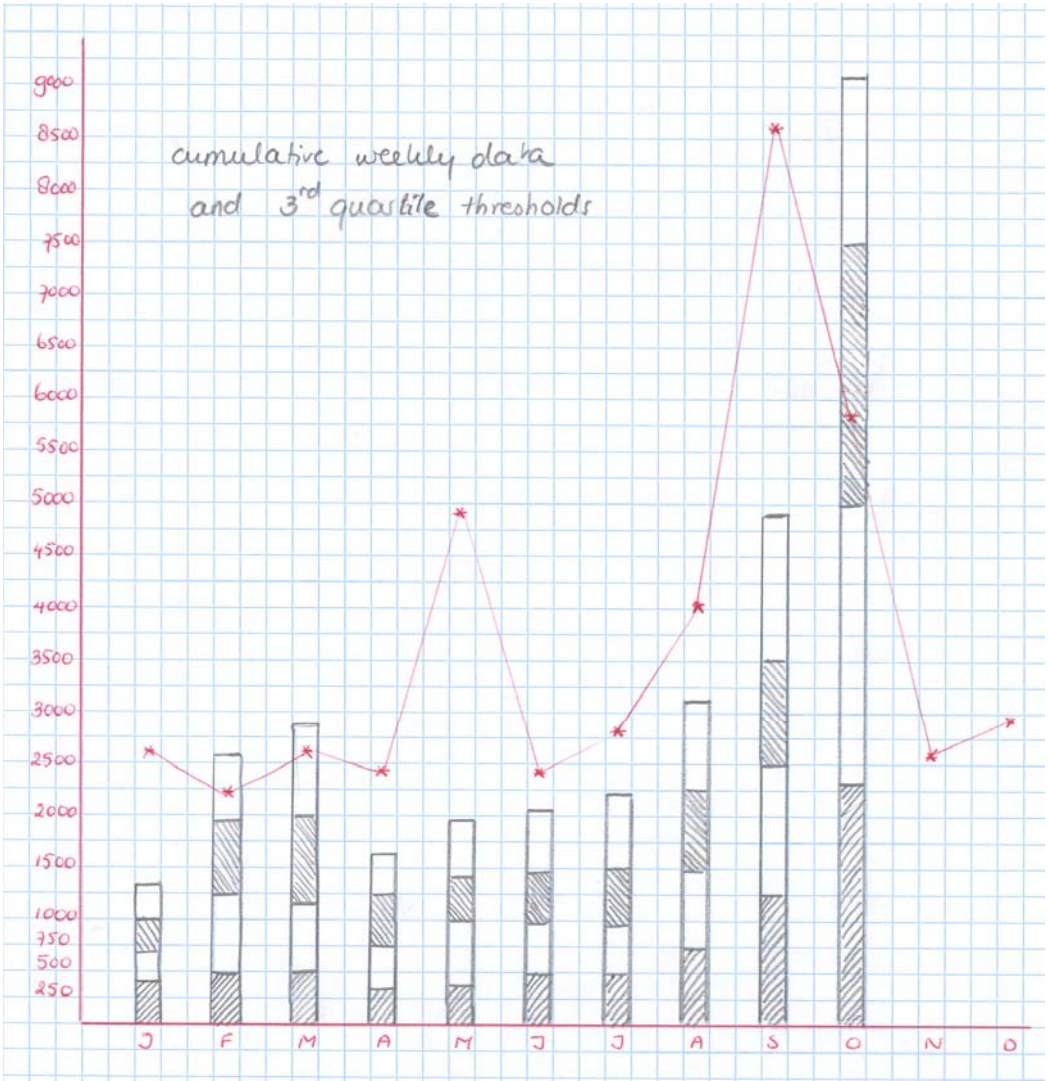
As was seen for method 1 (mean + 2 SD), the width of the 95% confidence interval depends on the variability of the monthly data included in the calculations. In the example dataset from Sudan this variability is particularly large for September and October (ranging from 1939 to 9245 and from 1842 to 10 158 cases per month respectively over the period 1994–1998), resulting in a lesser sensitivity of the epidemic detection threshold for these months. As more data become available, the epidemic threshold can be recalculated based on a period of relative stability, excluding epidemic years. This will result in a narrower 95% confidence interval above the C-SUM.

