Malaria control in emergencies

Field manual

World Health Organization

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Contents

Case studies

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Abbreviations

ACT	artemisinin-based combination therapy
AL	artemether-lumefantrine
AQ	amodiaquine
AS	artesunate
ASMQ	artesunate-mefloquine
ASPY	artesunate-pyronaridine
ATSB®	attractive targeted sugar baits
CHW	community health worker
CQ	chloroquine
DHAPQ	dihydroartemisinin-piperaquine
EWARS	Early Warning, Alert and Response System
GIS	geographic information systems
HRP2/3	histidine-rich protein II or III
IASC	Inter-Agency Standing Committee
iCCM	integrated community case management
IDP	internally displaced persons
IRS	indoor residual spraying
ITN	insecticide-treated net
IV	intravenous
LSM	larval source management
MDA	mass drug administration
MSF	Médecins Sans Frontières
NGO	nongovernmental organizations
NMCP	national malaria control programmes
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PDMC	post-discharge malaria chemoprevention
pLDH	*Plasmodium* lactate dehydrogenase
PMC	perennial malaria chemoprevention
RDT	rapid diagnostic test
SAM	severe acute malnutrition
SMC	seasonal malaria chemoprevention
SP	sulfadoxine-pyrimethamine
TDA	targeted drug administration
UNHCR	Office of the United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
WASH	water, sanitation and hygiene
WHO	World Health Organization

Foreword

Our world is grappling with a complex convergence of crises – from conflict and climate-induced shocks to wide-scale displacement – placing millions of lives in peril and straining the systems designed to support them. Communities uprooted from their homes are among the hardest hit, often left to face both insecurity and heightened exposure to disease – including malaria.

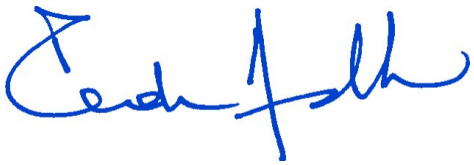
A record 117 million people were displaced across the globe by the end of 2023, including nearly 80 million living in 43 malaria-endemic countries. These staggering figures reflect a rapidly shifting global landscape in which health systems are under growing pressure and response capacity is stretched thin.

Displaced populations often have no choice but to live in overcrowded settlements, with health systems disrupted or no longer functioning. In such fragile settings, people are more vulnerable to malaria and other health conditions, while having little or no access to health services for prevention and treatment.

And yet, even in crisis settings, timely and coordinated action can transform health outcomes. When malaria interventions are embedded early in humanitarian operations, they help prevent illness, ease suffering, and save lives.

This updated field manual, *Malaria control in emergencies*, offers critical guidance for those working on the front lines of crisis. Grounded in real-world experience from more than 24 countries and shaped by the expertise of local and global partners, it provides practical tools for mounting swift and effective responses to malaria in complex emergency settings.

At its core, this manual is a call to action: to strengthen collaboration, uphold the right to health, and to ensure that no one is left behind – even in the most difficult of circumstances.



Dr Tedros Adhanom Ghebreyesus
Director-General
World Health Organization

Glossary

The glossary definitions were systematically developed through a thorough verification and adaptation process. This process built on previous versions of the manual (formerly known as the handbook) to maintain consistency, incorporated relevant UN agency references to align with humanitarian standards, and referenced WHO malaria terminology as the technical foundation. Additionally, terms were customized to reflect the manual's emergency-specific context. While only one glossary term currently includes a direct citation, all definitions underwent this rigorous review to ensure accuracy and relevance for malaria control in emergency settings.

A

acute emergency A sudden-onset crisis that requires immediate humanitarian response due to life-threatening conditions, such as natural disasters (earthquakes, floods, cyclones) or sudden outbreaks of conflict or disease. These emergencies typically overwhelm local response capacities and necessitate urgent external assistance.

adherence (compliance) Health-related behaviour that abides by the recommendations of a doctor or other health care provider.

anaemia A reduction in the quantity of the oxygen-carrying pigment haemoglobin in the blood. The main symptoms are tiredness, breathlessness on exertion, pallor and poor resistance to infection.

Anopheles A genus of widely distributed mosquitoes, occurring in tropical and temperate regions and containing some 400 species. Malaria parasites (*Plasmodium* species) are transmitted to humans through the bite of female *Anopheles* mosquitoes.

artemisinin-based combination therapy A combination of an artemisinin derivative with a longer-acting antimalaria drug that has a different mode of action.

asymptomatic Not showing any symptoms of disease, whether disease is present or not. (See **parasitaemia** for "asymptomatic malaria".)

B

breeding site (place) See **larval habitat**.

C

case A person who has the disease, health disorder or condition that meets the case definition.

case definition A set of diagnostic criteria that must be fulfilled for an individual to be regarded as a "case" of a particular disease for surveillance and outbreak investigation purposes. Case definitions can also be based on clinical criteria, laboratory criteria or a combination of the two.

case fatality rate The proportion of individuals diagnosed with a particular disease (ex. malaria) who die from that disease (ex. malaria) over a specified period of time. (usually expressed as a percentage).

chemoprevention Administration of antimalarial drugs to prevent or delay the development of an infection (ex. seasonal malaria chemoprevention).

chemoprophylaxis Administration of antimalaria drugs to prevent malaria in travels to prevent either the development of an infection or the progression of an infection to a disease. (ex. mefloquine for travellers)

clinical malaria malaria with observable symptoms combined with laboratory confirmation of Plasmodium infection and prompts a person to seek medical care.

community empowerment The process by which community members gain control over decisions shaping their lives; for example, by building capacity, developing partnerships and networks and gaining a voice to advocate for themselves. Effective humanitarian response must include community empowerment and capacity-building.

community health worker A member of the community who is integrated into primary health care programmes after a short period of training on health-related issues, and who acts as an intermediary between the community and the health services. Community health workers may be paid staff or volunteers.

complex emergency A humanitarian emergency in a country, region or society where there is a total or considerable breakdown of authority resulting from conflict, and that requires an international response that goes beyond the mandate or capacity of any single agency, and that the Inter-Agency Standing Committee (IASC) assesses requires intensive and extensive political advocacy and coordination *(1)*. Such emergencies have a devastating effect on children and women in particular and call for a complex range of responses.

contact (of an infection) In the context of malaria, contact means human contact with an infected female *Anopheles* mosquito.

coverage A measure of the extent to which services cover the potential need for these services in a community. It is expressed as a proportion in which the numerator is the number of services rendered and the denominator is the number of instances in which the service should have been rendered.

E

effectiveness A measure of the extent to which a specific intervention, procedure, regimen or service, when deployed in the field in routine circumstances, does what it is intended to do for a specified population; a measure of the extent to which a health care intervention fulfils its objectives.

efficacy The extent to which a specific intervention, procedure, regimen or service produces a beneficial result under ideal conditions; the benefit or utility being to the individual or population receiving the service, treatment regimen or intervention. Ideally, the determination of efficacy is based on the results of a randomized controlled trial.

endemic Term applied to malaria when there is a constant measurable incidence of both cases and natural transmission in an area over a number of years.

epidemic Term applied to malaria when the incidence of cases in an area rises rapidly and markedly above its usual (or seasonal) level (including when infections occur in an area where malaria was not previously present).

H

haemolytic anaemia A disorder in which red blood cells are destroyed faster than they can be made. The destruction of red blood cells is called haemolysis.

health communication Activity that informs at-risk individuals and communities about positive health-related behaviour changes that could reduce their risk (e.g. their risk of malaria infection) and improve their management of illness.

health education Any combination of learning experiences designed to help individuals and communities improve their health by increasing their knowledge or influencing their attitudes and behaviours. Effective health education includes interaction, participation and critical analysis.

health literacy The cognitive and social skills that determine the motivation and ability of individuals to gain access to, understand and use information in ways that promote and maintain good health. For an effective emergency response, community engagement efforts should recognize how power relations affect access to information and the ability to use that information, and should include interventions to address the barriers.

host (epidemiology) In an epidemiological context, the host is the individual, population or group harbouring or providing subsistence to a parasite. Biological, social and behavioural characteristics of this group that are relevant to health are called "host factors".

host community A community that hosts refugees or internally displaced persons, whether in settlements, integrated into households or independently.

household One or more persons who occupy a dwelling. The persons may or may not be a family. The term "household" is also used to describe the dwelling unit in which the persons live.

humanitarian emergency A situation in which the functioning of a community or society is severely disrupted, causing suffering and losses that exceed the affected population's ability to cope using its own resources. Humanitarian emergencies can be caused by instability, conflict or natural disasters. Humanitarian emergencies commonly involve population displacement, food insecurity and malnutrition, and health systems disruptions that cause excess mortality and morbidity in affected populations.

I

immunity, acquired Resistance acquired by a host as a result of previous exposure to malaria infection.

incidence rate The rate at which new events occur in a population. The numerator is the number of new events that occur in a defined period and the denominator is the population at risk of experiencing these events during this period, sometimes expressed as person-time.

infection, mixed Malaria infection with more than one species of *Plasmodium*.

informed consent Voluntary consent given by a subject (i.e. a person or a responsible proxy such as a parent) for participation in a study, immunization programme, treatment regimen, etc., after being informed of the purpose, methods, procedures, benefits and risks, and, when relevant, degree of uncertainty about outcomes. The essential criteria of informed consent are that the subject has both knowledge and comprehension, that consent is freely given without duress or undue influence, and that the right of withdrawal at any time is clearly communicated to the subject.

K

knowledge, attitudes, practice survey A formal survey, using face-to-face interviews, in which people are asked standardized pretested questions dealing with their knowledge, attitudes and practice concerning a given health or health-related problem.

L

large-scale pilot implementation A process of testing a new intervention in a broader context after initial small-scale trials have been completed. Large-scale pilot implementation typically involves deploying the project in a real-world environment across multiple sites or with a significant population to gather data, assess feasibility and evaluate effectiveness on a larger scale before a policy is made and full-scale rollout is conducted.

larva The pre-adult or immature stage hatching from a mosquito egg.

larval habitat Site where mosquitoes lay their eggs, or where their larvae or pupae are found. (Also known as "breeding site".)

larval source management The management of aquatic habitats (water bodies) that are potential larval habitats for mosquitoes, in order to prevent the completion of development of the immature stages. There are four types of larval source management:

1. habitat modification: a permanent alteration to the environment;
2. habitat manipulation: a recurrent activity;
3. larviciding: the regular application of biological or chemical insecticides to water bodies;
4. biological control: the introduction of natural predators into water bodies.

M

mobile clinic A mobile clinic is a customized motor vehicle that travels to communities to provide health care. Mobile clinics deliver a wide variety of health services and may be staffed by a combination of physicians, nurses, community health workers and other health professionals. They can include customized vehicles, motorbikes, boats or rickshaws.

morbidity Having a specific disease or condition. Morbidity is usually measured by incidence (persons who become ill) or prevalence (persons who are ill) within a population.

morbidity rate An estimate of the proportion of a population that becomes ill during a specified period. The numerator is the number of persons who become ill during the period and the denominator is the total number of the population, usually estimated as the mid-year population.

mortality rate An estimate of the proportion of a population that dies during a specified period. The numerator is the number of persons who die during the period and the denominator is the total number of the population, usually estimated as the mid-year population.

N

needs assessment A systematic procedure for determining the nature and extent of problems that directly or indirectly affect the health of a specified population. Needs assessment makes use of epidemiological, sociodemographic and qualitative methods to describe health problems and their environmental, social, economic and behavioural determinants. The aim is to identify unmet health care needs and make recommendations about ways to address these needs.

O

outreach (clinic, team) The extending of services or assistance beyond fixed facilities, mainly to ensure access for underserved communities. Outreaches may be offered by health workers via a fixed site or mobile clinics.

P

parasitaemia Condition in which malaria parasites are present in the blood. If this condition in the human subject is not accompanied by fever or other symptoms of malaria except for a possible enlargement of the spleen, it is known as asymptomatic parasitaemia, and the person exhibiting the condition is known as an asymptomatic parasite carrier.

passive emanator A device that passively emits volatile chemicals, currently pyrethroids, that reduce malaria transmission by killing or repelling mosquitoes or interrupting their feeding cycle. Also known as a spatial repellent.

Plasmodium A genus of parasitic protozoa that causes malaria in humans and other animals. It is transmitted to humans through the bites of infected female Anopheles mosquitoes from four specific the species *P. falciparum, P. vivax, P. ovale, P. malariae, P. knowlesi.*

prevention The concept of prevention is best defined in the context of levels, called primary, secondary and tertiary prevention. In epidemiological terms, primary prevention aims to reduce the incidence of disease; secondary prevention aims to reduce the prevalence of disease by shortening its duration; and tertiary prevention aims to reduce the number and/or impact of complications.

protracted emergency A crisis that persists over an extended period, often characterized by recurrent or continuous humanitarian needs due to prolonged conflict, displacement, food insecurity, or weak governance. These emergencies require sustained humanitarian support alongside long-term development efforts to build resilience and reduce dependency on aid.

protection (humanitarian) Activities aimed at obtaining full respect for the rights of the individual in accordance with the letter and spirit of human rights, refugee and international humanitarian law. Protection involves creating an environment that is respectful to human beings, prevents and/or alleviates the immediate effects of a specific pattern of abuse, and restores dignified conditions of life through reparation, restitution and rehabilitation *(2)*.

protection (infection) The use of preventive strategies and measures intended to reduce the risk of infection.

public health event Any event that may have negative consequences for human health. The term includes events that have not yet led to disease in humans but have the potential to cause human disease through exposure to infected or contaminated food, water, animals, manufactured products or environments.

pulmonary oedema Swelling caused by an excess of fluid associated with or affecting the lungs.

R

recrudescence Repeated manifestation of an infection after a period of latency following the primary attack. It is used particularly in the context of treatment failure of *P. falciparum,* often the result of non-completion of the recommended treatment regimen (especially with short-acting drugs such as quinine and artemisinins), poor efficacy of antimalarials, resistance of parasites to antimalarials, or persistence of subclinical infection in immunocompromised individuals.

refugee A person who meets the eligibility criteria under the applicable refugee definition, as provided for in international or regional instruments, under the mandate of the Office of the United Nations High Commissioner for Refugees (UNHCR) and in national legislation.

relapse Renewed manifestation (of clinical symptoms and/or parasitaemia) of malaria infection separated from previous manifestations of the same infection by an interval greater than that related to the normal periodicity of the episodes. The term is used mainly for renewed manifestation due to survival of exoerythrocytic forms of *P. vivax* or *P. ovale*.

reservoir (of infection) Any person, animal, arthropod, plant, soil or substance, or combination of these, in which an infectious agent normally lives and multiplies, on which it depends primarily for survival, and where it reproduces itself in such a manner that it can be transmitted to a susceptible host. Includes the natural habitat of the infectious agent.

resistance Ability of a parasite strain to multiply or to survive in the presence of concentrations of a drug that normally destroy parasites of the same species or prevent their multiplication. Ability in a population of insects to tolerate doses of an insecticide that would prove lethal to most individuals in a normal population of the same species. Resistance develops as a result of selection pressure.

retention (with respect to insecticide-treated nets) An indicator used to establish whether insecticide-treated nets remain with the individuals to whom they were originally distributed. Retention alone is not an indicator of the correct use of insecticide-treated nets.

risk The probability that an event will occur; for example, that an individual will become ill or die within a stated period or by a certain age. Also, a nontechnical term that encompasses a variety of measures of the probability of a (generally) unfavourable outcome.

risk communication The real-time sharing of information, advice and opinions among experts, community leaders, officials and the people at risk. Risk communication conducted before, during and after an emergency is called emergency risk communication.

S

sample A selected subset of a population. A sample may be random or non-random and may be representative or non-representative.

sensitivity (of a screening test) The proportion of diseased persons in the screened population who are identified as diseased by the screening test. Sensitivity is a measure of the probability of correctly diagnosing a case, or the probability that the test will identify any given case. See also **specificity**.

social and behaviour change communication A package of communication strategies and approaches aimed at changing specific behaviours and social norms among target groups.

social mobilization A process to engage a broad range of traditional, community, civil society and opinion leaders around a common cause or issue, involving reaching out to a broad range of stakeholders (e.g. nongovernmental organizations, professional networks, youth groups, women's groups, community-based organizations, faith-based organizations, professional networks and the private sector) to catalyse them to act.

specificity (of a screening test) The ability of a test to designate an individual who does not have a disease as negative. A highly specific test is one that results in few false positive results.

surveillance The continuous process of systematic collection, orderly consolidation and evaluation of pertinent data with prompt dissemination of the results to those who need to know, particularly those who can take action.

survey An investigation in which information is systematically collected; usually carried out in a sample of a defined population group, within a defined time period. Unlike surveillance, a survey is not continuous; however, if repeated regularly, surveys can form the basis of a surveillance system.

T

transmission Any mechanism by which an infectious agent is spread from a source or reservoir to another person. May be perennial or seasonal.

V

vector Any insect or living carrier that transports an infectious agent from an infected individual or the individual's waste to a susceptible individual or the individual's food or immediate surroundings. The organism may or may not pass through a developmental cycle within the vector.

vector control Measures of any kind directed against a vector of disease and intended to limit its ability to transmit the disease.

vulnerability Defencelessness, insecurity, exposure to risks, shock and stress, and having difficulty coping with them. The potential that when something destructive happens or goes wrong, people will not be able to handle the consequences by themselves and the ability to sustain life is endangered.

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Introduction

Growing emergencies and displacements across the world demand increasingly complex interventions and responses. The World Health Organization (WHO) has developed *Malaria control in emergencies: a field manual* to provide technical guidance to help partners respond effectively to malaria in emergency situations. This field manual supersedes the 2013 WHO handbook.

Development of the manual involved gathering evidence and practical solutions, the coordination of multiple agencies, extensive consultation with partners and many rounds of review, including extensive input from the Working Group on Malaria Control in Humanitarian Emergencies and other malaria experts.

This handbook serves as a comprehensive resource that consolidates consensus on the core elements and key content for malaria interventions in humanitarian emergency and post-emergency contexts. It is grounded in current WHO recommendations and incorporates best practices, lessons learned, and practical solutions to address the main challenges in malaria management during crises. The manual also highlights the ongoing nature of research and innovation in malaria control, ensuring that users have access to the most up-to-date guidance. It includes suggestions for further reading, useful tools and resources, and links to current information, making it an essential tool for humanitarian actors, health workers, and decision-makers operating in emergency settings.

The world is facing grave humanitarian emergencies in increasing numbers and of longer durations than ever before. The Office of the United Nations High Commissioner for Refugees (UNHCR) estimates that at the end of April 2024 there were more than 120 million forcibly displaced persons *(1)*. The average period of displacement ranges from 10 to 26 years *(2)*. In addition, natural disasters are becoming more frequent and catastrophic because of extreme weather events caused by climate change and aggravated by environmental degradation. Conflicts have become more protracted than ever. These emergencies often lead to population displacements, food insecurity and negative impacts on health.

Displaced populations that have little previous exposure to malaria have no immunity. This is especially true for people who have lived in highlands that are too cold for malaria parasites or in arid areas with few mosquitoes. These populations experience malaria outbreaks if they move to or transit through high transmission zones, such as lower-lying or wetter areas. Malaria outbreaks can also occur when populations from high transmission areas with asymptomatic malaria move to communities that have no immunity.

Malaria epidemics can occur in former high transmission areas if control activities are not maintained or if control interventions are disrupted (e.g. because of conflict, natural disasters or large-scale public health emergencies). Floods lead to favourable conditions for malaria outbreaks because the stagnant flood-waters left in their aftermath create and expand larval habitat, enabling prolific vector breeding and enormous increases in vector density.

A partial or total collapse of the health system may occur in the early stages of humanitarian emergencies. The presence of malaria should be considered potentially life-threatening because, even in the absence of outbreaks or any notable increase in incidence, malaria often becomes the major cause of death within the context of humanitarian emergencies.

Despite the challenges to implementing malaria control in emergencies, many opportunities exist to leverage coordinated support (infrastructure, human resources and others) through the humanitarian response system. As much as possible, malaria control activities should be integrated into the broader humanitarian response. Opportunities for integration include larval source management (LSM) within water, sanitation and hygiene (WASH) activities, the distribution of insecticide-treated nets (ITNs) by the health sector, and indoor residual spraying (IRS) through shelter cluster/sector activities.

Each chapter of this manual provides essential guidance on key aspects of malaria control in emergency settings, including epidemiology, coordination, diagnostics, case management, chemoprevention, vector control, risk communication, operational research, and surveillance. The manual consolidates WHO recommendations, practical solutions, and best practices to support effective malaria response during humanitarian emergencies.