The above methods use monthly figures. By the time the figures are collected and analysed it could be 4 weeks or more after the onset of an epidemic, with unacceptable delays to the investigation and response. Ideally data should be collected on a weekly basis, and all three methods described can be adapted to weekly figures. However, few places have weekly figures going back 5 years. The following method is suggested to use the thresholds developed from 5 years of monthly data and apply them to current weekly data.

Practical example: 3rd quartile method adapted to weekly figures

Use graph paper with the quartile threshold clearly marked as above. As the weekly data are collected, mark the number as a column under the month in question. The next week, add the number to that of the first week, and extend the column to the new figure. Using a different colour for each week will make it clearer. Do the same for the 3rd and 4th weeks. If the column is already at the threshold by the 2nd or 3rd week, it will be possible to raise the alert of an epidemic much sooner than if you wait for the whole month's figures (see example on graph paper).

In the third week in October, the numbers have already exceeded the threshold, allowing the earlier investigation and declaration of an epidemic:



Applying common sense, the first two weeks in October already give a warning, with cases double the previous weeks' numbers. A sudden rapid rise in weekly cases over a period of a few (2–4) weeks may raise an alarm even if the cumulative numbers do not cross the monthly threshold yet. For this purpose weekly data may be presented in simple bar charts, allowing direct comparison from week to week, where possible against historical data.

Annex 2

Making graphs to show the outbreak pattern when previous 5 years' data are not available

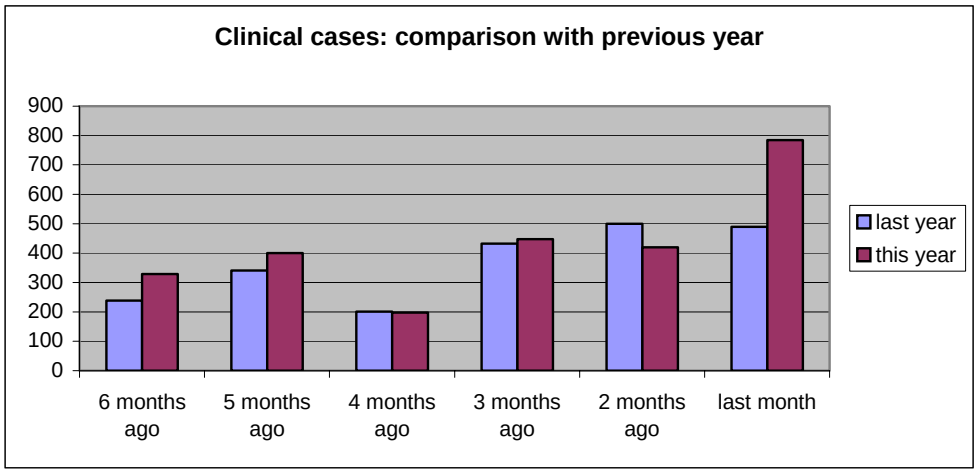
1. Is this an epidemic?

Comparing monthly reported cases of this year with last year

Total number of clinical cases:

	6 months ago	5 months ago	4 months ago	3 months ago	2 months ago	last month
last year	239	341	201	390	500	489
this year	329	400	198	378	420	784

Chart 2.1



The considerable increase in the last month over the year before is suspicious, but not enough on its own to say there is an epidemic.

2. Confirmation of malaria and proportion of suspected cases diagnosed

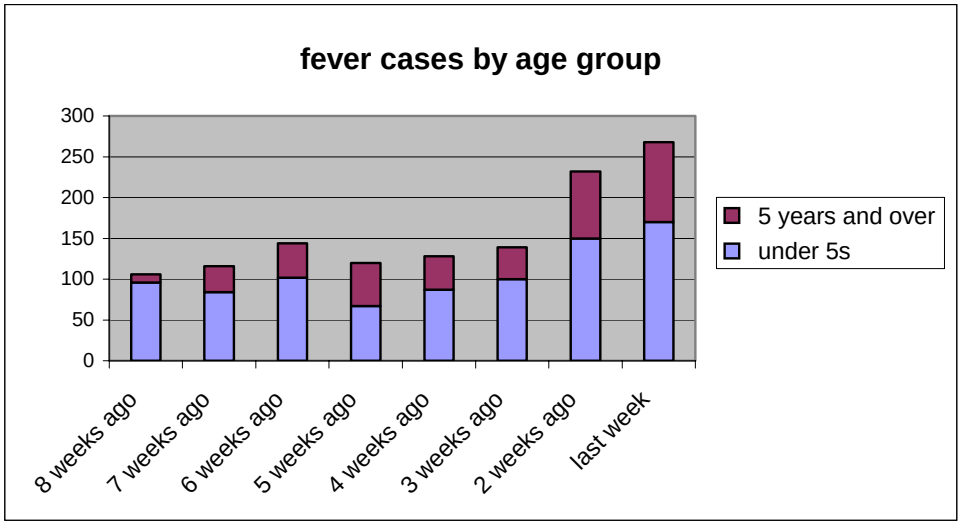
Comparing case numbers by age grouping for the past 8 weeks