Chapter 1. Malaria epidemiology and control in emergencies outlines the nature of humanitarian emergencies, malaria epidemiology, and risk factors (e.g., climate, immunity, and vector species). It highlights the challenges posed by malaria outbreaks during emergencies and presents a summary of core malaria control interventions, including case management, vector control, and chemoprevention.

Chapter 2. Coordination emphasizes the importance of coordination among United Nations agencies, government bodies, and emergency response partners. It provides guidance on planning and implementing malaria responses, funding mechanisms, procurement, logistics, and human resource considerations to streamline emergency malaria interventions.

Chapter 3. Diagnostics and case management focuses on assessing and managing uncomplicated and severe malaria in emergencies. It details danger signs, use of rapid diagnostic tests (RDTs), treatment protocols, pre-referral care, and the management of severe malaria complications. Special considerations for vulnerable groups (e.g., children, pregnant women, and people living with HIV) are included, along with monitoring and evaluation (M&E) indicators for case management.

Chapter 4. Chemoprevention outlines the use of drugs to prevent malaria infections, covering mass drug administration (MDA), seasonal malaria chemoprevention (SMC), intermittent preventive treatment (IPT) for pregnant women and school-aged children, and post-discharge chemoprevention for vulnerable groups in emergency settings. The chapter highlights planning, implementation, and monitoring and evaluation of chemoprevention programs.

Chapter 5. Vector control presents key approaches to vector control, including insecticide-treated nets (ITNs), indoor residual spraying (IRS), and larval source management (LSM). It discusses operational planning, procurement, distribution, and entomological monitoring. It also introduces emerging vector control tools, such as spatial repellents, insecticide-treated clothing, and attractive targeted sugar baits (ATSBs), that may be useful in emergency settings

Chapter 6. Risk communication and community engagement (RCCE) highlights how to effectively engage and inform communities about malaria risks and control measures. It focuses on developing communication plans, community participation, and messaging strategies, using appropriate communication channels. The chapter also emphasizes monitoring and evaluation of RCCE activities to ensure effective messaging.

Chapter 7. Operational research supports continuous improvement in malaria control strategies. It explores areas for research on diagnostics, treatment, prevention, and new vector control tools (like spatial repellents and insecticide-treated textiles) and highlights the need for vaccine research. The chapter provides guidance on operational research design and implementation in emergency settings.

Chapter 8. Surveillance, monitoring and evaluation (M&E) explains how to assess malaria risk and track outbreaks in emergencies. It emphasizes the establishment of early warning systems, surveillance systems, and outbreak detection mechanisms. It provides M&E frameworks and indicators to ensure accountability and continuous learning in emergency malaria response.

Development of the manual and methodology

The development of this manual followed a rigorous, collaborative process designed to ensure technical soundness, contextual relevance and practical applicability. A dedicated Working Group on Malaria Control in Humanitarian Emergencies was established, comprising experts selected for their technical expertise and field experience. All members signed a Declaration of Interest (DOI), and no conflicts of interest were reported or identified. Sub-teams were formed to draft individual chapters, aligning responsibilities with specific areas of expertise. The content was shaped through an extensive consultation process, beginning with two in-person meetings to review current practices in emergency response and align guidance with the WHO guidelines on malaria. These discussions were further refined through a series of virtual meetings aimed at achieving consensus on each chapter.

The manual's guidance is grounded primarily in existing WHO malaria guidelines to maintain alignment with global standards, while carefully adapting interventions to emergency contexts to prioritize feasibility, relevance, and operational practicality. In deliberating on interventions, the Working Group assessed factors such as feasibility in resource-constrained or crisis-affected settings – including supply chain limitations and staffing shortages – along with resource requirements like cost, infrastructure, and the availability of tools such as rapid diagnostic tests and insecticide-treated nets. Equity was also a key consideration, with attention to ensuring access for vulnerable groups such as displaced populations, children and pregnant women. Epidemiological relevance was evaluated by considering local malaria transmission patterns and overlapping health burdens like malnutrition and concurrent infections.

Where WHO guidelines did not provide emergency-specific evidence, the Working Group incorporated lessons from field experiences and well-documented case studies, and identified interventions with potential benefit for operational research or pilot implementation in crisis settings. The inclusion of case studies for each chapter was determined based on relevance, operational feasibility, scalability and impact, with expert consensus ensuring context-appropriate guidance for emergencies.

External resources were carefully selected based on their evidence base, relevance to emergency contexts, and impartiality, with particular attention to avoiding materials containing conflicts of interest from contributors or funders, and excluding implementers' promotional claims.

Chapter 1.
Malaria epidemiology and control in emergencies

1.1 Overview

Humanitarian emergencies significantly disrupt health systems and exacerbate vulnerabilities within affected communities, posing substantial challenges for malaria control. The displacement of populations into settlements for refugees or internally displaced persons (IDPs) often results in environmental modifications that create optimal breeding sites for malaria vectors, thereby increasing transmission risk. Malaria is frequently a leading cause of morbidity and mortality during emergencies, particularly in regions with moderate to high transmission.

The health impact of emergencies is further compounded by the heightened risk and severity of comorbidities, such as malnutrition, which weaken immune responses and increase susceptibility to malaria. The coexistence of concurrent public health crises, including disease outbreaks, further complicates malaria prevention, diagnosis and case management. Effective malaria control in emergency contexts requires a multi-sectoral, coordinated response. Humanitarian assistance must be context-specific, ensuring that interventions are tailored to the emergency's nature and phase. This involves harmonizing activities among partners, fostering active participation of local actors, and ensuring accountability among all stakeholders. Interventions must be delivered with efficiency and precision to mitigate the health impact of malaria in these complex settings.

1.2 Introduction to humanitarian emergencies

1.2.1 Definition and scope

The world is affected by humanitarian emergencies on an unprecedented scale with devastating health, economic, political and societal consequences, both immediately and in the long term. Humanitarian emergencies have major impacts on the health and well-being of communities, resilience of health systems and stability of national economies, slowing progress towards the United Nations Sustainable Development Goals. Control of malaria and other communicable diseases during humanitarian emergencies can be particularly challenging.

A humanitarian emergency is a situation in which the functioning of a community or society is severely disrupted, causing suffering and losses that exceed the affected population's ability to cope using its own resources. They may be caused by instability or conflict or by natural disasters, such as earthquakes, floods or drought. Humanitarian emergencies often involve population displacement, food insecurity and malnutrition, and health systems disruptions that cause excess mortality and morbidity in affected populations.

A complex emergency is a humanitarian emergency that occurs in a country, region or society where there is a total or considerable breakdown of authority resulting from conflict, requiring an international response that goes beyond the mandate or capacity of any single agency and that the Inter-Agency Standing Committee (IASC) assesses requires intensive and extensive political advocacy and coordination *(3)*.

Despite the existence of standards, the quality of humanitarian assistance is often variable, even within the same context. The Grand Bargain, agreed between donors and humanitarian organizations in 2016, outlined priorities for improving humanitarian assistance, including through localization, participation of communities and the provision of quality funding and sustainable aid *(4)*. The 2023 revision of the Grand Bargain is aimed at better effectiveness and efficiency, strengthened partnerships and accountability to all constituencies.

Malaria control interventions in emergencies should be implemented in the spirit of the Grand Bargain, ensuring that partners harmonize their interventions, the participation of local actors, accountability to each other and communities, and the efficient and effective delivery of interventions.

1.2.2 Types and phases

Sudden-onset emergencies involve a suddenly deteriorating situation, such as the impact of an earthquake or flood. Slow-onset emergencies involve a gradually deteriorating situation; for example, food insecurity developing into a nutrition crisis. Protracted emergencies are drawn-out emergencies with consistently high levels of humanitarian need and often lower levels of aid, as the root causes of the emergency remain unresolved. Humanitarian emergencies involving conflict frequently become protracted. The nature and duration of the humanitarian emergency affects malaria control. This field manual addresses malaria control in different types of emergency settings.

Increasingly, humanitarian emergencies involve forcibly displaced persons settling in host communities and urban areas. Providing humanitarian assistance in these out-of-camp settings is more complicated than in settlements or camps. It is important to expand assistance to host communities to address their needs alongside those of refugees or IDPs. Understanding which phase an emergency is in can help guide how humanitarian aid should be provided. These phases generally consist of acute, protracted and recovery phases, summarized in Table 1. Humanitarian emergencies can evolve rapidly and unpredictably, including by moving back and forth between acute and protracted phases, with or without recovery.

Table 1. Phases of humanitarian emergencies

Phase	Sudden onset crisis	Slow-onset crisis	Protracted crisis
Phase 1 (acute)	First 24–72 hours	First 1–2 weeks	Ongoing for more than 6 months
Phase 2 (acute)	First 4–10 days	First month	Not applicable
Phase 3 (protracted)	4–6 weeks for natural disaster Up to 3 months for conflict	2–3 months	Indefinite (continued low-level response)
Phase 4 (recovery)	Continued response and progressive recovery	Not applicable	

Sources: adapted from WHO *(5)* and Howard *et al. (6)*

1.3 Malaria epidemiology

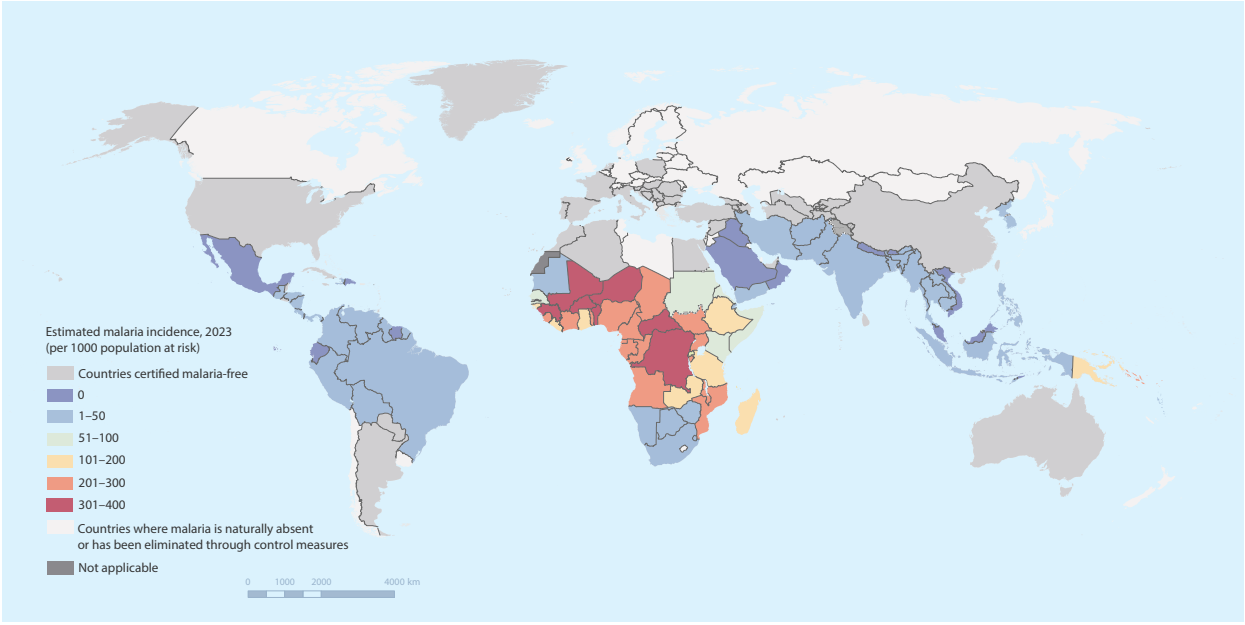
1.3.1 Malaria, where it occurs and who is affected

Malaria is a life-threatening disease caused by protozoan parasites of the genus *Plasmodium*, transmitted between humans by *Anopheles* mosquitoes. Even though malaria is largely preventable and treatable, nearly half of the world's population is still at risk of malaria infection (see Fig. 1). Malaria transmission occurs when humans come into "contact" with *Anopheles* mosquitoes that are infected with *Plasmodium* parasites. This typically happens when an infected mosquito bites a human, injecting sporozoites into the bloodstream. The risk of infection depends on the frequency and intensity of these interactions, as well as the level of *Plasmodium* transmission in the area. The risk of infection depends on the frequency and intensity of human-mosquito interactions, the density of infected mosquitoes, and the level of *Plasmodium* transmission in the area, including local transmission dynamics, environmental conditions, and the presence of vector control measures.

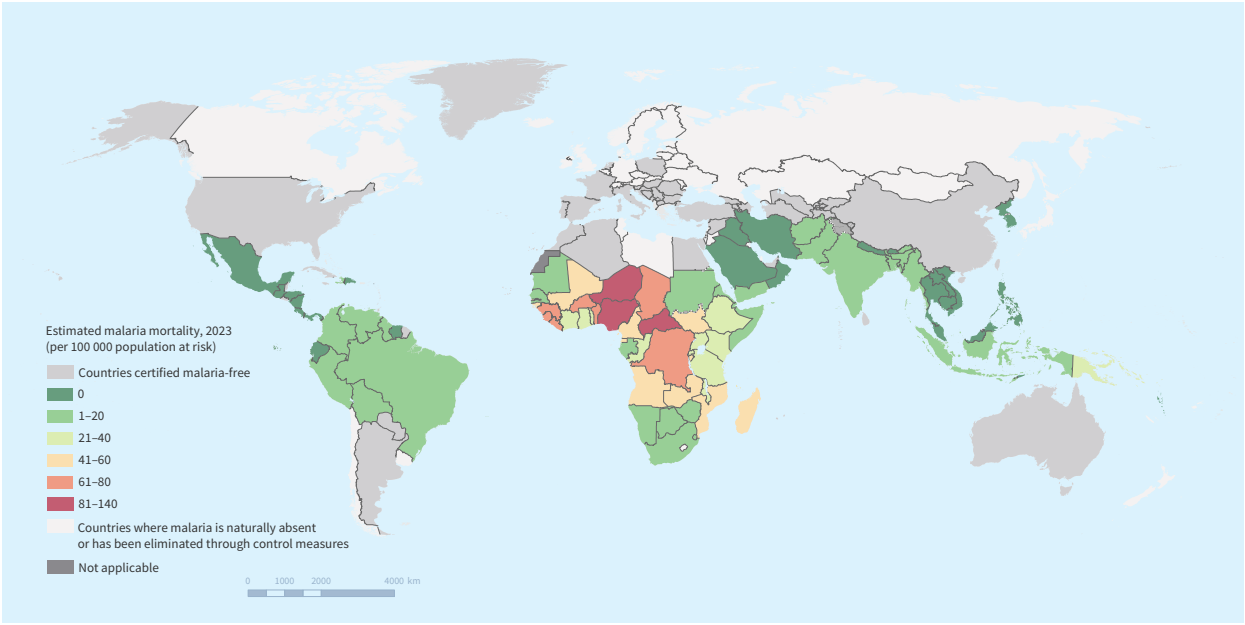
An estimated 263 million malaria cases occurred in 2023 (an increase of 14 million cases from 2021), resulting in an estimated 597 000 malaria deaths, making it the third most deadly infectious disease in low-income countries after tuberculosis and HIV *(7)*. By the end of 2023, 83 endemic countries reported indigenous malaria cases. The WHO African Region accounted for about 94% of cases and 95% of deaths globally. Eleven countries, namely Burkina Faso, Cameroon, Democratic Republic of the Congo, Ghana, Mali, Mozambique, Niger, Nigeria, Uganda, United Republic of Tanzania and Sudan, account for more than 70% of cases and deaths. Nine of these countries are experiencing protracted conflict. Some have other factors favouring the high transmission of malaria; the countries in the Sahel, the Horn of Africa, southern and eastern Africa, and some parts of Asia are increasingly affected by extreme weather events such as long droughts and severe flooding. For example, the main countries contributing to the increase in cases between 2022 and 2023 were Ethiopia (+4.5 million), Madagascar (+2.7 million), Pakistan (+1.6 million), Nigeria (+1.4 million) and the Democratic Republic of the Congo (+600 000) all of which experienced displacement *(8)*.

Fig. 1. Estimated (a) malaria cases per 1000 population at risk, and (b) malaria deaths per 100 000 population at risk, 2023

a Estimated malaria cases per 1000 population at risk



b Estimated malaria deaths per 100 000 population at risk

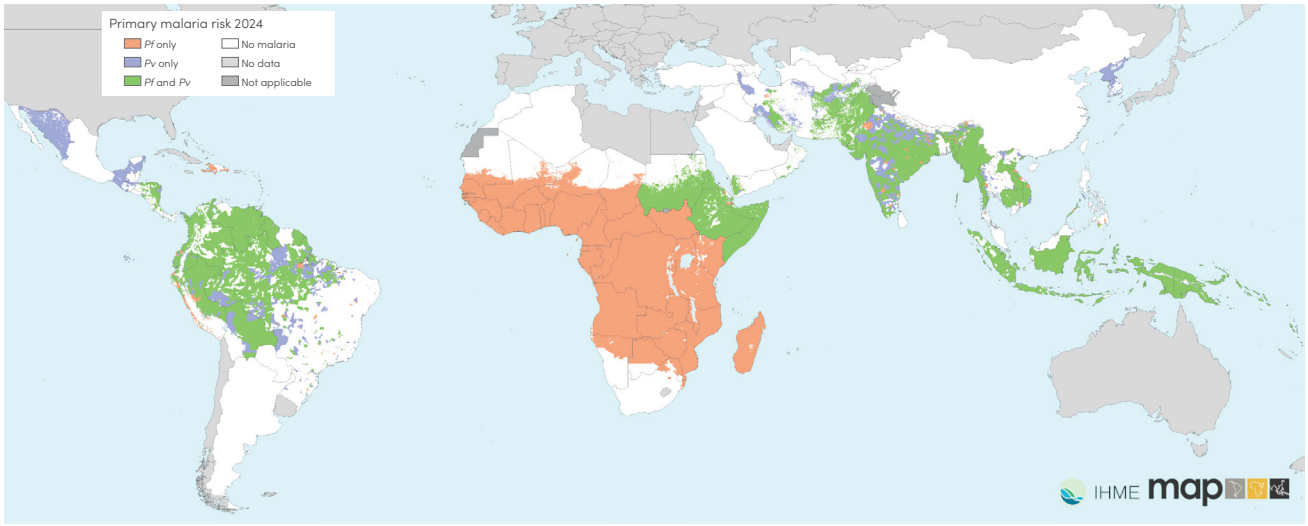


Source: *World malaria report 2024 (7)*

In Asia, the Western Pacific, South and Central America, the risk of malaria is generally much lower (except for Papua New Guinea), and high transmission is much more focal than in Africa, mainly due to less-efficient vector species. Local transmission of malaria is often restricted to small hotspots populated by high-risk groups such as forest dwellers, while large areas and populations around and in between them have very low or non-existent transmission. In the Amazon basin, very high malaria transmission is reported by gold and gem miners around illegal mines. Implementing effective control in these settings requires in-depth knowledge of the local vector species and their breeding and biting habits.

The most common and dangerous malaria parasite is *Plasmodium falciparum*, which can cause fatality. The second most common parasite, *P. vivax*, is mainly found in cooler areas at higher altitudes with lower malaria transmission. *P. vivax* malaria is usually not fatal but can involve serious illness. Fig. 2 shows the areas of the world at risk of *P. falciparum and P. vivax* malaria. The other human malaria parasite species are rare (accounting for less than 5% of cases). In emergency settings, all malaria parasite species can be treated with the same medication as *P. falciparum*. Zoonotic *P. knowlesi* occurs in focalized areas in some South-East Asian countries, including Malaysia and Indonesia, and is of less relevance to emergencies *(9)*.

Fig. 2. Areas at risk of *P. falciparum* and *P. vivax malaria*, 2024



Source : Malaria Atlas Project, 2025 *(10)*.

1.3.2 Signs and symptoms of malaria

Malaria may be uncomplicated or complicated (severe).

- **Uncomplicated malaria:** the clinical features of malaria are variable but typically include weakness, fever, chills, headache, muscular aches and abdominal pain. This may be followed by shortness of breath, vomiting, diarrhoea and drowsiness. Vomiting can make oral treatment difficult. The initial

symptoms are nonspecific and may easily be mistaken for other febrile illnesses, contributing to delays in seeking appropriate treatment for malaria. All cases with fever or a history of fever should be assessed as part of fever management with parasitological diagnosis.