Cases presenting at the health centre:

	under 5 years		5 years and over	
	all fever	*P.f.*	all fever	*P.f.*
8 weeks ago	96	80	10	5
7 weeks ago	84	68	32	18
6 weeks ago	102	88	42	20
5 weeks ago	67	59	53	22
4 weeks ago	87	80	41	29
3 weeks ago	100	87	39	28
2 weeks ago	150	140	82	68
last week	170	156	98	89
total	856	758	397	279

Chart the total fever cases (clinical malaria cases), split by age grouping, as follows:

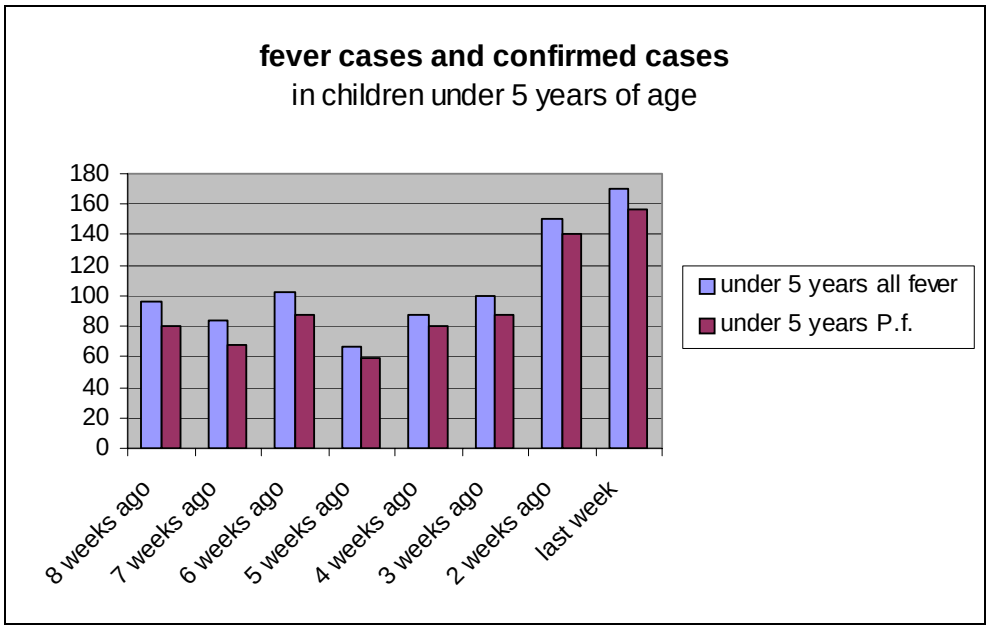
Chart 2.2



The total numbers have increased in the last 2 weeks, and the proportion of affected older children and adults is increasing.

Chart the ratio of confirmed cases to fever cases in children under 5, as follows:

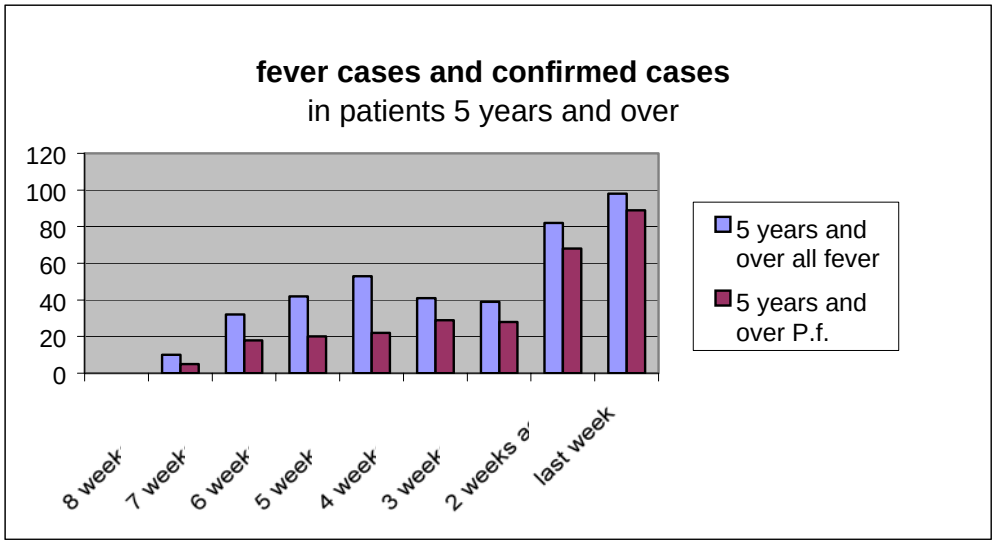
Chart 2.3



The ratio of confirmed to suspected cases has not changed much, which is common in young children.

By contrast, in older children and adults, the proportion of fever cases that are confirmed as malaria is increasing considerably in the past 2 weeks – this often occurs in an epidemic:

Chart 2.4



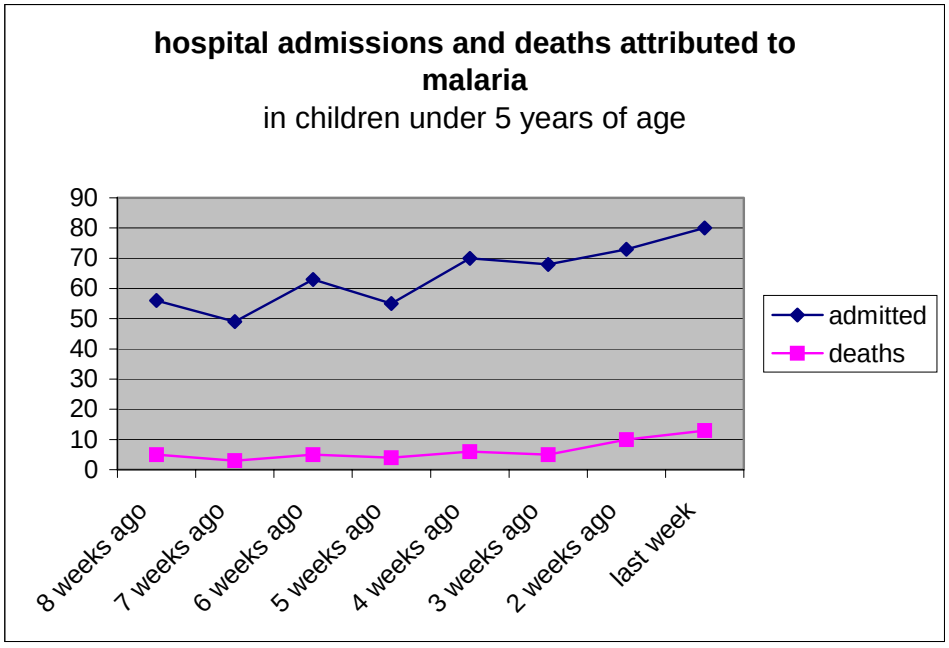
3. Hospital admissions, deaths and case-fatality rates

Comparing data by age grouping for the past 8 weeks

Children <5: Hospital data			
	admitted	deaths	CFR (%)
8 weeks ago	56	5	8.9
7 weeks ago	49	3	6.1
6 weeks ago	63	5	7.9
5 weeks ago	55	4	7.3
4 weeks ago	70	6	8.6
3 weeks ago	68	5	7.4
2 weeks ago	73	10	13.7
last week	80	13	16.3