- **Complicated (severe) malaria:** when uncomplicated malaria due to *P. falciparum* is not treated within 24 hours with the appropriate medication, it may progress into a severe form. Symptoms of severe malaria include one or more of the following: impaired consciousness, coma (cerebral malaria), prostration, multiple convulsions. metabolic acidosis, severe anaemia, hypoglycaemia, severe malarial anaemia, renal impairment, jaundice or pulmonary oedema *(11)*.

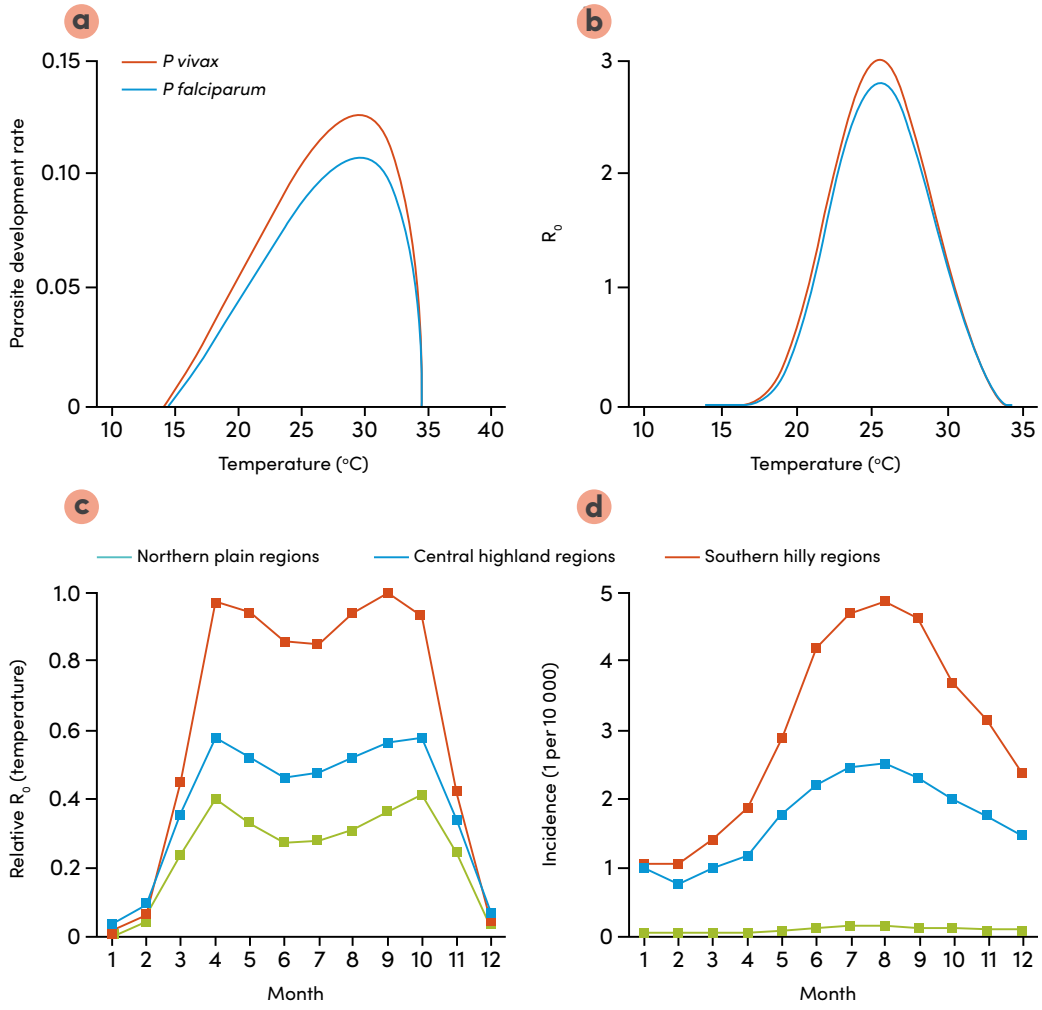
- The illness may be further complicated by haemolytic anaemia, in which red blood cells are destroyed faster than they can be replaced *(12)*, leading to renal failure or pulmonary oedema and respiratory failure. Patients with severe malaria often become comatose. Severe malaria requires intensive care.

Malaria can have a very short time interval between the onset of symptoms and death. If complicated malaria is not treated within 24 hours, it may be fatal, particularly in *P. falciparum* cases. Early recognition of signs and symptoms and timely diagnosis and treatment within 24 hours are therefore critical before cases progress to severe malaria that requires referral and case management using commodities (e.g. oxygen, blood) that may not be readily available in emergency contexts.

1.3.3 Altitude, temperature, rainfall, seasonality and climate change

The malaria parasite can only be naturally transmitted between humans by mandatory passage through an *Anopheles* mosquito (called the "vector"). Inside the mosquito, the parasite undergoes certain developmental stages that require a median daily temperature of > 20 °C for *P. falciparum* and > 18 °C for *P. vivax*. This temperature requirement explains why malaria transmission is lower or absent at altitudes above 2000 m, even in the tropics or in temperate zones *(13)*. There are, however, recent reports of malaria cases in areas above 2000 m in the Ethiopian and Kenyan highlands, where climate change is contributing to warming at higher altitudes where malaria was traditionally absent *(14)*. Malaria transmission is lower or absent during the cooler winter months of the year, even at lower altitudes, especially as winter is often the dry season. As an example in China during its elimination efforts, the effects of temperature on malaria parasite development are illustrated in Fig. 3(a) shows the variation of the parasite development rate of *P. falciparum* and *P. vivax* (expressed as 1 over the number of days to parasite development) with temperature. Fig. 3(b) shows the temperature-dependent R0 (the number of cases generated by one infected individual) for *P. falciparum* and *P. vivax*. Fig. 3(c) shows the seasonality of temperature-dependent relative R0 (reproductive potential) of *P. falciparum* and *P. vivax* in three regions, that differ in altitude. Fig. 3(d) shows the average seasonal incidence of malaria for the same three regions.

Fig. 3. Time and temperature required for transmission of malaria between vectors



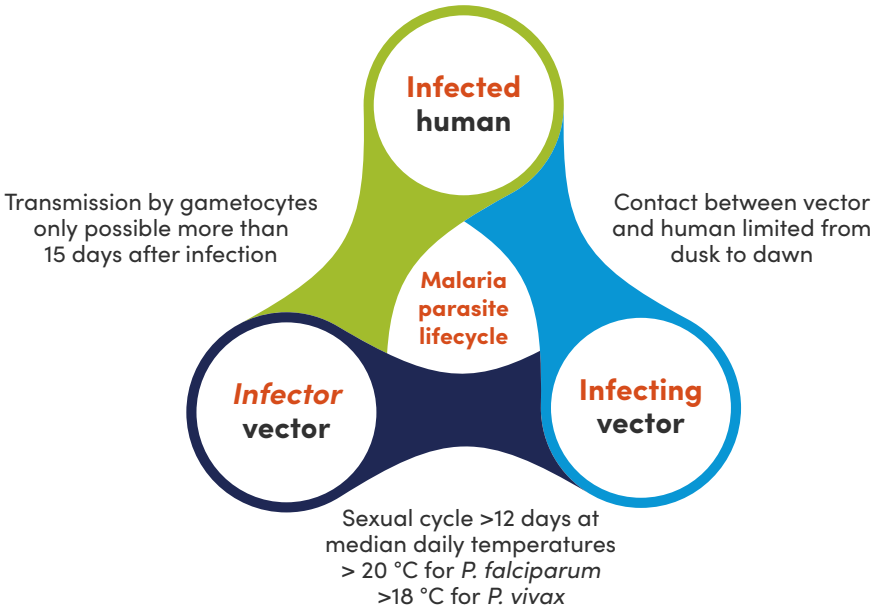
Source: Wang *et al. (15)*.

Rainfall increases malaria vector density by creating areas of stagnant water that become larval habitat. Rainfall affects the timing of malaria transmission in several ways.

- The high malaria season begins about 4 weeks after the start of the rains. During this 4-week period, mosquitoes hatch and grow old enough to become infectious.
- Transmission is usually highest at the end of the rainy season and during the month immediately following it. This is because heavy rains or flooding during the height of the rainy season may wash out larval habitat.
- The duration of the high transmission season is roughly as long as the rainy season.
- The Horn of Africa, Great Lakes subregions and the Indian subcontinent have two rainy seasons (long and short rains). In these areas, most transmission takes place between the second and third quarter of the year.
- The Sahel countries typically have seasonal malaria transmission coinciding mainly with the rainy season (ranging from 3–6 months).

The malaria parasite lifecycle is summarized in Fig. 4.

Fig. 4. Malaria parasite lifecycle



1.3.4 Immunity against malaria

Repeated *Plasmodium falciparum* infections in endemic areas lead to the development of partial immunity, which provides protection against severe forms of the disease. Individuals with partial immunity typically remain asymptomatic but may still carry and transmit the parasite, acting as contacts – persons who, through close association with an infected individual or a contaminated environment, have the opportunity to acquire the infection.

Partial immunity is therefore most evident in adolescents and adults living in high-transmission settings. In contrast, young children in these areas are at the greatest risk of severe malaria or death, as they are immunologically naive. They only begin to develop partial immunity after experiencing and surviving multiple malaria episodes, frequently with the assistance of treatment.

Pregnant women, particularly primigravidae, are at higher risk of severe malaria because of lower immune responses. Malaria can cause maternal and newborn anaemia, miscarriage, stillbirths and low birth weight.

Acquired partial immunity to malaria can be lowered by malnutrition, measles or other concomitant infectious diseases. Acquired partial immunity can also be lost after 2 years if an individual is not reinfected.

In highland and arid areas that are either too cold or unfavourable for parasite development, populations of all ages remain non-immune and thus susceptible to severe malaria illness and death if displaced to higher endemic areas.

Malaria vaccines (RTS,S/AS01 and R21/Matrix-M) confer partial immunity, reducing malaria cases, including severe malaria, by more than 50% during the year after vaccination. Vaccines may not play a critical role during the acute phase of an emergency but could be useful later if the district is eligible for vaccination (stratified as moderate or high burden), and young children are at particular risk. Many humanitarian emergencies become protracted, justifying the integration of the malaria vaccines with other primary health care services *(2)*.

1.3.5 Transmission potential of different vector species

The likelihood of being infected with malaria largely depends on how biologically fit the locally dominant vector is for transmitting malaria. *Anopheles gambiae* and closely related species are the most effective and dangerous malaria vectors but are only endemic in sub-Saharan Africa. This explains the transmission intensity in sub-Saharan Africa and why approximately 96% of the global malaria burden is reported there.

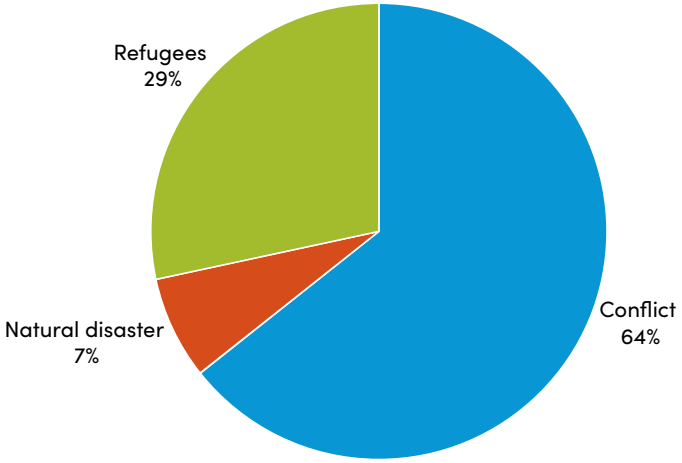
An. stephensi, an important malaria vector in South Asia, has spread through the Horn of Africa since 2016, and is now established in several areas in sub-Saharan Africa *(16)*. *An. stephensi* has the following special characteristics that should inform the malaria control response.

- It can breed in artificial water containers, cisterns, etc. and, as such, has been responsible for dry season outbreaks and urban malaria *(17)*.
- It is highly zoophilic, often associated with domestic animals, and feeds early and outside, complicating vector control efforts.
- It has a high level of insecticide resistance.

1.4 Malaria in emergencies

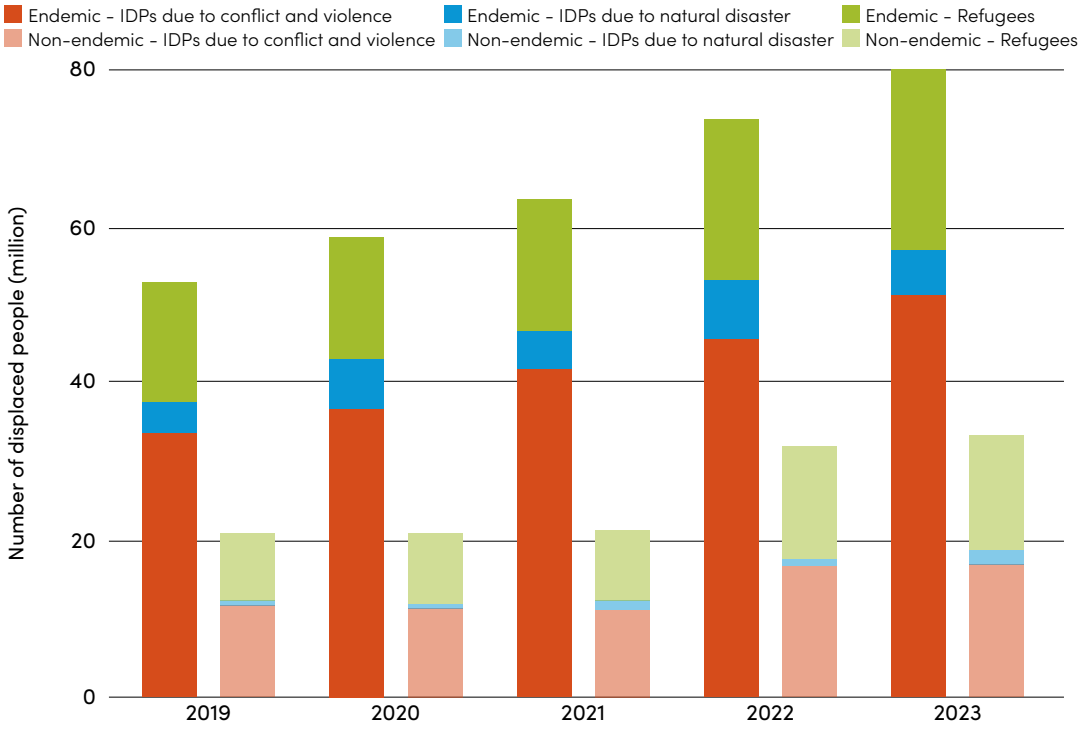
Global displacement reached 113.3 million in 2023, including 75.9 million IDPs and 37.3 million refugees, driven by conflict, disasters and crises. Of these, nearly 80 million were displaced in 43 malaria-endemic countries (up from 39 in 2019), with 51.3 million (64%) being conflict-driven IDPs across 43 countries and 5.8 million (7%) being IDPs driven by natural disaster across 51 countries. Combined, conflict and disasters displaced 57.1 million in these regions, leaving 22.7 million displaced globally from other causes. This surge heightens malaria risks due to disrupted healthcare, overcrowding and resource shortages, demanding urgent health-focused interventions in unstable, disaster-prone areas. Figs. 5, 6 and 7 highlight rising conflict-linked displacement in endemic zones since 2019, and the countries disproportionately affected by emergencies.

Fig. 5. Proportion of IDPs and refugees in malaria endemic countries (79.8 million)



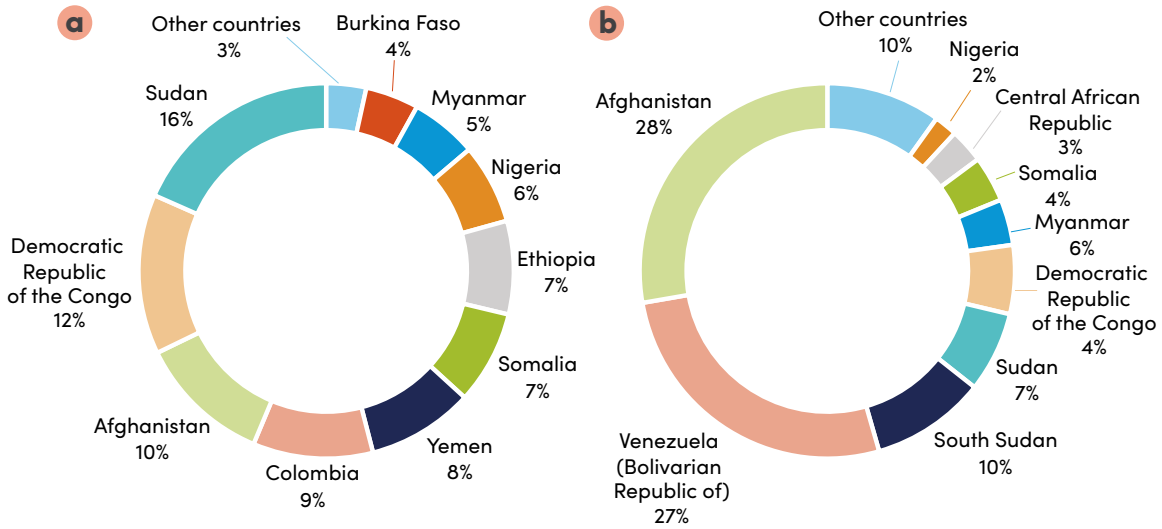
Source: *World malaria report 2024 (7)*

Fig. 6. Comparison of displaced persons in endemic and non-endemic countries, 2019–2023



Source: *World malaria report 2024 (7)*

Fig. 7. Proportions of a) IDPs due to humanitarian emergencies in malaria endemic countries and b) refugees from malaria endemic countries, 2023



IDMC: Internal Displacement Monitoring Centre; IDPs: internally displaced persons; UNHCR: United Nations High Commissioner for Refugees.
a: Humanitarian emergency IDPs are displaced due to disaster and conflict and violence. Refugees reflected here are those recorded under UNHCR mandate and other people in need of protection based on country of origin.
b: The top 10 countries with the most IDPs due to humanitarian emergencies and refugees are shown.

Source: *World malaria report 2024 (7)*

The response to malaria or a malaria epidemic differs depending on whether the setting is non-emergency or emergency, and also varies across different types of emergencies. There are three major malaria emergency scenarios:

- malaria in humanitarian emergencies in moderate to high transmission settings (non-epidemic)
- malaria epidemics in humanitarian emergencies
- malaria in the context of other public health emergencies.

In emergency situations in moderate to high transmission areas, the incidence of malaria may not substantially increase, but there may be an elevated risk of severe illness and death due to the disruption to established health care and vector control interventions.

A malaria epidemic exists when the incidence of cases in an area rises rapidly and markedly above its usual (or seasonal) level or when there is an outbreak in an area where malaria was not previously present. Often the threshold 75th percentile above cases in the last three to five years is taken as cut-off line for identifying malaria epidemic. The WHO malaria surveillance, monitoring and evaluation reference manual describes various simple calculations and thresholds for early detection of malaria epidemics *(18)*. Early detection enables appropriate control or response measures to be accelerated.

Even though in recent years, the geographical scope of humanitarian emergencies has greatly expanded within the Middle East and eastern Europe, most protracted humanitarian emergencies are in sub-Saharan Africa, which accounts for more than 90% of malaria cases and deaths, for the reasons outlined in Section 1.2.

1.4.1 Malaria epidemics in non-emergency situations

Malaria epidemic-prone areas are inhabited by populations without previously acquired immunity. For example, a population may lack immunity because they live in an area at a high altitude that is too cold for proper parasite development within the mosquito. These areas are not necessarily malaria-free anymore, as malaria has been reported in areas up to 2000 m and at higher altitudes in rare cases *(19)*. Populations living in areas that are naturally too arid for mosquito breeding will not develop immunity, while populations in areas that have experienced droughts for two or more consecutive years may have lost their acquired immunity.

For a malaria epidemic to occur, conditions must be suddenly favourable for transmission. This can arise from heavy flooding after long droughts (e.g. Pakistan in 2022), increasing temperatures at high altitudes due to extreme climatic events *(20)*, an influx of people carrying malaria parasites from moderate to high transmission areas into an area of low or unstable transmission, or a non-immune population moving from a low transmission area to a moderate to high transmission area. A combination of these is also possible.

Malaria epidemic preparedness and response in non-emergency situations should be implemented by national malaria control programmes (NMCPs) in line with the WHO malaria, monitoring and evaluation reference surveillance manual *(18)*.

1.4.2 Malaria in humanitarian emergencies in moderate to high transmission settings (non-epidemic)

Malaria is often the biggest contributor to illness and death during humanitarian emergencies, especially in sub-Saharan Africa where humanitarian emergencies often occur and persist within high transmission areas *(21)*.

Large population displacements typically result in reduced or lost vector control interventions and disruption of essential health services, including access to early malaria diagnosis and treatment. In emergencies, malaria control should be prioritized – regardless of whether the disease is classified as epidemic or non-epidemic – to prevent avoidable illness and death, especially among children, pregnant women and non-immune populations who are moving from highlands to endemic areas, as was the case for IDPs in northern Ethiopia in 2021 *(22)*.

In responding to emergencies, it is imperative to anticipate and mitigate risks. In emergencies in high transmission settings, the number of malaria cases may not increase significantly beyond seasonal variations but could lead to high numbers of malaria deaths and all-cause child mortality among non-immune populations.

1.4.3 Malaria epidemics in humanitarian emergencies

Malaria outbreaks can easily occur in IDP or refugee settlements in moderate to high transmission areas, where modification of the environment (e.g. construction, stagnant pools of water, poor waste management, crowding) creates favourable conditions for mosquito breeding and malaria transmission.

The use of malaria epidemic thresholds *(18)* helps understand case numbers in the context of usual and seasonal levels and can help identify and respond to an epidemic early. However, typical malaria outbreaks cases often escalate rapidly and are evident in the number of outpatients at one or several health facilities or by the increase of hospitalizations in severe cases.

1.4.3.1 Comorbidities

Malaria and comorbidities in emergencies result in high all-cause child mortality. Malnutrition, particularly acute malnutrition, compromises natural immunity, increasing susceptibility to infectious diseases, especially in children. Malaria and other infectious diseases can aggravate or precipitate malnutrition through decreased appetite and food intake, vomiting, diarrhoea, malabsorption and nutrient loss in the face of increased metabolic needs. Malnutrition is, in the latter sense, not simply a consequence of inadequate food supply but a result of recurrent infections that may cause anaemia and other conditions, leading to increases in all-cause child mortality. This vicious cycle of malnutrition and disease has been well documented for many years and highlights the importance of a comprehensive and multisectoral approach to managing acute malnutrition.

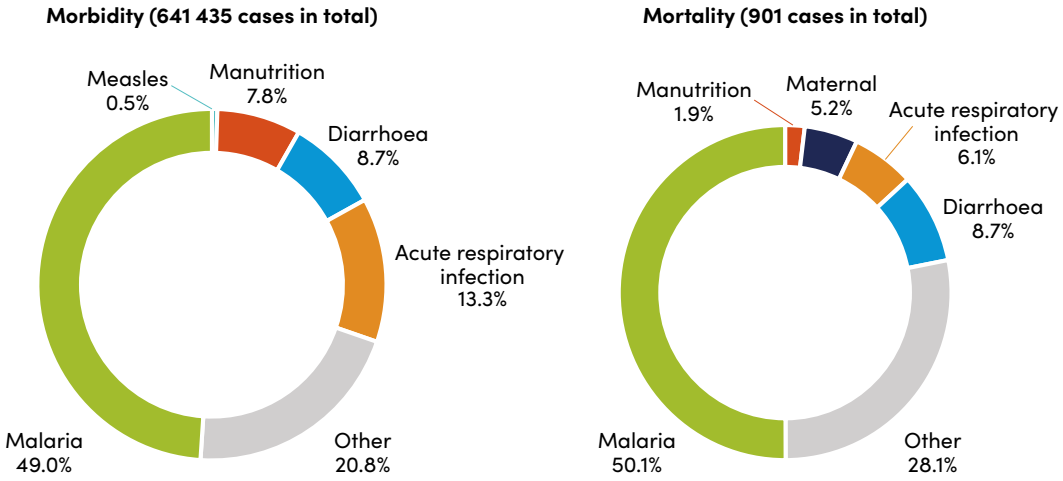
- Children under 5 years and pregnant women are at particularly high risk of developing severe malaria due to their naturally low immunity, which malnutrition, measles and other common infections may further decrease.
- Children with severe acute malnutrition (SAM) have compromised immunity and, hence, are vulnerable to severe malaria and other infections and death.

Malaria can lead to a high mortality rate in children with SAM. Another consequence of their compromised immunity can be that they may not always mount a fever response and so in malaria endemic areas, SAM children with generalized signs of being unwell (including hypothermia) should be routinely tested for malaria.

- Accessing appropriate preventive and curative paediatric care as well as measures such as sleeping under ITNs is important to limit the severity of prevent malaria in children; however there is evidence that these measures can also contribute towards preventing acute malnutrition, thus interrupting the vicious cycle of infection and malnutrition *(23)*.
- In humanitarian emergencies, comorbidities of malaria and SAM are a common phenomenon in children, leading to high child mortality. This is often exacerbated by increased rates of diarrhoeal illness and acute respiratory infections such as pneumonia, also prevalent in many humanitarian emergencies. Unfortunately, in some emergencies, these multifactored diagnoses are identified too late or not appropriately managed, including due to lack of ITNs, the disruption of essential health services, inadequate knowledge and skills of health workers (including community health workers [CHWs]), or lack of medical commodities and supplies. A key driver of acute malnutrition is the seasonality of livelihood systems given that they directly impact food security, care and health behaviours and outcomes *(24)*. Therefore, understanding the trends of child wasting in food insecure and fragile contexts and the seasonality of the relevant livelihoods in addition to the seasonality of malaria is key when designing integrated programmes.
- Children aged under 5 years who present with suspected malaria should also be screened to identify and properly manage SAM in line with the WHO growth standards *(25)*.
- Children aged under 5 years with acute malnutrition who present with uncomplicated *P. falciparum* malaria may be at higher risk of delayed parasite clearance, artemisinin-based combination therapy (ACT) treatment failure and reinfections. This is because acute malnutrition impacts medicine absorption and metabolism *(26)*.
- Children with SAM and any signs of severe malaria should be referred for inpatient management for both malaria treatment and appropriate nutritional treatment. Children with SAM and malaria without any signs of severity can be treated as an outpatient but with close follow-up and a low threshold to refer for inpatient care if there is no improvement in their clinical condition *(27)*.
- Children with moderate acute malnutrition should be screened and treated for malaria as per children without acute malnutrition (with the same admission criteria used for inpatient care) but as they have higher total energy requirements than children without acute malnutrition, an assessment must be made if they can likely meet those needs through their home diet or if they will need nutritional supplementation; especially to fully recover from episodes of illness such as malaria and to prevent further deterioration of their nutritional status to SAM.
- It is important to include school-aged children, who are also a high-risk group for malnutrition and malaria in multisectoral interventions *(28)*.

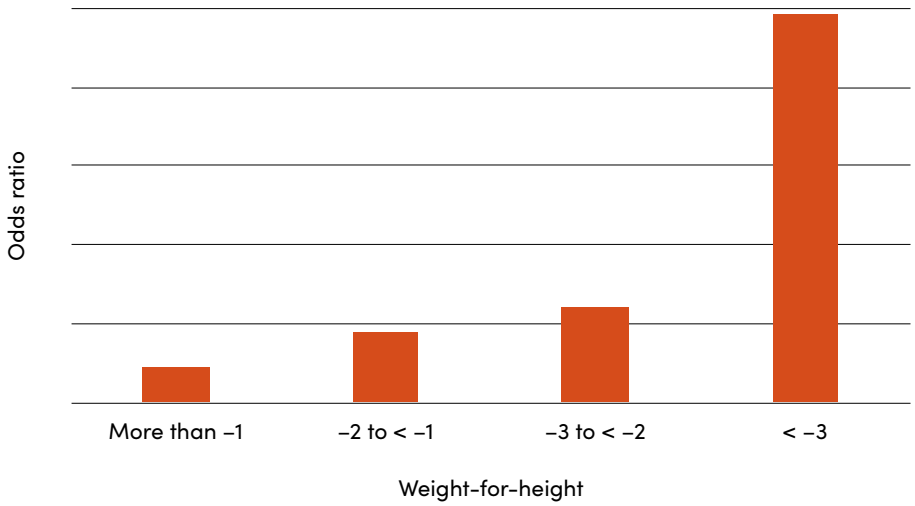
Fig. 8 shows the causes of morbidity and mortality during the humanitarian emergency in Borno State, Nigeria. Fig. 9 presents the odds ratio for mortality from all causes by weight for height for children aged under 5 years.

Fig. 8. Cross sectional survey on all causes of morbidity and mortality (10–16 October 2016), humanitarian emergency in Borno State, Nigeria



Source: adapted from UNHCR , 2016 *(29)*

Fig. 9. Odds of all-cause mortality by weight for height for children under 5 years



The reference category is children with a weight-for-height < –1 standard deviation.
Source: adapted from WHO and UNICEF, 2009 *(25)*.

Consequently, to reduce child mortality rates in humanitarian emergencies, the malaria control programme must identify – in consultation with the emergency nutrition stakeholders – the areas with high transmission in which acute malnutrition is highest, and the seasonal peaks of both malaria and acute malnutrition, to design timely, integrated and risk-informed programmes. Information from the Integrated Food Security Phase Classification or the latest nutrition survey data (if an Integrated Food Security Phase Classification exercise has not been conducted recently) can help prioritize malaria-specific emergency response measures for populations at the highest risk of mortality to reduce malaria-related child mortality during humanitarian emergencies *(30)*. Nutrition surveys or surveillance data can also help prioritize communities at risk.

The child mortality rate among the affected population must be closely monitored to assess the level of the crisis, ensure an optimal humanitarian response and, in particular, coordinate with other child health services due to the increased vulnerability of children with SAM to other conditions, such as diarrhoea and pneumonia, to ensure comprehensive services are offered and multiple diagnoses are not missed.

1.4.4 Malaria in the context of other public health emergencies

The initial clinical symptoms of malaria – fever, myalgia, vomiting and headache – are similar to the presentation of many other infectious diseases, including dengue, chikungunya, meningitis, yellow fever, COVID-19 and Ebola. Many of these infectious diseases also occur in malaria endemic areas, making it important to ensure appropriate diagnosis and treatment in the area experiencing a public health emergency.

In high malaria transmission settings, the main cause of fever is usually malaria and, if applied, the protocol for the management of fever should ensure a differential diagnosis for other possible causes. Positive microscopic or rapid diagnostic test (RDT) cases in high transmission settings (particularly among older children and adults) do not necessarily indicate a symptomatic malaria case, as this group will have had the opportunity to acquire immunity.

Coinfection of malaria with other infectious diseases is common in moderate to high transmission areas. It could lead people with asymptomatic malaria to develop a clinical form of the disease because of compromised immunity (parasitaemia increase). The response should, therefore, ensure the capacity for preventing, diagnosing and managing malaria, including uncomplicated and severe malaria and coinfection.

In low transmission settings, the main cause of fever is unlikely to be malaria and other possible causes should be investigated.

Any person with a fever and a positive malaria RDT must receive a full curative course of antimalarial treatment. This will increase the chances of survival.

In summary, malaria within the context of a public health emergency has a two-pronged focus – to contribute to outbreak control efforts and ensure the continuity of malaria control to sustain previous gains. Case study 1 is an example of a plan implemented by the Uganda malaria control programme during the 2022 Sudan Ebola outbreak (Sudan Virus Disease). It illustrates the integration of malaria within the different pillars of response.

1.5 Conducting a malaria risk assessment

Preliminary malaria risk assessment of the target population for emergency response is important, given the widespread prevalence of malaria, especially in sub-Saharan Africa.

The two main considerations for the assessment of the malaria risk in a humanitarian emergency are:

- the intensity of present and future malaria transmission in the emergency area
- the malaria immunity status of the populations affected by the emergency.

Depending on the local situation, four major outcomes are possible:

- high transmission and low immunity, resulting in an immediate risk of malaria epidemics;
- high transmission and high immunity, where only children, pregnant women and non-immune displaced people are at risk;
- low transmission and low immunity, with a moderate risk of local malaria outbreaks but only during the rainy season; and
- low transmission and high immunity among IDPs, with only sporadic malaria cases among IDPs, but a risk of a malaria epidemic affecting all age groups of the non-immune host population.

The risk assessment exercise needs to consider evidence of new or emerging risks related to expanding drug resistance, impacts of climate change and other factors.
Use the stepwise approach in Table 2 to conduct a malaria risk assessment.

Table 2. Malaria risk assessment: key steps and action considerations

Step	Key assessment questions	Epidemiologic features and key considerations	Remarks and action points
1. Assess malaria transmission in the emergency-affected area	Is there active malaria transmission in the emergency-affected area? What is the historical malaria burden in the region?	• In high-burden areas, a significant proportion of febrile illnesses may be due to malaria (consult Figure 1 and 2). • In low-burden areas, most febrile illnesses may have alternative causes, such as respiratory infections or typhoid.	• Confirm malaria transmission through epidemiological data from, recent surveillance reports, and entomological assessments. • Deploy malaria team with RDTs to verify malaria presence among suspected cases.

Step	Key assessment questions	Epidemiologic features and key considerations	Remarks and action points
2. Classify transmission intensity	Is the emergency area in a high, moderate, or low malaria transmission zone? Is the population coming from areas of different transmission levels?	• >90% of malaria cases and deaths occur in sub-Saharan Africa, where many humanitarian emergencies also take place. • In moderate and low transmission settings, epidemics can arise when transmission is reintroduced.	• Use national malaria maps, epidemiological reports, and WHO malaria transmission classifications. • If data are unavailable, conduct a rapid malaria prevalence survey in displaced populations.
3. Identify high-risk populations	Which groups are at the highest risk of severe malaria and mortality?	High transmission areas: • Children under 5 years, pregnant women, displaced individuals from low-transmission zones. Low transmission or epidemic-prone areas: • All age groups due to lack of immunity. Other high-risk groups: • Malnourished children, people with coexisting diseases (e.g., HIV/AIDS, tuberculosis), marginalized groups, and individuals with reduced immunity. • Those living in overcrowded settlements or shelters with high mosquito exposure.	• Identify whether displaced populations have been previously exposed to malaria. • Prioritize high-risk groups for preventive interventions (e.g., SMC, ITNs, chemoprevention). • Consider interactions with other outbreaks (e.g., measles, cholera, dengue) that may increase malaria vulnerability.
4. Determine seasonal transmission patterns	Is malaria transmission seasonal or perennial? When do the rains come, and how long does the peak transmission season last?	• Seasonal malaria transmission results in peak case surges during and after the rainy season, requiring timely interventions such as SMC. • Perennial transmission leads to cases throughout the year, though seasonal peaks still occur.	• Use local meteorological data, historical surveillance and rainfall patterns, and satellite precipitation models to anticipate malaria trends. • Stockpile essential malaria commodities (e.g., RDTs, ACTs, ITNs) in advance of seasonal peaks.

Step	Key assessment questions	Epidemiologic features and key considerations	Remarks and action points
5. Assess population displacement risks	Are displaced populations moving between high and low transmission areas? Are they transiting through high-risk areas?	Movement from low to high transmission zones: • High risk of severe malaria and mortality due to lack of acquired immunity. Movement from high to low transmission zones: • Can introduce malaria into previously low-risk populations, leading to localized outbreaks. Risk factors for malaria transmission: • Mass displacement into areas with limited vector control. • Lack of malaria awareness among non-immune populations.	• Deploy MDA of SMC in high-risk groups in transit or upon arrival. • Monitor imported malaria cases in newly affected low-burden areas and respond.
6. Evaluate shelter and vector control access	Do affected populations have adequate shelter and malaria prevention measures (e.g., ITNs, IRS-treated shelters)?	• Inadequate housing increases exposure to mosquito bites, particularly at night. • In camps or temporary settlements, lack of IRS, ITNs, and protective clothing elevates risk. • If ITNs were distributed over two years ago, efficacy may be reduced due to wear and tear.	• Conduct emergency ITN distribution in high-risk areas (if shelter is available). • Assess feasibility of IRS campaigns in temporary shelters. • Promote household-level vector control (e.g., repellents, screening of shelter openings).
7. Assess potential for increased malaria vector breeding	Have environmental changes (e.g., flooding, hurricanes, deforestation) increased stagnant water and mosquito breeding?	• Floods, heavy rainfall, and disruptions to drainage systems create new breeding grounds for *Anopheles* mosquitoes. • Post-flood settings require urgent LSM.	• Conduct entomological assessments to evaluate mosquito population density. • Mobilize community-based LSM activities (e.g., drainage clearing, larviciding). • Consider targeted IRS in flood-prone areas.

Step	Key assessment questions	Epidemiologic features and key considerations	Remarks and action points
8. Assess impact on routine malaria services	Have malaria diagnosis and treatment services been disrupted? Are health workers and CHWs still operational?	• Conflict, insecurity, and natural disasters often lead to health facility closures, supply chain breakdowns, and workforce attrition. • In some emergency settings, CHWs can sustain malaria care through integrated community case management (iCCM).	• Deploy mobile malaria teams in areas with disrupted services. • Ensure sufficient RDTs, ACTs, and parenteral artesunate are prepositioned.
9. Evaluate surveillance capabilities	Can malaria surveillance systems function during the emergency? What data gaps exist?	• Surveillance may be compromised due to disruptions in data collection, reporting structures, and access to health facilities. • Missed or delayed reporting leads to underestimation of the true malaria burden. Displaced people do not represent the local population.	• Integrate malaria case tracking into emergency disease surveillance. • Utilize digital and community-based reporting tools to compensate for facility-based data loss.
10. Overall evaluation of the emergency response	How were the speed of intervention, impact on cases and deaths, the adequacy of resources, and the integration of malaria control efforts within broader emergency health responses?	• Timeliness and impact of the response in reducing transmission and averting deaths • Adaptability to evolving conditions of the emergency • Coordination and integration with other health services	• Conduct periodic evaluations during and after the emergency. • Document lessons learned to improve ongoing or future responses. • Include feedback from affected communities in evaluations.

When including malaria control in emergency response efforts, several factors should be considered to select the most appropriate interventions for reducing mortality. These include:

- immediate responses for individual patient survival
- addressing high-risk groups
- effectiveness of interventions in reducing mortality
- speed of intervention delivery
- operational feasibility of reaching high-risk groups
- logistics for scaling up preventive and life-saving interventions within emergency responses.

Urgency in malaria emergencies is affected by transmission intensity, access to care and available supplies. The speed of intervention hinges on preparedness.

Initial focus should be on saving lives and protecting the vulnerable, then gradually reinstating comprehensive malaria control efforts. Decisions on actions should consider effectiveness, operational challenges and costs. It is necessary to address local hurdles, such as security, and explore partnerships with organizations that aid high-risk groups to ensure effective delivery of services.

Specific interventions are described briefly below and key malaria response actions in emergency settings are summarized in Table 3. These interventions are described in more details in Chapters 3, 4 and 5.

Table 3. Summary of priority malaria response actions in emergencies

Area of intervention	Action
Case management	
Testing (RDT and microscopy)	Strengthen case management by providing RDTs and microscopy for accurate diagnosis.
Treatment for *P. falciparum* malaria	Ensure access to quality assured ACTs (QAACTs), including doses of rectal and injectable artesunate for severe malaria.
Treatment for *P. vivax* malaria	Ensure access to radical treatments for *P. vivax*, including primaquine where appropriate.
Chemoprevention	
Mass drug administration (MDA)	Implement MDA for at-risk populations within a determined catchment area, ensuring proper dosing, coverage, and surveillance.
Seasonal malaria chemoprevention (SMC)	Implement SMC for eligible children during high transmission periods, ensuring proper dosing and coverage.
Vector control	
Indoor residual spraying IRS	Assess feasibility of conducting IRS in the emergency setting, considering logistics, safety and access.
Insecticide-treated net (ITN)	Evaluate behavioural and sleeping space suitability for hanging ITNs, ensuring communities are aware of proper use and maintenance.
Larval source management (LSM)	Target mosquito breeding sites, especially in displaced populations and temporary settlements where traditional vector control measures like IRS and ITNs may be insufficient or impractical.

1.5.1 Case management

In emergencies, establishing quick access to malaria diagnosis and treatment is vital. In areas in which services are interrupted, re-establishing or expanding case management is a priority when health services are inaccessible. Utilizing mobile clinics and CHWs helps bridge the gap. Mapping functional health facilities and budgeting for diagnostic tests and drugs are essential. Prioritizing the supply of malaria RDTs and ACTs, including for the management of severe cases, is critical. Adequate stock for treatments and tests should be based on transmission levels and the size of the population affected. Treatment alone is not enough to reduce overall morbidity; vector control and chemoprevention are also necessary.