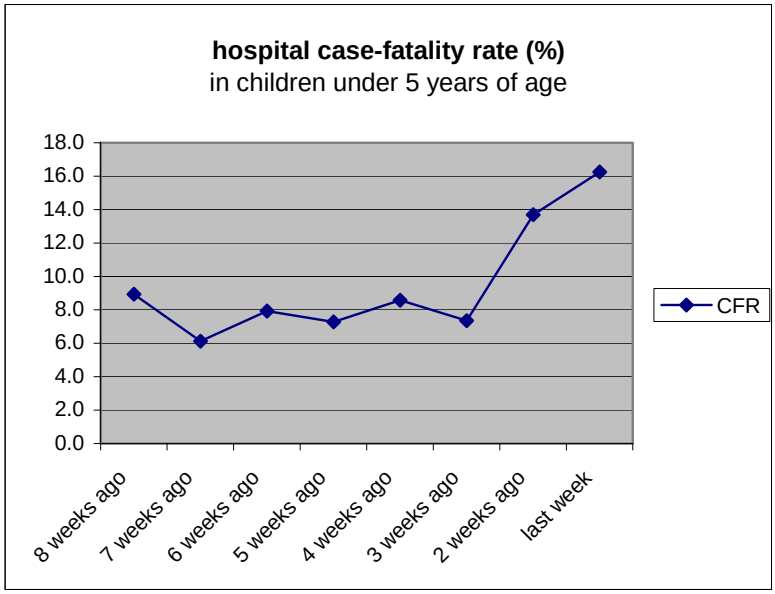
Using the data set above and plotting the malaria cases admitted and the deaths, the increase in both is obvious:

Graph 2.1



However, the graph of the case-fatality rate (deaths/admitted) shows a much clearer difference in the preceding 2 weeks, which is much more significant:

Graph 2.2



A similar graph can be made of case-fatality rates for patients aged 5 and over.

Bibliography

Books and documents relevant to malaria epidemics

General:

Warrell DA, Gilles HM, eds. ***Essential malariology*****, 4th ed.**
London, Arnold, 2002
A comprehensive textbook brought up to date. It includes the history and epidemiology of malaria. There are chapters on parasites, vectors and malaria control, and on clinical presentations and treatment. (Not included in the accompanying CD.)

Brès PLJ. ***Public health action in emergencies caused by epidemics: a practical guide.***
Geneva, World Health Organization, 1986
Although published more than 15 years ago, this book is strong on general principles for investigating and dealing with epidemics. Its emphasis is on organization at national level. The same principles can be applied at district level or within camps for the displaced. Detailed description of the planning of the outbreak investigation includes safety of personnel and organization of teams. Specifically for vector control, there is a section on the logistics of insecticide spraying operations. There are formats for reporting and for a final report. The annexes contain useful explanations of epidemiological terms and examples of statistical analyses. (Not included in the accompanying CD.)

WHO Expert Committee on Malaria. Twentieth report.
Geneva, World Health Organization, 2000 (WHO Technical Report Series, No. 892)
This very useful small book concentrates on current areas of particular concern in malaria, including the early detection, containment or prevention of malaria epidemics. There is a lot about epidemic risk, the prediction of epidemics and the development of early warning systems. The effects of drug resistance are discussed, including the part played by resistance in stimulating epidemics; the role of epidemics in the spread of resistant parasites is also discussed, and the place of mass chemotherapy. The increased risk of epidemics, the spread into urban areas and the re-emergence of malaria in areas where it was previously eradicated are described. Epidemic preparedness is emphasized, including post-epidemic evaluation and review of planning.

Najera JA. ***Malaria control: achievements, problems and strategies.***
Geneva, World Health Organization, 1999 (document WHO/CDS/RBM/99.10)
An overview of the history of the efforts to control and even eradicate malaria and the current global strategy. In the section on the control and prevention of malaria epidemics, indices for early warning are suggested, and practical use of clinical data is discussed.

The African Summit on Roll Back Malaria, Abuja, Nigeria, April 25 2000 (Abuja Declaration on Roll Back Malaria in Africa).
Geneva, World Health Organization, 2000 (document WHO/CDS/RBM/2000.17)
This report summarizes the Plan of Action agreed to by the participating countries, including the development of early warning systems and emergency preparation and response for malaria epidemics. It also includes the indicators for achieving control of epidemics namely that malaria epidemics to be detected and properly controlled within 2 weeks of onset.

Framework for monitoring progress and evaluating outcomes and impact.
Geneva, World Health Organization, 2000 (document WHO/CDS/RBM/2000.25)
Gives the framework for country malaria programmes, and the indicators to monitor the progress, outcomes and impact of programmes.