1.5.2 Chemoprevention

1.5.2.1 Mass drug administration

Mass drug administration (MDA) is a crucial response to drastically reduce transmission and avert mortalities during malaria outbreaks and in the early phase of emergencies, serving as an effective measure even when vector control methods are in place. MDA for malaria involves the large-scale distribution of antimalarial medications to populations in endemic areas, regardless of whether individuals show symptoms of malaria, along with low-dose primaquine to halt transmission. Targeted MDA for children aged under 5 years, followed by monthly chemoprevention, is vital in high-transmission areas to prevent excess mortality. The cost–effectiveness of the MDA should be viewed in relation to the significant role it plays in saving lives during emergencies. MDA is highly effective if antimalarial medicines have been pre-positioned and implemented early enough at high coverage (> 80%).

1.5.2.2 Seasonal malaria chemoprevention

Seasonal malaria chemoprevention (SMC) involves administering periodic antimalarial treatment to children during the high malaria season to clear existing infections and prevent new ones, especially in regions with highly seasonal transmission. SMC could be a crucial intervention during acute crises if antimalarial medicines are pre-positioned, offering rapid intervention by swiftly reducing malaria cases in emergency situations with high transmission rates.

1.5.2.3 Perennial malaria chemoprevention

Perennial malaria chemoprevention (PMC), formerly known as IPTi, involves giving full antimalarial courses at set intervals to children in moderate to high malaria transmission areas, regardless of their current malaria status. PMC seeks to protect children aged 12 to 24 months from severe malaria by maintaining preventive drug levels in their bloodstream to clear and prevent infections during high-risk periods.

1.5.2.4 Intermittent preventive treatment for malaria in pregnancies

Intermittent preventive treatment for malaria in pregnancies (IPTp) involves giving antimalarial medication at specific intervals during pregnancy to reduce risks to both mother and baby. The updated recommendation advocates for using sulfadoxine-pyrimethamine (SP) in the second and third trimester of the first and second pregnancies. Gravidity, malaria transmission intensity and SP resistance are considered for optimal effectiveness.

1.5.2.5 Post-discharge malaria chemoprevention

Post-discharge malaria chemoprevention (PDMC) is the administration of a full antimalarial treatment course at regular intervals to children admitted with severe anaemia. The purpose of PDMC is to prevent new malaria infections in children admitted with severe anaemia during the period after hospital discharge when they are at high risk of readmission or death.

For protracted emergencies where sustained preventive measures are required, PMC, IPTp and PDMC are more suitable in moderate to high transmission settings, ensuring continuous chemoprevention for the vulnerable target population.

Case study 1. Responding to malaria upsurges during the Ebola outbreak in Uganda, September 2022 to January 2023

In September 2022, Uganda's Ministry of Health declared an Ebola outbreak in Mubende District caused by the Sudan Virus Disease (SVD). The outbreak spread to nine districts, with 142 confirmed cases and 55 deaths. Simultaneously, a malaria epidemic affected 70 districts, including the Ebola epicentre, and over half of the children with Ebola had malaria coinfections, many with negative outcomes. Overlapping symptoms of the two diseases often led to misdiagnoses, compounding the pressure on the health care system. Fear of Ebola and lockdown measures further reduced access to essential health care services, including malaria prevention and treatment.

In response, Uganda's health authorities implemented key mitigation measures that are vital for countries experiencing dual outbreaks of malaria and Ebola or a similar infectious disease. To ensure continuity of malaria prevention, they distributed ITNs to vulnerable groups, including people with suspected and confirmed Ebola, health workers and responders; conducted IRS in health facilities and Ebola treatment centres; and conducted LSM in communities. Chemoprophylaxis was provided for at-risk populations such as patients with sickle cell disease, non-immune travellers and health workers. MDA was carried out in areas within 5 km of confirmed Ebola cases, with the first dose observed and subsequent doses delivered door-to-door by CHWs.

To ensure that Ebola case management appropriately considered malaria risk, health workers and CHWs were trained to screen for both diseases and offer presumptive malaria treatment. Severe malaria cases were treated three doses of intravenous (IV) artesunate, switching to IV quinine, if necessary, with follow-up treatment upon discharge. Health workers and CHWs were expected to observe strict infection prevention and control measures as transmission often happened while providing routine care in health facilities and the community, outside of Ebola treatment units.

Strengthening coordination between malaria and Ebola response teams ensured alignment in messaging and technical support for the response to both outbreaks. Monitoring and timely sharing of malaria surveillance reports optimized malaria interventions within the Ebola response framework. Social behaviour change/risk communication and community engagement played a vital role in promoting the importance of early diagnosis and the use of ITNs, stressing that malaria, though less feared, kills more people than Ebola. Logistics teams ensured the continued availability of essential malaria commodities and supported frontline providers in forecasting and ordering malaria supplies to avoid stockouts and programmatic disruption. This comprehensive strategy helped effectively mitigate the impact of both diseases amid the dual malaria and Ebola crises.

Source: Uganda Ministry of Health, Public Health Emergency Operations Centre and NMCP (unpublished data).

1.5.3 Vector control

In emergencies, swift treatment saves lives in malaria cases but does not reduce transmission. Therefore, vector control plays a critical role, especially in crowded settlements where high transmission levels can lead to severe disease burdens. Implementing WHO-recommended strategies such as IRS or distributing ITNs is vital to combat malaria.

- IRS swiftly reduces local transmission by spraying insecticides on shelters' interior surfaces. Effectiveness is influenced by walling materials and insecticide choice.
- ITN distributions aim for universal coverage to protect individuals, even before shelters are fully established, but timely supply and correct usage is crucial for their effectiveness.
- LSM may be necessary in crowded environments to tackle new breeding sites and can be effectively implemented early in the response.
- Other vector control interventions – pending WHO recommendation – that may be used in large-scale implementation projects in emergencies include passive emanators (spatial repellents), attractive targeted sugar baits (ATSB), topical repellents, treated clothing, insecticide-treated textiles and treatment of domestic animals.

Choosing the most feasible and effective vector control method promptly is crucial. When vector control interventions cannot be deployed immediately, MDA could be considered as a temporary solution until a suitable vector control method can be implemented. For detailed guidance on WHO-recommended MDA and vector control strategies, refer to Chapters 4 and 5, respectively.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Background note for the IASC Principals, update on the "New Way of Working". Geneva: Inter-Agency Standing Committee; 2016 (https://interagencystandingcommittee.org/principals/news-public/background-note-iasc-principals-update-new-way-working).
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- RTS,S Clinical Trials Partnership. Efficacy and safety of RTS,S/AS01 malaria vaccine with or without a booster dose in infants and children in Africa: final results of a phase 3, individually randomised, controlled trial. The Lancet, Volume 386, Issue 9988, 31 – 45 (https://doi.org/10.1016/S0140-6736(15)60721-8).

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- Malaria factsheet [website]. World Health Organization; 2023 (https://www.who.int/news-room/fact-sheets/detail/malaria).

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- WHO guidelines for malaria [website]. World Health Organization; (https://app.magicapp.org/#/guideline/LwRMXj).

- Malaria Toolkit app [mobile application]. World Health Organization; (https://www.who.int/teams/global-malaria-programme/malaria-toolkit-app).

Chapter 2.
Coordination

2.1 Overview

Governments have primary responsibility for the security, health and general well-being of people on their territory. Regardless of the nature of the emergency (even during armed conflicts), the NMCP is usually able to provide oversight and technical and operational coordination of all malaria control efforts in government-controlled areas. Consequently, all emergency responders need to coordinate with NMCPs.

Likewise, NMCP managers in countries experiencing humanitarian emergencies should collaborate with emergency responders, regardless of whether they are operating under the United Nations Inter-Agency Standing Committee cluster/sector system, the UNHCR Refugee Coordination Model (which falls outside the cluster system), or a hybrid approach adapted to the specific context.

Partners provide support to governments to ensure an optimal response. In a few settings globally, there are areas outside of government control; in these areas, partners may be required to step up and lead.

The coordination of malaria and other response partners is described in this chapter and further information is available in the resources listed in the further reading.

2.2 Coordination mechanisms for malaria in emergency settings

2.2.1 United Nations-led coordination mechanisms

The primary coordination mechanisms for the international community in a large-scale emergency are led by the UN in partnership with NGOs, donors and host government authorities, and in accordance with systems set out by IASC. The Office for Coordination of Humanitarian Affairs (OCHA) is the key agency mandated to facilitate effective humanitarian coordination in an emergency, except in the case of refugees, in which case UNHCR is the mandated UN Agency for refugee protection, assistance and solutions and the Refugee Coordination Model applies.

2.2.1.1 Humanitarian coordination and the cluster approach

Humanitarian response is guided by the core humanitarian principles of humanity, impartiality, independence and neutrality, which have been adopted by more than 400 organizations globally and endorsed by the United Nations General Assembly *(31)*. The IASC is the primary mechanism for interagency coordination of humanitarian assistance under the leadership of the Emergency Relief Coordinator.

The IASC uses five criteria to assess and grade a humanitarian emergency *(32)*.

1. **Scale** considers the number of affected people and the size of affected areas.
2. **Urgency** considers crude mortality rates, access to life-saving support, the number of people displaced and critical risks to humanitarian protection.
3. **Complexity** considers the risks of politicization, lack of humanitarian access and security risks to humanitarian actors.
4. **Capacity** considers local or international response capacities and required specialized or technical expertise.
5. **Risk of failure to deliver** considers violations of human rights and international humanitarian law, exacerbation of food insecurity and deterioration of civil unrest.

Since 2005, the cluster approach has been used, to plan and organize the international response to humanitarian emergencies. This approach aims to improve the predictability, effectiveness and accountability of humanitarian responses by grouping humanitarian actors into sector-based clusters.

For new humanitarian emergencies, cluster activation will follow consultation of relevant partners by the United Nations Humanitarian Coordinator (appointed by the emergency relief coordinator) or, if a Humanitarian Coordinator has not been appointed, Resident Coordinator (who leads the United Nations country team).[1] Following the consultation process, the Humanitarian Coordinator or Resident Coordinator will then propose leads for each major area and share the proposal with the Emergency Relief Coordinator, who in turn shares it with global cluster leads. The Emergency Relief Coordinator ensures agreement at the global level and communicates agreement to the Humanitarian Coordinator or Resident Coordinator and partners within 24 hours. The Humanitarian Coordinator or Resident Coordinator then informs the host government and all partners *(33)*.

Each cluster is headed by a cluster lead agency that is tasked with facilitating a coordinated response and supporting national capacity. There are 11 clusters.

Malaria prevention and control falls under the Health Cluster, led by WHO. Effective malaria coordination should be multisectoral, involving key partners across clusters/sectors such as nutrition, water, sanitation and hygiene (WASH), shelter and protection (social protection/community-based protection). It is critical to work with national and local government departments when planning and implementing an emergency malaria control response. Existing health facilities and national staff play an important role in any response and are often best placed to deliver emergency health care, with international support. National nongovernmental organizations (NGOs), faith-based organizations and community groups are important partners in an emergency response, particularly after the acute phase. Local, IDP and refugee communities have important skills, influence and cultural understanding, which may be lacking in the international humanitarian community. It is important to identify existing capacity as soon as possible and work together.

Note that in refugee settings, the cluster approach is not activated, and UNHCR is the lead agency for cross-sectoral coordination, including coordination of health response.

1 It is possible that an existing Resident Coordinator may also be designated as the Humanitarian Coordinator, thereby assuming a "double-hatted" role covering both functions.

2.2.1.2 Refugee coordination model

States bear the primary responsibility for protecting and assisting refugees within their territories, including coordinating any response efforts. UNHCR is mandated to support governments in fulfilling these roles, ensuring that refugees receive the necessary humanitarian protection and assistance until durable solutions are found. The Refugee Coordination Model sets out principles and UNHCR's duties, vision and responsibilities in coordinating refugee operations. When designing an appropriate response at the country level, UNHCR takes into account the host government's approach and capacity, aiming to complement and strengthen the government's role while involving other actors, particularly local civil society, in sector leadership.

The Refugee Coordination Model is designed not only to coordinate immediate emergency responses but also to build national capacity for coordination and refugee inclusion. It is an integral yet distinct part of the broader United Nations-led coordination framework (Fig. 10) and is applicable in refugee situations, whether they involve new or ongoing emergencies, and regardless of whether refugees are in camps or settlements, rural areas, urban settings or mixed environments.

Under the Refugee Coordination Model, UNHCR leads the development, implementation and resource mobilization for interagency Refugee Response Plans (RRP). These plans, which can be country-specific or regional (addressing significant refugee influxes into multiple countries), establish a common strategy and provide host governments and donors with a comprehensive overview of the interagency response, including resource needs.

Fig. 10. United Nations-led interagency coordination landscape

Coordination mechanisms	Cluster system	Refugee system	Development system
Accountability lines	Emergency Relief Coordinator reports to the Secretary General	High Commissioner reports to the General Assembly	Reports through the chair of the UN Sustainable Development Group (Deputy Secretary General to the Secretary General)
Leadership	Humanitarian Coordinator (HC)	UNHCR representatives/ Regional Director (country and regional), Refugee Coordinator	Resident Coordinator (RC)
Inter-agency strategic plan	Humanitarian response plan (HRP)	(Regional or country) Refugee response plan	UN country team (UNCT) UN Sustainable Development Cooperation Framework (UNSDCF)
Inter-agency coordination	Inter-cluster coordination (clusters)	Refugee coordination forum & inter-sector coordination (sectors)	Programme management team Thematic working groups (thematic work groups)
Resource mobilization	Central Emergency Response Fund (CERF), country pooled	Bilateral funds, CERF, other multi-partner trust funds (MPTFs)	UNSDCF funds and other joint programme funds

Source: adapted from UNHCR, 2018 *(32)*.

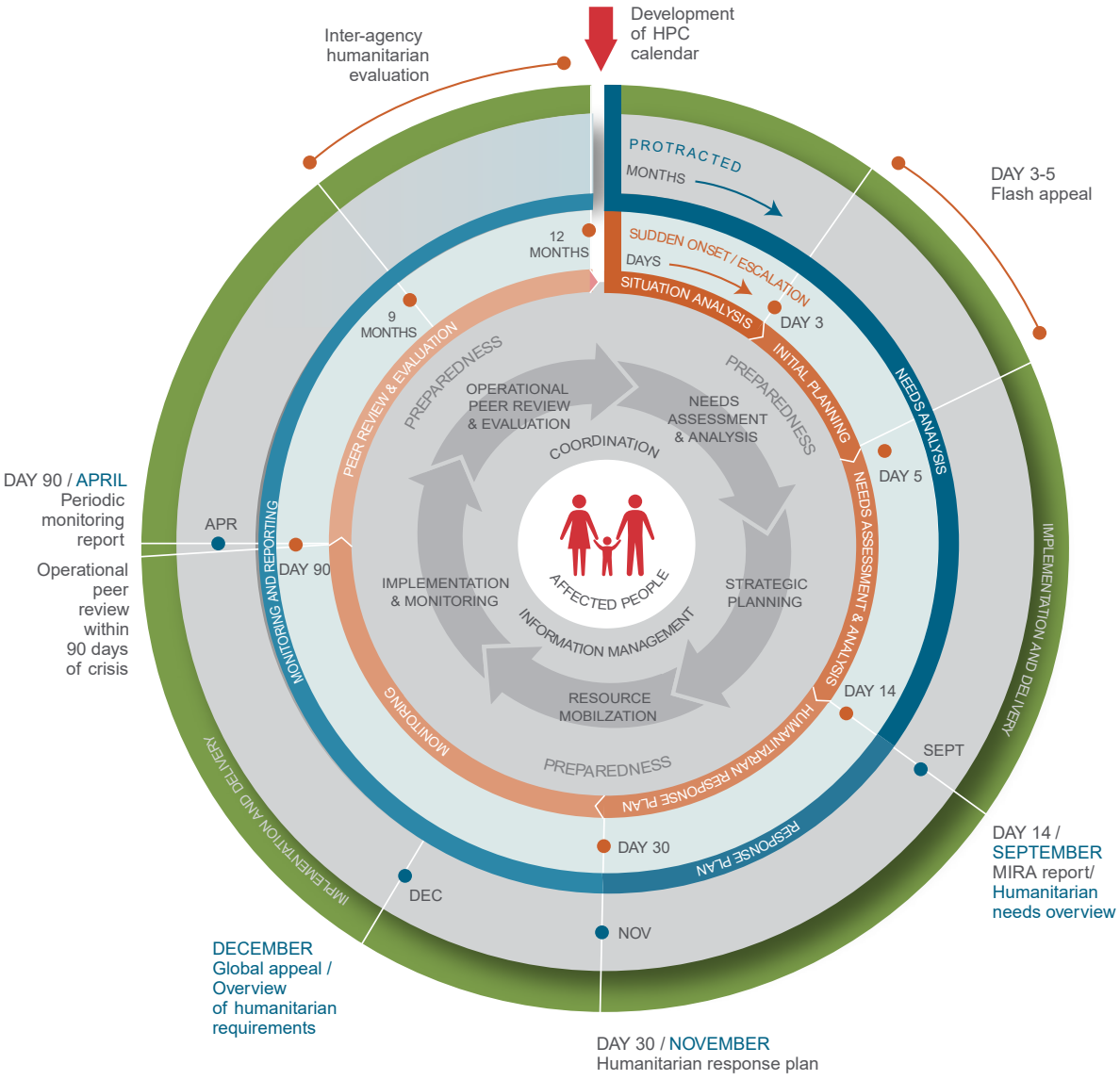
2.2.1.3 Other humanitarian processes and mechanisms

Various other processes and mechanisms are relevant to the coordination of malaria control responses in emergency settings. These are described briefly below.

A Humanitarian Needs and Response Plan (HNRP) is a multisectoral strategic plan that outlines the overall impact and needs arising from an emergency and the priorities for addressing these needs. OCHA is responsible for the broader inter-cluster coordination and overall development of the plan. WHO will usually lead the planning process for the health cluster/sector. It is important that malaria is included as a priority in the health cluster/sectoral response plan. The HNRP is closely linked to the national government emergency response plan and is usually vetted by the government.

The humanitarian programme cycle provides a framework for the delivery of aid to meet the needs of affected people quickly, effectively and in a principled manner. Fig. 11 visualizes the key elements of the humanitarian programme cycle at the core. The first inner ring represents the indicative steps in sudden onset crises or sudden escalations in existing crises. The second inner ring represents the annual planning cycle of protracted crises. The outer ring depicts the operationalization of these elements through implementation and delivery.

Fig.11. Humanitarian programme cycle



Source: IASC, 2015 *(34)*

This framework applies to all humanitarian emergencies; however, the process, timeline, tools and documents can be used flexibly. Inclusion of malaria risk analysis and needs in the humanitarian needs overview analysis is crucial to ensure malaria control is included in further humanitarian programming.

The IASC's Humanitarian System-Wide Scale-Up Protocols *(35)* are designed to address increasing humanitarian needs and ensure that organizations and partners can rapidly mobilize the necessary operational capacities and resources to respond to critical humanitarian needs on the ground. These exceptional measures are applied for a time-bound period of up to 6 months and may be exceptionally extended by another 3 months. In 2024, UNHCR likewise introduced a Refugee Emergency Response Scale-Up Protocol to ensure coherence of scale up measures across responding partners in a refugee emergency.

The WHO emergency response framework and protracted emergency framework are other examples of procedures used in emergencies that may be leveraged for malaria control. Annex 1 provides an overview of these frameworks. Other agencies have emergency response frameworks and procedures that they use for emergency preparedness and response.

2.2.2 Government-led public health emergency coordination structures and mechanisms

Country-level mechanisms are usually led by government organizations.

2.2.2.1 Public health emergency operations centres

Public health emergency operations centres are physical hubs for the coordination of information and resources to support incident management activities. They bring together partners and stakeholders from multiple sectors and agencies to facilitate a unified response. They facilitate:

- timely, event-specific operational decision-making using the best available information, policy, technical advice and plans;
- communication, coordination and collaboration with response stakeholders in a centralized location;
- collection, collation, analysis and presentation of event data and information to support planning and document progress;
- acquisition and deployment of response resources, including surge capacity, services and material support for emergency operations and responders; and
- monitoring of financial commitments and provision of administrative services for emergency operations.

Public health emergency operations centres link with subnational emergency operations centres and incident management systems. Most countries that did not have functional emergency operations centres by 2020 established them as part of their COVID-19 response.

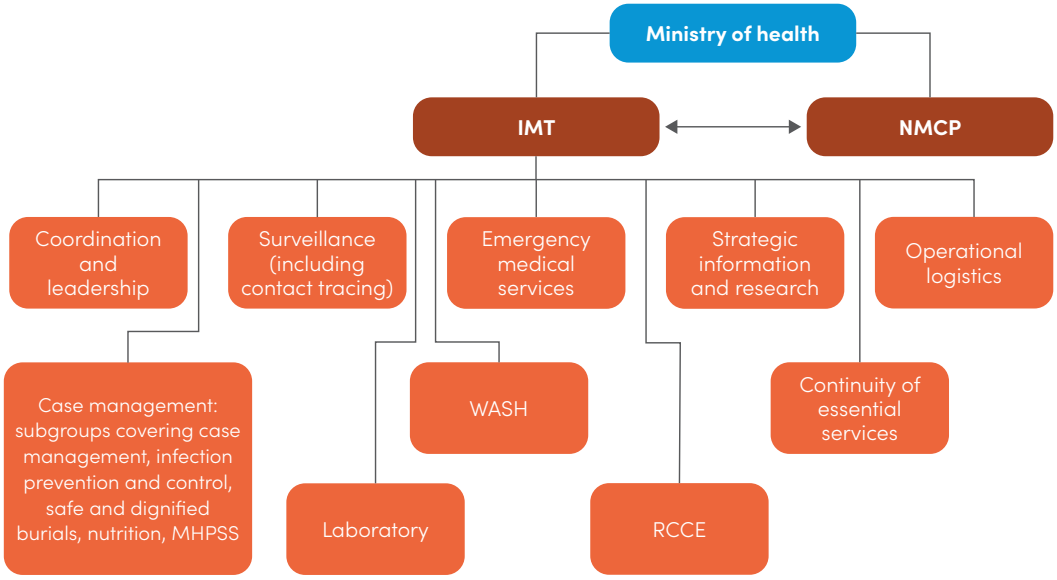
2.2.2.2 Incident management systems for public health

Lack of coordination and leadership, overlaps and poor planning can create problems during emergencies. In response, the global health community established the

incident management system as a structure for public health through the emergency management continuum of preparedness, readiness, response, recovery and mitigation. An example is presented in Fig. 12. Incident management system structures offer various potential benefits for malaria response.

- They are flexible and integrated systems that provide a common framework across levels of government and partner agencies to prepare for, respond to, recover from and mitigate the health effects of public health events.
- They have a clear chain of command, with clearly described functional roles by area. The incident manager/commander oversees interpillar coordination.
- They can be adapted to respond to different public health threats/hazards and have a clear operational period – they are activated for an acute event and deactivated when the situation returns to below a normal threshold or ends.

Fig. 12. Example of collaboration between a national incident management team and the national malaria control programme



IMT: incident management team; MHPSS: mental health and psychosocial support; NMCP: national malaria control programme; RCCE: risk community and community engagement; WASH: water, sanitation and hygiene.

2.2.2.3 National malaria control programmes

NMCPs provide strategic direction for the prevention, diagnosis, treatment and surveillance of malaria in all settings on the recommendation of their technical teams. NMCPs typically develop strategic control or elimination plans that provide a framework for all stakeholders, including in emergency settings. They work interactively with other departments, line ministries and development partners. Within the ministry of health, NMCPs typically have the following units: vector control; case management and chemoprevention; social and behaviour change/health promotion; logistics; finance and administration; and surveillance, monitoring and evaluation. Depending on national arrangements, NMCPs and incident management support teams may jointly coordinate to ensure good technical guidance, and efficient use of resources and capacities for an integrated response.

Case study 2 describes the malaria response of Médecins Sans Frontières (MSF) after Cyclone Idai struck Mozambique. MSF collaborated closely with the country's ministry of health to ensure efforts were coordinated.

Case study 2. Malaria emergency response post Cyclone Idai, Mozambique

In March 2019, Cyclone Idai struck the Beira region of Mozambique, leading to severe flooding and a high risk of malaria outbreaks in affected districts. The response of MSF in Dondo district aimed to address the immediate health needs resulting from the cyclone's devastation, particularly focusing on malaria, a major cause of morbidity and mortality in Mozambique. The large amounts of stagnant water created ideal breeding conditions for mosquitoes, significantly increasing malaria transmission. MSF provided crucial support by setting up temporary health facilities and operating mobile clinics to manage malaria cases among other conditions. These efforts were vital because the flooding had disrupted existing health services, making it challenging for the local population to access care.

To further combat the heightened malaria risk, MSF distributed 7000 survival kits containing essentials, including mosquito nets, to around 30 000 people in remote areas such as Chibuabuabua, Tundane and Savane. The intervention included a door-to-door campaign to ensure widespread coverage and protect vulnerable communities from malaria. Throughout the response, MSF worked with local health authorities to restore essential health services and rebuild damaged infrastructure, which was crucial for sustaining long-term malaria prevention and treatment efforts. Despite the challenges, including difficult access and community distrust, MSF's comprehensive response played a significant role in reducing the immediate malaria burden in the aftermath of Cyclone Idai. Fig. 13 shows an example of an MSF team working with partners to ensure availability of supplies.

Fig. 13. MSF team offload supplies transported by boat, Mozambique

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Source: Private communication Esperanza Santos, MSF Emergency Coordinator, 14 May 2019.

2.2.3 Health Cluster Emergency coordination between United Nations and country-level mechanisms

In emergencies with activated clusters, the health cluster is responsible for the coordination of malaria response activities. The health cluster will need to collaborate with the nutrition, WASH, shelter and logistics clusters and work closely with the programmes focused on development activities.

The health cluster should collaborate with the NMCP to coordinate operational aspects of malaria control, as the NMCP will already have mechanisms for collaborating with government departments and agencies. Existing health facilities and national staff play an important role in any response and, with support, are often best placed to deliver malaria interventions. Country-level coordination mechanisms should be mirrored at the subnational level.

In refugee settings where the Refugee Coordination Model (RCM) is active, the aim is to not develop parallel systems for refugees but rather to include refugees in existing national systems and programmes. This means supporting the NMCP to include refugees in their work rather than coordinating parallel programming within the refugee response Public Health and Nutrition Working Group. While additional coordination mechanisms may be required, these should be established as close to the point of delivery as possible, led by local or national actors (e.g. state authorities or civil society), and closed when their function is no longer needed.[2]

Within the context of the emergency response, health programming should also prioritize and integrate response and preventive interventions against other diseases (e.g. immunization campaigns, ITN distribution, community mobilization and sensitization activities) and essential health and nutrition actions (e.g. nutrition screening, micronutrient supplementation, (such as vitamin A), and deworming).

Concomitant factors such as water shortages, unsafe water sources, low immunization coverage, displacements resulting in poor hygiene and sanitation, and loss of access to preventive health services (including immunization) and other malaria prevention tools can further aggravate the situation. Awareness of these factors should be used to help direct priority targeting.

2.3 Planning and implementation of malaria control in emergency

Effective malaria planning requires leadership and accountability from the ministry of health/NMCP and contributions from other relevant line ministries, United Nations agencies, NGOs, civil society and other key stakeholders.

Planning involves the development of a malaria operational plan, with inputs from other teams within the response, including surveillance and monitoring and evaluation, risk communication and community engagement/social and behaviour change, finance and administration, and operational support and logistics.

2 For more guidance on RCM design, see the RCM guidance website under the "Further reading" section, which includes tools and resources for setting up and operating a refugee coordination system.

Upon completion of the malaria risk assessment (see Chapter 3), an initial strategic malaria plan should be developed and costed to guide the immediate response activities. A more detailed operational version can be elaborated on later. The operational plan specifies objectives, priorities and costed activities for malaria control in the emergency setting.

The following criteria should be considered in choosing the optimal combination of malaria interventions:

- effectiveness of selected interventions to reduce morbidity and mortality;
- operational coverage to reach high-risk groups;
- availability of essential commodities and supplies; and
- opportunities to integrate malaria control interventions within the broader emergency response and within the health system.

It is essential the population (including vulnerable groups) has sufficient access to health facilities that can provide prompt and accurate diagnosis and effective case management.

The operational plan for malaria control should match the population affected, risk groups and access to health services. Mobile teams can be used to provide outreach services to communities cut off following a natural disaster or to supplement services where facilities are damaged or not functioning, or communities are hard to reach. Additional fixed units may be required in temporary settlements or camps for displaced populations. To ensure that they are not left behind, services should also benefit host communities – through either existing facilities or mobile services.

Malaria control activities should be integrated within the activities of other clusters/sectors where possible; for example, WASH, shelter, logistics and nutrition. Partners can also provide additional human resources and surge capacity to meet health cluster/sector needs.

Table 4 outlines the steps for creating an operational plan. This process can be adapted to different contexts.

Table 4. Steps for development of a malaria operational plan

Step	Description	Remarks
1.	**Organize the planning process**	• Gather required background and baseline information, including national policy, relevant global guidance and operational environment (security). • Invite and request all stakeholders to be involved throughout the plan development process to ensure the appropriate technical assistance is available. Stakeholders include health cluster/sector, ministry of health/NMCP, NGOs, United Nations agencies and civil society. • Collaborate with other clusters/sectors covering shelter, WASH, nutrition, and logistics/supply. • Agree on the methodology for the development process, including relevant logistics.
2.	**Develop the situation analysis**	• Review available malaria epidemiology, entomology, stratification, population movement (displacement), behavioural information and others as required. • Collate data and relevant information from the multisectoral initial rapid assessment report. • Review/conduct a malaria risk assessment, ensuring that historical information is considered.

3.	**Draft the plan**	• The plan outline may include:
		  • country profile (socio-political and economic situation, demography, ecosystem, environment and climate, health systems analysis);
		  • malaria situation analysis (details in step 2, above); and
		  • framework (goal, objectives, workplan, implementation arrangements, budget, monitoring and evaluation framework).
		• Consider approaches based on not only the disease and its local epidemiology, but also the political and economic context and familiarity with control options.
		• Agree on a strategy, goal and objectives that are linked to activities, with an indication of when they will be implemented and by whom.
		• Spell out the coordination arrangements, implementation mechanism, procurement and supply (including last mile distribution) and financial resource management.
		• Quantify and determine costs based on target/or affected population.
		• Develop a budget summary by cost categories (e.g. human resources, commodities and medicines, monitoring and evaluation) that will also inform resource mobilization.
		• Map existing funding streams and available resources and identify resource gaps that need to be prioritized.
		• Develop a monitoring and evaluation framework, identifying data sources (e.g. routine data from health management information systems, integrated disease surveillance and response, surveys).
		• Describe how data will be managed, including quality assurance, warehousing, processing and communication.

4.	**Review and finalization**	• Gather stakeholders to review, refine and adopt the plan.
5.	**Implementation**	• Ensure that malaria is integrated within the broader health emergency response and is covered during periodic reporting and reviews. • Identify challenges and success stories to refine implementation.
6.	**Monitoring and evaluation**	• Refer to Chapter 8 for information on public health situation analyses, early outbreak detection, surveillance systems, and monitoring and evaluation of interventions.

2.4 Finance and administration for the malaria response

The finance and administration function provides financial management and administrative support for the malaria response. These are often internal processes of individual agencies that manage funding allocations and awards and facilitate payments. Some activities (e.g. donor proposals and reporting) may be a collaborative exercise between agencies managing the malaria response. Annex 2 provides costing templates for treatment, diagnosis, chemoprevention and vector control to facilitate robust planning.

2.4.1 Funding mechanisms

Several funding sources are available for malaria control in emergencies. Resource mobilization for malaria requires close coordination and partnership with agencies and sectors across the emergency response and integration of routine malaria activities within the HNRP or Refugee Response Plan (RRP).

Malaria response should be systematically integrated into broader emergency grading, intervention planning and costing. This will facilitate access to resources for malaria response in humanitarian emergencies and public health emergencies.

Typical funding sources for emergency malaria control are listed in Table 5.

Table 5. Snapshot of funding sources for malaria control in emergencies

	NMCP routine funding sources	Emergency funding sources
Channel	The Global Fund funding applications	Emergency appeals which may be interagency or agency-specific
Mechanism	The Global Fund U.S. President's Malaria Initiative/ United States Agency for International Development	The Central Emergency Response Fund (CERF) managed by OCHA Other emergency pooled funds Internal facilities for early response, including: • the WHO Contingency Fund for Emergencies • the UNICEF Emergency Programme Fund • Other organizations may have similar mechanisms to provide funding for initial responses.

Note: See "Resource mobilization" under "Further reading" for more details

2.4.1.1 Typical funding sources for national malaria control programmes

The primary funding sources for NMCPs in many countries are the Global Fund and the United States President's Malaria Initiative (funded by the United States Agency for International Development). Up to 10% of funds allocated by the Global Fund can be reprogrammed at the country level for emergencies, and this option should be considered in recipient countries, noting reprogramming conditions.

Other potential funding sources for malaria control include the World Bank, Multi-Donor Trust Funds and the United Nations Development Assistance Framework. These and other funding sources should be explored in-country through in-country coordination mechanisms (See "Resources mobilization" under "Further reading" for more details).

2.4.1.2 Typical emergency funding sources

The Central Emergency Response Fund is managed by OCHA to enable timely and reliable humanitarian assistance in emergencies. Applications for funding are made by sector: malaria control activities should be integrated with other health proposals.

A United Nations Flash Appeal is launched 5 to 7 days after the onset of an emergency to fundraise for the first 3 to 6 months. Malaria control activities during the acute phase of the emergency should be included in this appeal.

The Contingency Fund for Emergencies is managed by WHO to facilitate rapid response to disease outbreaks and health emergencies. Partners can be subcontracted under the Contingency Fund for Emergencies to provide immediate support, including for preparedness, readiness, assessment and response activities. UNICEF maintains an Emergency Programme Fund, which is an internal rapid response loan facility that can provide financing ahead of the receipt of broader donor support, which can be used to facilitate field response through implementing partners. Other agencies have similar internal grants or loans that may be requested for early response.

2.4.1.3 Prioritizing malaria emergency responses during financial crises

In malaria-endemic countries facing acute global or regional funding shortages, prioritization for emergency response should focus on the following cost-effective, community-driven solutions while advocating for systemic fixes to sustain progress amid crises:

1. **Prioritize life-saving tools**: sustain distribution of bed nets, diagnostics and antimalarials targeting high-transmission zones (e.g. conflict areas, IDP settlements).
2. **Local networks**: mobilize community health workers and NGOs to deliver low-cost, decentralized care.
3. **Emergency funding**: redirect domestic budgets, appeal to multilateral donors (e.g. Global Fund, EU), and pool regional procurement to reduce costs.
4. **Adaptive strategies**: use low-tech surveillance (SMS, satellite data) to track outbreaks and allocate resources dynamically.
5. **Displacement risks**: integrate malaria prevention (bed nets, chemoprevention) into humanitarian aid packages.
6. **Advocacy**: highlight the cost of inaction (e.g. drug resistance, deaths) and push for restored funding through bipartisan or public pressure.
7. **Contingency planning**: pre-position supplies in high-risk areas and strengthen cross-border coordination.

2.5 Operations support, logistics and human resources

With the increase in the number of forcibly displaced persons over time, the growing complexity of humanitarian and public health emergencies, and the large number of protracted emergencies, robust logistics and supply chain management is needed more than ever. The supply chain plays a critical role in emergency response, facilitating a rapid response by delivering required equipment, supplies and commodities in a timely and effective manner to those in need.

Managing the logistics cycle involves considering the needs of the client or customer, product selection, quantification, procurement and inventory management (storage, distribution and the logistics information system), workflow and human resources management, including supervision, budget, monitoring and evaluation.

Good supply chain and logistics management in an emergency reflects two key principles: life-saving and agility. The focus should be on high performance and efficiency, even if that comes at a greater cost.

Demand volumes, capacity for distribution and regulatory processes may be uncertain in the initial acute phase or if the population is mobile and, therefore, may have changing disease burden and demographics. Quantification may be based on consumption, morbidity data or a combination of the two.

In the context of an emergency, a logistics/supply manager needs to consider:

- the six "rights" of logistics: the right *goods* in the right *quantities*, delivered in the right *condition*, to the right *place*, at the right *time* and at the right *cost*;
- the distinction between logistics/supply chain management in the regular health system and in the context of an emergency response;
- best practices and considerations by phase of emergency; and
- available support and resources.

2.5.1 General procurement

Good procurement practices in an emergency setting are listed below.

- **Negotiate flexible procurement:** conduct comprehensive stock assessments and negotiate procurement agreements that offer flexibility in buying stock, adapting to evolving needs and market dynamics for optimal cost–effectiveness.

- **Factor in lead times and import processes:** align procurement practices with global guidelines, considering lead times and implementing contingency plans to mitigate the impact of potential delays in production, shipping and customs clearance.

- **Secure registrations and seek waivers:** navigate regulatory landscapes (market authorization), securing necessary registrations and approvals, while strategically managing waiver processes to streamline regulatory pathways for efficient product introduction. The ministry of health may be able to provide waivers from the usual requirements of customs authorities, regulatory authorities and state operators in the supply chain space. This can help avert potential bottlenecks created by usual regulatory, supply chain and tax processes.

- **Receive and inspect supplies upon arrival:** receipt and inspection of supplies should be done as soon as possible. Supplies that cannot be checked upon receipt should be quarantined until the inspection is done.

- **Develop a detailed importation plan:** a detailed plan for customs clearance should focus on ensuring accurate documentation and collaborative coordination with authorities to expedite the importation process.

- **Optimize transport and storage:** delivery of supplies will often involve reliance on infrastructure that may not be functioning optimally or may have been destroyed. Optimize transportation routes, secure suitable storage facilities, and implement robust tracking mechanisms to ensure timely and secure delivery of supplies and maintain supply chain visibility throughout.

- **Ensure effective use of supplies:** implement training programmes for proper product application, establish monitoring and evaluation systems for ongoing effectiveness, and engage local communities to foster awareness and adherence.

- **Manage waste disposal:** adhere to environmentally responsible disposal practices, explore recycling opportunities and develop comprehensive plans for the proper disposal of expired or obsolete products, considering the ecological consequences of different approaches.

- **Manage delays in receiving supplies:** delays in accessing funding, supply chain shortages and disruptions may have a knock-on effect, causing delays in delivery of supplies. Different agencies have ways to overcome these problems, including borrowing from neighbouring countries (this may not apply to borrowing pharmaceuticals unless both countries are members of a free trade area), borrowing from interagency regional supplies, and putting in place or using an existing system to rapidly access contingency supplies from manufacturers.

- **Manage donations:** though well meaning, many donations of supplies may not be aligned with local drug and commodity policies, may not meet minimal quality criteria, and may strain the system because of lack of space, human resources and disposal/waste management requirements. The logistics technical working group, ministry of health, and regulatory and other relevant offices and partners should adapt and implement the WHO generic guidance on donations of medicines and medical devices *(36)*.

Across all processes, coordination is crucial. Logistics coordination is critical for preventing potential overlaps and wastage, and for ensuring collaboration to ensure smoother delivery of goods and services. Coordination may be done via the health working group of the logistics cluster (if it has been activated) or a logistics technical working group coordinated by the government or partners.

2.5.2 Safety and security

In areas with threats to safety or security, specific approvals may be required for the movement of staff and goods. Negotiations may be through the ministry of health with the ministry responsible for internal affairs, with the military or with non-state parties. Obtaining approvals may require centralized coordination through United Nations Civil–Military Coordination (led by OCHA) and with NGOs *(37)*.

It is important to ensure the safety and security of staff in areas affected by conflict. Many partners designate security focal points from among the logistics team. These focal points should normally coordinate across agencies to ensure the latest information is available and used to inform planning of staff and supply movements. Orientation must be provided to all staff deployed to such areas both before they arrive and upon arrival to ensure that they understand how to keep safe and follow local security procedures.

In many conflict-affected areas, a humanitarian access snapshot helps to keep partners updated about where security incidents have been reported. The OCHA website is one source of humanitarian access updates *(38)*. Various partners maintain databases of attacks on health care to advocate for the protection of the medical mission as well as to keep responders informed about ways to protect themselves *(39, 40)*.

2.5.3 Logistics plan

The logistics function ensures the timely and efficient provision of supplies and equipment to support the malaria response. Working with the logistics cluster/sector or technical working group is key to ensuring effective and coordinated operational support, including elements related to transport, warehousing, procurement and supply chain management.

The logistics (or supply) plan should be developed with partners responsible for health, WASH and shelter and should be appended to the malaria operational plan.

In preparing the logistics plan, it is important to consider the following points.

- **Sufficient stock:** the logistics plan should include planning for sufficient stock of essential laboratory and diagnostic supplies (including RDTs and microscopy), case management and treatment supplies (antimalarials, fluids, consumables), vector control interventions (ITNs, insecticide, protective clothing) and health education materials (see Annex 2 for templates for quantification and costing).