Connolly MA, ed. ***Communicable disease control in emergencies: a field manual***
Geneva, World Health Organization (in press)
The general principles of data collection for communicable diseases, and sources of data. The chapter on malaria deals with diagnosis and treatment, and the information required to investigate a suspected malaria outbreak. There are useful annexes with case definitions, indicators and standards for use in an emergency and sample forms

Epidemics:

Najera JA. ***Malaria epidemics: detection and control, forecasting and prevention.***
Geneva, World Health Organization, 1998 (document WHO/MAL/98.1084)
This very informative little book starts with a historical overview and gives many examples of epidemics of malaria in more recent years, with good graphical illustrations of their evolution. The major determinants of epidemics are discussed in detail. The chapter on early detection and control of epidemics describes the early outbreak investigation and identification of resource capacity. Various aspects of disease management and control of transmission are described, with discussion of the possibilities and constraints of early transmission control by mass drug administration and space spraying with insecticides. The third part of the book covers surveillance and forecasting.

Prevention and control of malaria epidemics; 3rd meeting of the Technical Support Network.
Geneva, World Health Organization, 2002 (document WHO/CDS/RBM/2002.40)
A report on the progress to date and definition of further needs. There is emphasis on surveillance and communication, and the need for decision-making guidelines. Pointers are given to clearer definition of an epidemic. Importance of epidemic preparedness and response plans is emphasized.

A framework for field research in Africa. Malaria early warning systems: concepts, indicators and partners.
Geneva, World Health Organization, 2001 (document WHO/CDS/RBM/2001.32)
This book is mainly concerned with the development of malaria early warning systems, with the possibility of epidemic prevention. Much of it is concerned with climatic data, but also the importance of the regular collection and interpretation of clinical data. Ways of identifying epidemic thresholds are also discussed.

Najera JA. ***Malaria epidemics; preparedness; early warning systems.***
Geneva, World Health Organization (in draft)
This extremely informative draft is largely concerned with early warning systems and risk factors, but early detection based on epidemiological surveillance systems is also addressed, and illustrated with many tables and graphs.

Najera JA. ***Malaria control among refugees and displaced populations.***
Geneva, World Health Organization, 1996 (document CTD/MAL/96.6)
Since refugees and displaced populations are at particular risk of epidemics of malaria, this small book provides very useful information on how to assess the level of risk, the preventive measures in camp situations, and the need for effective treatment, taking into account the relative immunity of the displaced and the resistance of the parasite to antimalarials. It discusses the "epidemiological exchange" between the displaced and host populations. It describes preventive measures during the emergency phase and when the camp is more settled. Consideration is given to the benefits and dangers of mass treatment and chemoprophylaxis. The importance of information systems and their adaptation to different stages of the emergency is emphasized.

A guideline for malaria epidemic prediction, prevention, detection and control in Africa.
Geneva, World Health Organization (in preparation)

Malaria control in complex emergencies.
Geneva, World Health Organization (in preparation)
With chapters on initial assessment and planning. Detailed information on how to do a survey.

Hay SI. ***The inter-sectoral response to the 2002 malaria outbreak in the highlands of western Kenya; report of an individual consultancy to the UNICEF Kenya Country Office.***
Available at http://www.rbm.who.int
A retrospective analysis of the epidemic of the same year, applying the different methodologies for defining an epidemic. Recommendations are given for tightening up surveillance and using available information for early warning systems. The triggers for the epidemic are discussed, and many practical recommendations made to address those issues and improve the detection and management of future outbreaks.

Vector control:

Manual for indoor residual spraying: application of residual sprays for vector control.
Geneva, World Health Organization, 2000 (document WHO/CDS/WHOPES/GCDPP/2000.3 Rev.1)
A very practical manual giving step-by-step descriptions of the available insecticides and their safe and effective application.

Najera JA, Zaim M. ***Malaria vector control: insecticides for indoor residual spraying.***
Geneva, World Health Organization, 2001 (document WHO/CDS/WHOPES/2001.3)
This manual gives straightforward advice on the choice of insecticide for different situations, and how to purchase, store, use and dispose of insecticides safely. It gives a detailed description of the various insecticides, their use and adverse effects.

Scaling-up insecticide-treated netting programmes in Africa: a strategic framework for coordinated national action.
Geneva, World Health Organization, 2002 (document WHO/CDS/RBM/2002.43)
A framework for national ITN programmes.

Specifications for netting materials: report of an informal consultation, WHO, Geneva, 8–9 June 2000.
Geneva, World Health Organization, 2001 (document WHO/CDS/RBM/2001.28)
Technical detail with clear explanation of the need for particular materials and requirements.

Entomological field techniques for malaria control. Part 1: Learner's guide.
Geneva, World Health Organization, 1992
A manual, divided into learning units, that takes a student through the practical techniques of malaria-related entomology.

Test procedures for insecticide resistance monitoring in malaria vectors, bio-efficacy and persistence of insecticides on treated surfaces: report of the WHO informal consultation, Geneva, 28–30 September 1998.
Geneva, World Health Organization, 1998 (document WHO/CDS/CPC/MAL/98.12)
The report contains results from a number of studies and updated recommendations.

Rozendaal JA. ***Vector control: methods for use by individuals and communities.***
Geneva, World Health Organization, 1997
Manual with practical information on all major disease vectors and pests, intended for health workers and auxiliary staff working with people at district and community level. For each group of vectors, information is provided on biology, public health importance and control measures.

Disease management:

New perspectives: malaria diagnosis. Report of a joint WHO/USAID informal consultation, 25–27 October 1999.
Geneva, World Health Organization, 2000 (document WHO/CDS/RBM/2000.14)
This extremely useful book describes the various rapid tests now being used for malaria diagnosis. It compares the two main types, and their sensitivity and specificity and test performance. Comparison is made between the advantages and disadvantages of using rapid tests as opposed to microscopy, and there is discussion on further research needs.

The use of antimalarial drugs: report of a WHO informal consultation, 13–17 November 2000.
Geneva, World Health Organization, 2001 (document WHO/CDS/RBM/2001.33)
A useful overview of the individual antimalarials currently in use, and programmatic considerations.

Antimalarial drug combination therapy: report of a WHO technical consultation, 4–5 April 2001
Geneva, World Health Organization, 2001 (document WHO/CDS/RBM/2001.35).
An update and overview of available and potential combinations, with clear recommendations for their use to replace monotherapy. Their use needs to be accompanied by careful monitoring.

***Management of severe malaria: a practical handbook,* 2nd ed.**
Geneva, World Health Organization, 2000
All you need to know about the clinical presentation and management of severe malaria.

Basic tests for pharmaceutical dosage forms.
Geneva, World Health Organization, 1991
This book describes how to confirm or verify the identity of pills or tablets where there is some doubt. The tests will also show whether there has been gross degradation. It is intended for use in a peripheral laboratory and describes the equipment and reagents required. The tests described do not take the place of pharmaceutical analysis and cannot be considered as quality control. The only antimalarials in the book are chloroquine and quinine. Tests are also described for tetracycline and doxycycline. No tests are described for amodiaquine, sulfadoxine and/or pyrimethamine or artemisinin derivatives. In view of the growing problem of fake artesunate this is an omission that needs to be rectified soon.

Monitoring antimalarial drug resistance: report of a WHO consultation, Geneva, Switzerland, 3–5 December 2001.
Geneva, World Health Organization (document WHO/CDS/CSR/EPH/2002.17)
The consultation reviewed and updated the WHO protocols for assessing therapeutic efficacy of antimalarials against *P. falciparum* and *P. vivax*. The report should be read in conjunction with the existing protocols of 1996 (WHO/MAL/96.1077, *Assessment of therapeutic efficacy of antimalarial drugs for uncomplicated falciparum malaria in areas with intense transmission*) and 1998 (OPS/HCP/HCT/ 113/98, *Evaluación de la eficacia terapeutica de los medicamentos para el tratamiento del paludismo por* Plasmodium falciparum *sin complicaciones en las Americas*). There are significant changes to the classification of therapeutic response and recommendations about analytical and statistical procedures. The place of in vitro tests and molecular markers is also discussed.

***In vitro micro-test (Mark III) for the assessment of the response of Plasmodium falciparum to chloroquine, mefloquine, quinine, amodiaquine, sulfadoxine/pyrimethamine and artemisinin instructions for use of the in vitro micro-test kit (Mark III),* 2nd rev.**
Geneva, World Health Organization, 2001 (document CTD/MAL/97.20 Rev.2 2001)
The technical procedure in detail.

The use of artemisinin and its derivatives as antimalarial drugs: report of a joint CTD/DMP/TDR informal consultation, Geneva, 10–12 June 1998.
Geneva, World Health Organization, 1998 (document WHO/MAL/98.1086).
The meeting reviewed the research and use of artemisinin derivatives and the recommendations and availability at that time. The clinical use, especially in combination, is described and the need for ongoing research.