- **Availability of kits**: interagency emergency health kits are standardized to provide for the basic health needs of 10 000 people for 3 months in emergency contexts *(41)*. The kit includes two types of units dedicated to malaria management. The malaria unit in the basic module includes RDTs, oral treatments and items for disposal logistics. The malaria unit in the supplementary module contains extra treatments and specialized supplies tailored for hospital use.

- **Pre-positioning of stock:** stock should be pre-positioned regionally or in countries at high risk of malaria outbreaks or with access challenges.

- **Storage space:** supplies for some malaria interventions, such as IRS and ITNs, require significant storage space (see Section 5.2.2).

- **Medical stock management system:** a system should be developed to manage the storage of diagnostics, medicines and other medical stock. Guidance is available in the WHO guidelines on good storage and distribution practices of medical products *(42)*.

2.5.4 Human resources

During the acute phase of emergencies, national capacity may be weakened and health services are often unable to cope with the scale of response required. There is often a lack of the malaria technical skills required to ensure the delivery of interventions in difficult and challenging situations.

A key part of responding to malaria in an emergency is to ensure the deployment of sufficient technical expertise to ensure an effective response. The human resources function ensures sufficient malaria expert staff are available for effective assessment and operational response. Strong technical input is required for all components of the malaria operational response, including risk assessment, surveillance and early warning, information management, social behaviour change, planning, health operations, logistics and finance and administration.

Adequate staff training on health emergency response, including specific malaria in emergency components, is essential during an emergency. Appropriate training should therefore be organized.

The following experts must be deployed in the field immediately when an emergency is declared; for example, an epidemiologist, a vector control expert and skilled health workers to manage uncomplicated and severe malaria. The Global Outbreak Alert and Response Network is a WHO network of more than 250 technical partners, institutions and academia that respond to public health events and emergencies by deploying technical staff and resources to affected countries *(43)*. This network may be mobilized on request to support various specialized elements of malaria control, including clinical care, vector management and others. With its wide geography and range of partners, many specialists may be mobilized even at the subregional level.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

Coordination

- Clark-Ginsberg A, Fisher H, Awan J, Rico A, Thomas T, Rose D et al. Conceptual framework for understanding incident management systems during public health emergencies. Disaster Med Public Health Prep. 2023;17:e158 (https://doi.org/10.1017/dmp.2022.77).

- Public health emergency preparedness (PHEP) program and guidance [website]. US Centers for Disease Control and Prevention; (https://www.cdc.gov/readiness/php/phep/index.html).

- Refugee Coordination Model (RCM) [website]. UNHCR, The UN Refugee Agency; 3 December 2024 (https://www.unhcr.org/handbooks/rcm/).

- World Health Organization. Health cluster guide: a practical handbook. Geneva: World Health Organization; 2020 (https://iris.who.int/handle/10665/334129).

Resource mobilization

- Central Emergency Response Fund [website]. United Nations Central Emergency Response Fund; (https://cerf.un.org/).
- Contingency Fund for Emergencies [website]. World Health Organization; (https://www.who.int/emergencies/funding/contingency-fund-for-emergencies).
- Emergency pooled funds [website]. Humanitarian Action; (https://humanitarianaction.info/).
- The Advance UHC Multi-Donor Trust Fund [website]. World Bank Group; (https://www.worldbank.org/en/programs/multi-donor-trust-fund-for-integrating-externally-financed-health-programs/overview-and-features).
- The Global Fund funding applications [website]. The Global Fund (https://www.theglobalfund.org/en/).
- UNICEF Emergency Programme Fund [website]. United Nations International Children's Emergency Fund (https://www.unicef.org/partnerships/funding/other-resources-emergency).
- United Nations Development Assistance Framework. New York: United Nations Development Programme; 2022 (https://www.undp.org/publications/comprehensive-multisectoral-action-framework-malaria-and-sustainable-development).

Logistics

- CARE emergency toolkit: programme support – logistics [website]. CARE; (https://www.careemergencytoolkit.org/programme-support/1-logistics/).
- Guidelines for managing the malaria supply chain: a companion to the logistics handbook. Washington, D.C.: USAID; 2017 (https://www.ghsupplychain.org/guidelines-managing-malaria-supply-chain).
- Humanitarian commodities logistics [website]. International Association of Public Health Logisticians; (https://community.iaphl.org/iaphl/hcl).
- Interagency Emergency Health Kit [website]. World Health Organization; 2017 (https://www.who.int/emergencies/emergency-health-kits/interagency-emergency-health-kit-2017).
- Sourcing & management of health products [website]. The Global Fund; (https://www.theglobalfund.org/en/sourcing-management/).
- Supply chain management for health care in humanitarian response settings: addendum to the supply chain manager's handbook. Burlingame: JSI; (https://www.jsi.com/resource/supply-chain-management-for-health-care-in-humanitarian-response-settings-addendum-to-the-supply-chain-managers-handbook/).
- UNICEF supply catalogue [website]. United Nations Children's Fund; (https://supply.unicef.org/).

Safety and security

- Attacks on health care [website]. Insecurity Insight; (https://insecurityinsight.org/projects/healthcare).
- Attacks on health care [website]. Physicians for Human Rights; (https://phr.org/issues/health-under-attack/).
- Center for Public Health and Human Rights at Johns Hopkins University, Insecurity Insight, International Rescue Committee and Physicians for Human Rights. Toolkit: evidence that protects health care [website]. Insecurity Insight; (https://toolkitprotecthealth.org/).
- Surveillance system for attacks on health care (SSA) [website]. World Health Organization; (https://extranet.who.int/ssa/Index.aspx).

Human resources and surge capacity support

- Emergency medical teams [website]. World Health Organization; (https://www.who.int/emergencies/partners/emergency-medical-teams).
- Global Outbreak Alert and Response Network [website]. World Health Organization; (https://goarn.who.int/).
- Refugee Emergency Response Scale-up Protocol [website]. UNHCR, The UN Refugee Agency (https://www.unhcr.org/handbooks/rcm/refugee-emergency-response-scale-protocol).

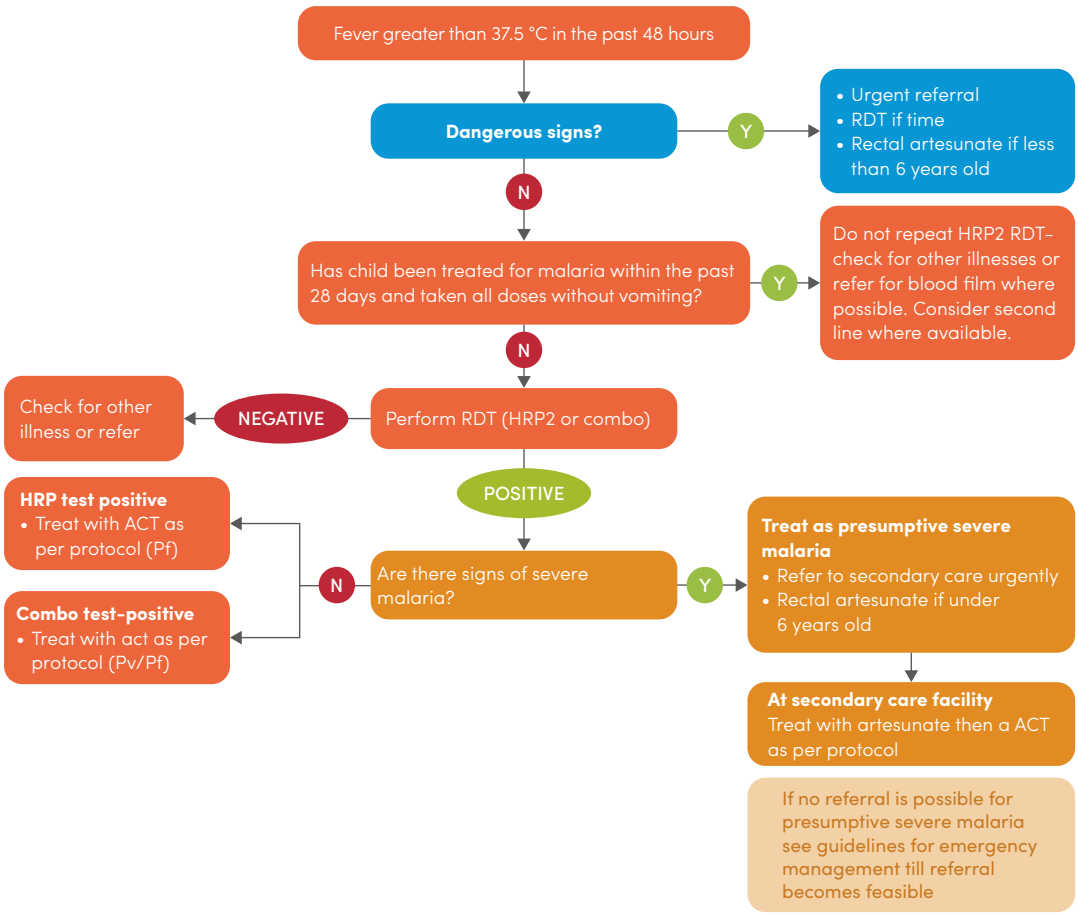
Chapter 3.
Diagnostics and case management

3.1 Overview

The immediate priority in an emergency context – where malaria is recognized to be a priority disease leading to high morbidity and mortality – should be prompt provision of diagnostic-guided treatment for malaria, in line with national malaria policy wherever possible. Fig. 14 provides a summary flow chart for diagnosis and case management of malaria in emergencies. Annex 2 provides quantification and costing templates for case management. Planning, procurement and deployment of commodities for case management are outlined in Chapter 2.

This chapter describes details, protocols and definitions for malaria diagnosis and case management based on the *WHO Guidelines for malaria (11)*.

Fig. 14. Summary flow chart for diagnosis and case management in emergencies



ACT: artemisinin-based combination therapy; HRP: histidine-rich protein; HRP2: histidine-rich protein II; Pf: *P. falciparum*; Pv: *P. vivax*; RDT: rapid diagnostic test.

3.2 Initial assessment: triage of danger signs and clinical features of uncomplicated and severe malaria

3.2.1 Danger signs

In an emergency, patients may present late in their illness or with multiple comorbidities that complicate the clinical picture.

Health care staff and CHWs must be aware of danger signs (with or without fever) that require rapid initial treatment (e.g. pre-referral treatment – see Section 3.5.1) and urgent referral to an appropriate well-equipped level of care. Danger signs with and without fever are listed in Table 6.

Danger signs are not only relevant for malaria but also useful for general triage of any severe illness, such as meningitis and respiratory infections.

Table 6. Danger signs to be quickly identified

With fever	Without fever
Confusion, agitation, lethargy	**Airway and breathing:** breathing frequency > 20 breaths per minute among adults and > 50 breaths per minute in neonates (tachypnoea) or central cyanosis (blue mucosa) or severe respiratory distress
Stiff neck	**Circulation:** weak and fast pulse or capillary refill longer than 2 seconds
Very weak (not able to stand or walk unaided)	**Unconscious/convulsing:** convulsing now or recently, or unconscious
Not able to drink or vomiting everything	**Severe pain:** abdominal, thoracic, neck pain or severe headache
Severe abdominal pain	
Fast and deep breathing or severe respiratory distress	

3.2.2 Clinical features of uncomplicated and severe malaria

Severe malaria with complications, mainly from *P. falciparum* infections, is a medical emergency to be carefully identified. Patients with severe malaria need immediate referral – following administration of a pre-referral medication (if indicated) – to an appropriately equipped health facility for treatment and intensive follow-up.

The features of uncomplicated malaria may vary with age and local endemicity.

Non-*falciparum* infections are usually not severe.

Clinical features of uncomplicated and severe malaria are listed in Table 7. A description of clinical features with additional details can be accessed in the *WHO guidelines for malaria (11)*.

Table 7. Summary of clinical features of uncomplicated and severe malaria

Uncomplicated malaria	Severe malaria
Fever Headache Vomiting Diarrhoea Cough Influenza-like symptoms (chills, muscle pains)	Prostration (generalized weakness so patient is unable to sit or walk) Impaired consciousness or unarousable coma, not attributable to another cause Multiple convulsions (> 2 in 24 hours) Severe anaemia Hypoglycaemia Metabolic acidosis Deep breathing, respiratory distress Acute renal injury Acute pulmonary oedema and adult respiratory distress syndrome (ARDS) Circulatory collapse or shock Abnormal bleeding (e.g. bruising, bleeding gums, haemoglobinuria) Jaundice plus evidence of vital organ dysfunction

3.2.3 Specific notes for emergencies

In most malaria endemic settings, severe malaria is usually seen in children and pregnant women. However, when populations are displaced (e.g. if non-immune populations move to malaria endemic areas), adults may also develop severe illness. Malaria should always be considered when adults present with the symptoms listed in Table 7 in any setting where malaria is a risk, as well as factored into the provision of health services (see also Chapter 2).

3.3 Confirmatory testing

In emergency settings, especially during the initial stage of a crisis when services are still being set up, it is easier to use quality RDTs with minimal capacity-building than to use microscopy. It is critical to establish enough supplies of confirmatory diagnostic tests at the start of any emergency response.

3.3.1 Initial malaria risk assessment for guiding the case management algorithm

The initial malaria risk assessment is described in Section 1.5. Testing (a sample of) the population provides basic information on the malaria endemicity. The results of this risk assessment should guide the case management algorithm for that setting.

- **In moderate to high transmission zones** (e.g. > 10% RDT positivity in population screening, higher among febrile care seekers): all cases of fever should be suspected as malaria and should be confirmed by diagnostic test before

starting treatment because high immunity may mask clinical symptoms. Children and pregnant women are most at risk. If populations from low endemicity areas are displaced into high transmission zones, all age groups should be included in the algorithm.

- **Important in emergencies**: if populations from a low endemicity setting are displaced to a high transmission setting – and are clinically determined to be RDT-positive as part of the malaria risk assessment – then it is critical to consider wider measures because this is a risk of epidemic malaria (see Chapter 4).

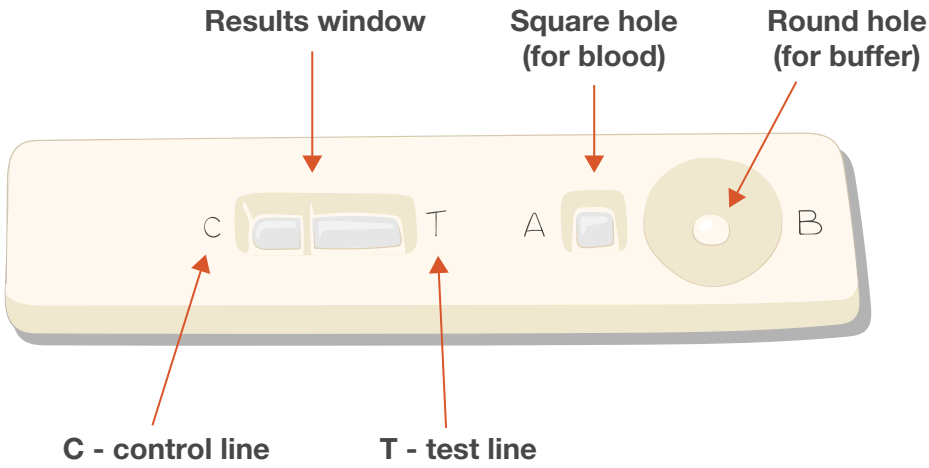
- **In low transmission zones**: a careful assessment of the patient should exclude other causes of fever before taking a malaria diagnostic test. In these settings, the whole population (adults and children) is at risk of clinical malaria, especially in case of population displacement. Clinical malaria generally refers to malaria with observable symptoms combined with laboratory confirmation of Plasmodium infection and prompts a person to seek medical care.

Malaria should always be considered as a possible diagnosis for any sick child or febrile adult, regardless of the case management algorithm; however, since fever can have multiple causes – even if a malaria test is positive – it is crucial to also assess for other potentially life-threatening diseases, such as lower respiratory tract infections or meningitis.

3.3.2 Rapid diagnostic tests for confirmatory testing

Malaria RDTs detect antigen proteins produced by malaria parasites present in the blood of infected individuals. RDTs can significantly improve prompt case management and should be first choice, rather than microscopy, in emergencies. They require basic skills to be deployed and staff can be easily trained and monitored in their proper use, making them ideal for emergency settings. An example RDT is illustrated in Fig. 15.

Fig. 15. Typical RDT cassette for malaria



Different RDTs detect different types of malaria protein – most commonly HRP2/3 or pLDH. The NMCP and WHO should advise which RDT is best suited to a given setting (e.g. to detect *P. falciparum* only or all species).

Three geographical zones have been defined by WHO:

- **zone 1:** where *P. falciparum* is predominant and most non-*falciparum* species cause mixed infection with *P. falciparum* (e.g. most areas of sub-Saharan Africa and lowland Papua New Guinea);
- **zone 2:** where *P. falciparum* and non-*falciparum* infections occur commonly as single-species infections (e.g. most endemic areas of Asia and the Americas and isolated areas in the Horn of Africa); and
- **zone 3:** where only non-*falciparum* infections occur (e.g. mainly *P. vivax*-only areas of east Asia, central Asia, South America and some highland areas elsewhere).

There are two further considerations in how RDTs should be included in the case management algorithm relating to HRP2 RDTs *(44)*.

1. HRP2 tests can stay positive for a median of 42 days. If a patient presents with a fever to a health facility but has been recently diagnosed with malaria (e.g. within the past 28 days) and was fully treated (i.e. took the full course of treatment without missing a dose or vomiting), then there is a chance that the HRP2 test will be still positive from the previous infection and may give a false positive. As shown in Fig. 14, do not repeat the HRP2 RDT if a patient returns within 28 days of a full course of malaria treatment. Instead refer, where possible, to a facility where blood films can be done to investigate further and consider an alternative infection.
2. Deletions of the gene producing HRP2/3 antigen are now seen in several parts of the world. If HRP2/3 is not produced by the parasite, there is a risk of a false negative test. NMCP guidelines should take into account the potential that local epidemiology of HRP2/3 deletions could impact RDT performance. WHO continuously monitors the efficacy of RDTs to detect malaria parasites. Countries with high prevalence of HRP2/3 deletions are currently observed mainly in the Horn of Africa (Djibouti, Eritrea and Ethiopia). However, the list of countries is expected to expand. In areas where ≥ 5% of *P. falciparum* cases are missed due to negative RDTs resulting from HRP2/3 deletions, WHO recommends a shift away from exclusive HRP2-based RDTs, and alternative tests should be used. WHO maintains detailed guidance on WHO prequalified RDTs on its website on selecting and procuring malaria RDTs *(45)*.

3.3.3 Role of light microscopy

In most emergency situations, especially at the initial stage, microscopy is not the appropriate diagnostic tool to diagnose a malaria infection. Effective microscopy for malaria parasites requires good-quality equipment and reagents, skilled experienced technicians and rigorous supervision supported by stringent quality control procedures. When performed optimally, microscopy can be more sensitive than RDTs, can detect low levels of parasitaemia (< 100 parasites/µl) and can differentiate between malaria species. Well set up, quality microscopy in the longer term can also contribute to monitoring and quality assurance of RDTs and can be used to investigate cases with suspicion of false negative RDT results. When poorly performed, microscopy produces unreliable results with lower sensitivity and specificity than RDTs *(40)*.

3.4 Case management – uncomplicated malaria (all species)

ACTs are currently the most effective antimalarial medicines available and are effective in the initial management of all malaria species. All ACT treatments should be administered for three consecutive days according to dosage regimens based on weight where possible or age if necessary.

In emergencies WHO recommends ACTs for all uncomplicated *P. falciparum* malaria and non-*falciparum* infections in children and adults (including women in all trimesters of pregnancy). This is for operational ease, simplification of protocols and to avoid confusion *(11)*.

Fixed-dose and co-formulated drug combinations should be used where possible to improve patient adherence and for operational ease. Artemisinin derivatives are contraindicated in cases of a proven allergy. WHO guidance *(11)* recommends children and adults (including pregnant women in all trimesters) with uncomplicated *P. falciparum* malaria should be provided with three consecutive days' treatment with one of the following ACTs:[3]

- artemether-lumefantrine (AL)
- artesunate-amodiaquine (AS+AQ)
- artesunate-mefloquine (ASMQ)
- dihydroartemisinin-piperaquine (DHAP)
- artesunate-pyronaridine (ASPY).

As stated above, wherever possible use ACTs. Chloroquine should only be used in circumstances where it is possible to reliably diagnose a mono-infection of *P. vivax* in a region where chloroquine is effective. This is to avoid the risk of mixed infections being treated with a suboptimal therapy.

3.4.1 Optional additional treatment in management of uncomplicated malaria

3.4.1.1. Single low-dose primaquine for *P. falciparum* malaria only

Single low-dose primaquine (0.25 mg/kg) can be given along with ACT treatment in contexts of low to moderate malaria transmission. This can be done without checking G6PD (glucose-6-phosphate dehydrogenase) status. Primaquine is contraindicated in children under 6 months, pregnant women and breastfeeding women. The aim of giving single low-dose primaquine is to reduce gametocytes circulating in the blood, and thereby reduce transmission. This is an optional measure for a public health impact.

3 NB: artesunate + sulfadoxine-pyrimethamine and artesunate-pyronaridine are not recommended for use in the first trimester of pregnancy.

3.4.1.2 Relapses in non-*falciparum* infections (*P. vivax* and *P. ovale* only)

P. vivax and *P. ovale* infections can relapse in the absence of radical therapy, causing chronic disease. However, most radical therapy regimens require ascertaining G6PD status *(11, 46)* which is challenging in emergency contexts.

On the other hand, recurrent febrile illness and the sequelae of chronic infection (such as chronic anaemia) may be significant in contexts with limited access to care, so there is pressure to treat the patient as completely as possible within one interaction.

Hence, if a radical therapy is being implemented in an emergency context, it is recommended to follow the WHO guidance that is most operationally feasible for patients with unknown G6PD status; that is, primaquine at 0.5 mg/kg per day for 7 days under medical supervision or 0.75 mg/kg weekly for 8 weeks. As noted above, primaquine cannot be given to children under 6 months, pregnant women and breastfeeding women.

3.4.2 Treatment failure

After treatment, patients may return to health care facilities still febrile or unwell. This may be due to a number possible of causes.

1. **Treatment/therapeutic failure:** this involves the failure of an antimalarial to effectively clear malaria parasites from the blood. Such failures may result from poor absorption (e.g. vomiting), poor prescribing practice or poor adherence to the full course of treatment. Drug quality may also be affected by inadequate transport, storage or counterfeit drugs.
2. **Non-malarial febrile illness:** a careful history and examination is necessary to ascertain any non-malaria cause of symptoms.
3. **Recrudescence:** this is the repeated manifestation of an infection after a period of latency following the primary attack. It is used particularly in the context of treatment failure of *P. falciparum*, which is often the result of non-completion of the recommended treatment regimen, especially with short-acting drugs such as quinine and artemisinin; poor efficacy of antimalarials; resistance of parasites to antimalarial medicines; or persistence of subclinical infection in immunosuppressed individuals *(47)*.

To minimize treatment failure:

- All programmes should include a component of patient counselling to encourage and improve adherence to treatment (see Section 6.4).
- Health care workers should directly observe the first dose of the ACT (3-day) regimen, especially to identify vomiting.
- A record should be kept of the number of patients who return within 28 days of treatment with symptoms of malaria as a simple proxy for possible resistance.
- Patients who return within 28 days of initial treatment, and who have taken a full course of treatment (no vomiting, missed doses, etc.), should be referred to secondary care facilities where they can be fully investigated. If the patient is found to have a malaria infection, then, where possible, they should be treated with a second-line antimalarial, which is usually an alternative ACT known to be effective in the given setting. It is also important to keep a record of all true treatment failures and inform the NMCP or other health authorities.

Monitoring of specific resistance markers may not be appropriate in acute contexts. However, in more protracted crises, therapeutic efficacy studies can be planned and conducted to monitor ACT efficacy, including identification of specific artemisinin resistance markers.

3.5 Case management – severe malaria

3.5.1 Pre-referral treatment – when severe malaria is suspected/danger signs are present

When patients present with danger signs or are clinically suspected of severe malaria in an emergency setting (e.g. in primary care or community sites not equipped to manage severe disease), they should be:

- referred as soon as possible to an appropriate health facility, and
- given a pre-referral dose of artesunate *(48)* urgently, either:
  - » rectal artesunate (10 mg/kg) – if a child aged under 6 years; or
  - » intramuscular single-dose artesunate – (3 mg/kg for children < 20 kg or 2.4 mg/kg for children and adults greater than 20 kg).
  - » Where rectal or intramuscular artesunate is not available, intramuscular artemether can be considered.

Initial parenteral treatment of hypoglycaemia and a broad-spectrum antibiotic should be included prior to referral, where possible, in cases of altered levels of consciousness.

Referral should occur as soon as possible following the pre-referral dose. Attendance at an appropriate health facility may need to be facilitated in settings of limited access (e.g. providing vouchers for travel, organizing moto-taxis).

Case study 3 describes the pre-referral treatment of vulnerable populations in the context of civil war in Central African Republic.

At the hospital level, management of severe malaria should proceed with an immediate dose of weight-appropriate artesunate as per protocol for severe malaria. The pre-referral dose should not be counted as dose 1 of artesunate.

In case of non-possible or delayed referral in some emergency contexts to an appropriate facility (e.g. travel not possible overnight or at all), rectal or parenteral artesunate may need to be continued until the patient can tolerate oral medication.

Case study 3. Management of severe febrile illness in vulnerable populations in Central African Republic, civil war context

In 2008, the MENTOR Initiative established a network of CHWs in the highly malaria endemic regions of north-west Central African Republic to address health needs amidst a civil war. This intervention was concentrated in the Ouham and Ouham-Pendé prefectures, where an estimated 200 000 individuals had been displaced. The CHW programme was specifically designed to adapt to the frequent and often temporary displacements of IDPs who typically fled into the bush, making traditional health care approaches ineffective. The programme focused on malaria case management for children aged under 5 years and pregnant women. It began with 30 CHWs in the subprefecture of Paoua in 2008 and expanded to 60 by 2011, including 20 additional CHWs in the subprefecture of Markounda. These literate volunteers were selected with the help of community leaders and trained over 5 days by NGO-employed nurses or physicians to deliver basic health interventions, focusing primarily on malaria diagnosis and treatment, malnutrition screening and maternal health services.

The CHWs utilized RDTs for malaria. They treated children with uncomplicated cases with artemether-lumefantrine (AL) and administered rectal artesunate for severe cases before referring those patients to health facilities. They also conducted malnutrition screening using mid-upper arm circumference measurements; provided deworming treatments, oral rehydration solutions and vitamin A supplements for children aged under 5 years; and administered intermittent preventive treatment for malaria and folic acid supplements for pregnant women. Supplies were delivered monthly, and CHWs were supervised twice a month by NGO staff to ensure quality control and stock replenishment. Despite the challenging conditions, including poor road accessibility and security issues, the programme achieved high coverage and treatment rates, with 81.2% test positivity and 99.2% of RDT-positive cases receiving appropriate treatment. The programme's success in maintaining care and surveillance in conflict zones highlighted its effectiveness, though it faced limitations in handling RDT-negative cases due to restricted referral options.

Source: RuckStuhl, Lengeler, Moyen, Garro, Allan *(49)*

3.5.2 Treatment of severe malaria in a health facility

WHO guidance *(50)* recommend that first-line treatment of severe malaria at a health facility is parenteral artesunate given either by the intravenous or intramuscular route. Parenteral treatment should be given immediately when severe malaria is suspected.

Adults and children with severe malaria (including infants, pregnant women in all trimesters and lactating women) should be treated with parenteral artesunate with a minimum of 3 doses in 24 hours and then continued once daily until they can tolerate oral medication.

Dose 1 should be considered the first dose given in the hospital facility (i.e. do not count any pre-referral treatment as dose 1).

Dosage of artesunate is by weight:

- children < 20 kg: 3 mg/kg per dose
- children/adults > 20 kg: 2.4 mg/kg per dose.

If injectable artesunate in not available, secondary options are artemether or quinine, although not ideal.

Once the patient can tolerate oral medications, they should be given a full course of oral ACT (approx. 48 hours after sever malaria treatment).

3.5.3 Complications of severe malaria

Coma, convulsions, hypoglycaemia, severe anaemia, shock, pulmonary oedema and acute renal failure are all potential complications of severe malaria that require immediate management.

Regular observation of patients with severe malaria is critical, because the clinical situation may change quickly. The most important observations are pulse, respiratory rate and pattern, blood pressure, temperature and level of consciousness. If there is any deterioration in consciousness, it is essential to check for hypoglycaemia and for a significant fall in haemoglobin, because these are amenable to treatment.

A summary of complications and management is shown in Table 8.

Table 8. Overview of the management of complications of severe malaria

Manifestation	Immediate management
Coma (cerebral malaria)	Maintain airway, place patient on his or her side; exclude or treat other treatable causes of coma (e.g. hypoglycaemia, bacterial meningitis); avoid harmful ancillary treatments; intubate if necessary.
Hyperpyrexia	Administer tepid sponging, fanning, a cooling blanket and paracetamol.
Convulsions **12% of adults, 30% of children**	Maintain airways; treat promptly with intravenous or rectal diazepam, lorazepam, midazolam or intramuscular paraldehyde. Check blood glucose.
Hypoglycaemia **Less common in adults except pregnant women; common in children**	Check blood glucose, correct hypoglycaemia and maintain with glucose-containing infusion. The threshold for intervention is < 3 mmol/L for children aged under 5 years and < 2.2 mmol/L for older children and adults.

Manifestation	Immediate management
Severe anaemia	Transfuse with screened fresh whole blood.
Acute pulmonary oedema	Prop patient up at an angle of 45 degrees, give oxygen, give a diuretic, stop IV fluids, intubate and add positive end-expiratory pressure or continuous positive airway pressure in life-threatening hypoxaemia.
Acute kidney injury	Exclude pre-renal causes, check fluid balance and urinary sodium; if in established renal failure, add haemofiltration or haemodialysis, or, if not available, peritoneal dialysis.
Spontaneous bleeding and coagulopathy	Transfuse with screened fresh whole blood (cryoprecipitate, fresh frozen plasma and platelets, if available); give vitamin K injection.
Metabolic acidosis **Common in adults and children**	Exclude or treat hypoglycaemia, hypovolaemia and septicaemia. If severe, add haemofiltration or haemodialysis.
Shock	Suspect septicaemia, take blood for cultures; give parenteral broad-spectrum antimicrobials; correct haemodynamic disturbances.

It is assumed that appropriate antimalarial treatment will have been started in all cases.

Case study 4 describes the emergency response of MSF and the Sudan Ministry of Health to a sharp increase in malaria cases, including severe malaria cases, in 2019.

Case study 4. Malaria outbreak experience by MSF in North Darfur, Sudan, in 2019

The capital of North Darfur State, El Fasher, is one of the country's most populated cities and was hosting a large number of IDPs. From monitoring activities in 2019, a sharp increase of malaria cases was recorded – around double the number compared to the same period in 2018. As a result, MSF decided in September 2019, jointly with the Ministry of Health, to launch an emergency response by first strengthening malaria case management in the two main referral health care facilities – the teaching hospital and the paediatrics hospital. The average bed occupancy rate at the supported facilities had been 90% above capacity over the past month. Sometimes there were three to four patients per bed in some wards, leading to the use of tents to increase bed capacity. The triage system was also strengthened to assess the disease severity of patients (urgent, severe, stable) and decide who was to be admitted in order to avoid missing critical cases or treating them too late, resulting in deaths.

Between 23 September and 26 October 2019, MSF carried out more than 13 000 rapid tests for malaria and 51% of people tested positive. More than 2450 people were admitted to hospital, with approximately half of them children. Mobile activities were also launched on the outskirts of the city, in rural communities and in settlements where internally displaced people were settled. This remote approach outside hospitals helped reduce the malaria burden and the number of people admitted to hospitals. Nearly 3000 people were treated for malaria through these outreach services. Children aged under 5 years were often critically ill and, in some cases, family members were severely affected by malaria and unable to talk or walk.

Severe malaria patients were immediately managed with intravenous artesunate malaria treatment, with dosage determined by their weight. If the patient was recovering after 24 hours of artesunate intravenous treatment, oral tablets for a 3-day regimen were provided to complete the full dosage regimen. Health facilities in the areas outside the city did not have the same response capacity as those in the city and preventive measures were often not available. While insecticide-impregnated mosquito nets had been distributed, many households were not fully covered, received them too late or were not using them properly, rendering the response quite fragmented. The rainy season in 2019 was longer and heavier than in 2018, lasting into October. Many mosquito breeding sites were identified, justifying additional long-term environmental measures to reduce larval habitat.

Source: MSF UK, 2019 *(51)*.

3.6 Vulnerable groups

3.6.1 Children under 5 kg

Infants weighing < 5 kg with uncomplicated *P. falciparum* malaria should be considered to be high risk for severe malaria and should be carefully monitored. These infants should be treated with an ACT at the same target dose as children weighing 5 kg.

Children weighing under 5 kg with malaria should be monitored carefully for deterioration. Treatment with ACTs can be challenging, so CHWs and/or mothers should be trained to administer medication, especially to young infants. Wherever possible it is best to monitor treatment at a clinical facility to ensure appropriate administration of treatment. Treatment dose is the same as for children weighing 5 kg.

It is important to watch for signs of dehydration and hypoglycaemia and to give appropriate treatment if necessary. Caregivers should be informed it is important for infants to breastfeed frequently and for older children to drink plenty of fluids to prevent dehydration. Severe malaria should be treated with parenteral artesunate as per protocol.

For prevention of malaria in children, consider implementing PMC (see Chapter 4) in this vulnerable population as well as distribution of ITNs through neonatal and malnutrition pathways.

3.6.2 Pregnant women

All pregnant women with uncomplicated malaria should be treated with an ACT (ideally AL; otherwise AS-AQ, DHAP or ASMQ) during all trimesters of pregnancy including in the first trimester. In high endemicity settings, pregnant women may not present with a fever, so routine screening for malaria should be considered at any consultation opportunity (including antenatal care). Severe malaria should be treated with parenteral artesunate as per protocol.

Complications such as hypoglycaemia, convulsions, pulmonary oedema and anaemia are a significant risk of malaria in pregnancy and must be checked during management, even if uncomplicated.

For prevention of pregnant women in an emergency, antenatal care should be prioritized wherever possible. This is an important opportunity for prevention, including:

- intermittent preventive treatment for pregnant women (IPTp; see Chapter 4) with SP from the second trimester onwards until delivery; SP should not be given more frequently than monthly (SP is contraindicated in the first trimester and in HIV+ women on co-trimoxazole [Co-TMX]); and
- distribution of ITNs to ensure both the pregnant woman and any children are protected.

3.6.3 Malnourished persons

Malnutrition is a significant cause of morbidity and mortality in emergencies, and often coexists with malaria. It is both a risk factor for infection and progression to severe disease. Patients with SAM may have asymptomatic malaria and should be routinely screened for malaria (using RDT) on admission to a therapeutic feeding programme and weekly thereafter until discharge. Patients with severe malaria and SAM are at high risk of death and require intensive medical and nursing care. They should be hospitalized in a therapeutic feeding centre and treated with parenteral artesunate.

For prevention of malnourished children, consider implementing PMC (see Chapter 4). Where possible, adults and children with malnutrition should also receive ITNs.

3.6.4 People living with HIV

There is considerable geographical overlap between malaria and HIV, with the potential for coinfection in emergencies. People living with HIV may suffer more severe manifestations of malaria and increased risk of severe malaria and death.

National guidelines and WHO-approved protocols should be followed for malaria treatment in people living with HIV. Overall management remains ACTs for uncomplicated malaria and parenteral artesunate for severe malaria. The main differences in management of patients who have HIV/AIDS and uncomplicated *P. falciparum* malaria are:

- AS+AQ is not recommended if they are being treated with a regimen containing efavirenz or zidovudine;
- SP is not recommended if patients are receiving Co-TMX; and
- pregnant women on Co-TMX should not be given SP for IPTp.

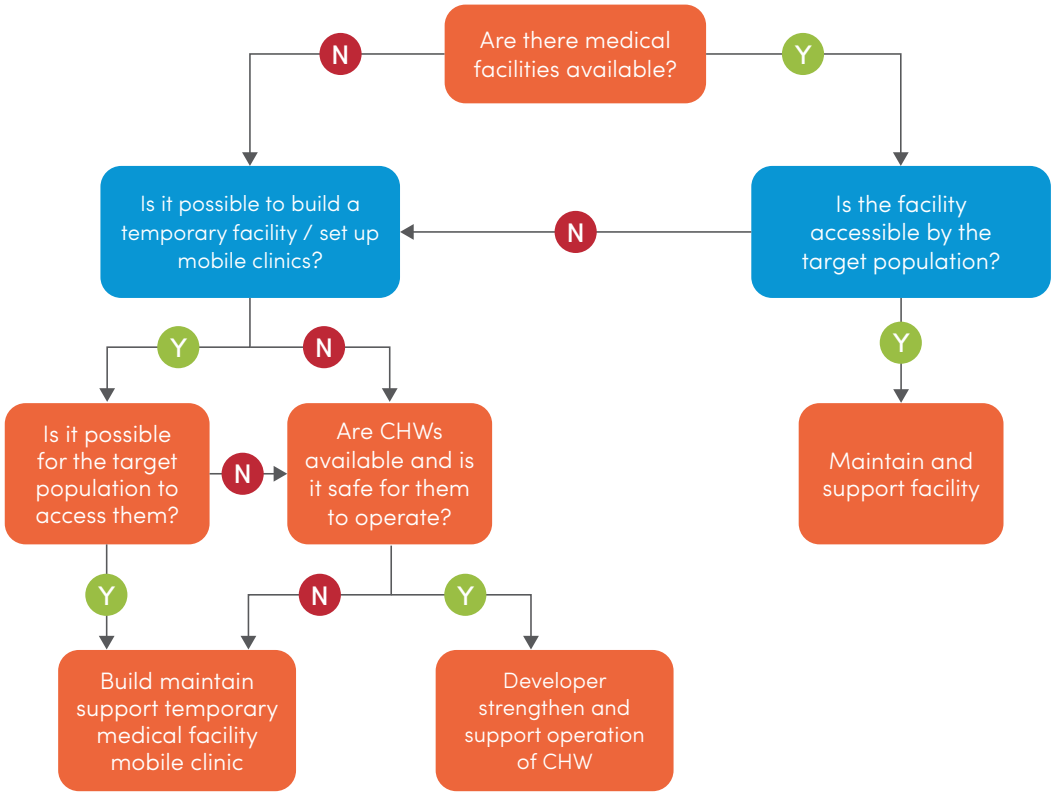
Blood safety protocols must also be maintained at the highest level, even when taking blood for a malaria RDT.

For prevention of malaria among people living with HIV, distribute ITNs through HIV management pathways.

3.7 Operationalizing malaria case management in emergency situations

Depending on the stage of the emergency and the state of the prevailing health system, malaria case management may need to be delivered flexibly, including through fever points, CHWs or mobile clinics as well as via fixed health services (see Fig. 16). Management of malaria is usually within the lens of a febrile patient so differential diagnoses should always be considered and, wherever possible, case management should be integrated with more holistic management (e.g. management of malnutrition).

Fig. 16. Assessment and management of health services and skilled human resources available



There are four key tasks in operationalizing malaria case management in emergency situations.

1. Coordinate with the health cluster to understand scope of need (e.g. population size) and existing resources, and to coordinate the implementation of response. Working through the cluster and NMCP/ministry of health allows integration of the response and efficient procurement (e.g. WASH for vector control, and nutrition).
2. Assess access to health services and coordination mechanisms (see also Chapter 2):
    - » Was the pre-emergency health system sufficiently functional in delivering health services including malaria care?
    - » Has the emergency led to a forcibly displaced population among a host population, stretching resources? Fig. 17 outlines how a health system can become overburdened in emergency situations and steps to respond.
3. Ensure teams are supported in triaging and prioritizing multiple competing needs, ideally with capacity for management of severely ill patients with danger signs where possible. Position both malaria services and management of malaria patients in the context of a sick person/child – ensure wherever possible that there are options for assessment of febrile patients who test negative and for checking that malaria is not the only cause of illness in a child with a positive malaria test; for example, use of integrated community case management (iCCM) protocols (see Fig. 18) and integration with other services (e.g. nutrition activities, antenatal care, piggybacking on vaccination outreach).
4. Malaria case management may need to be adapted in the face of other public health emergencies (e.g. in COVID-19 or Ebola). Ensure the latest technical guidance is followed and see Case Study 5.

Fig. 17. Rapid decision-making assessment of health services in a given emergency context

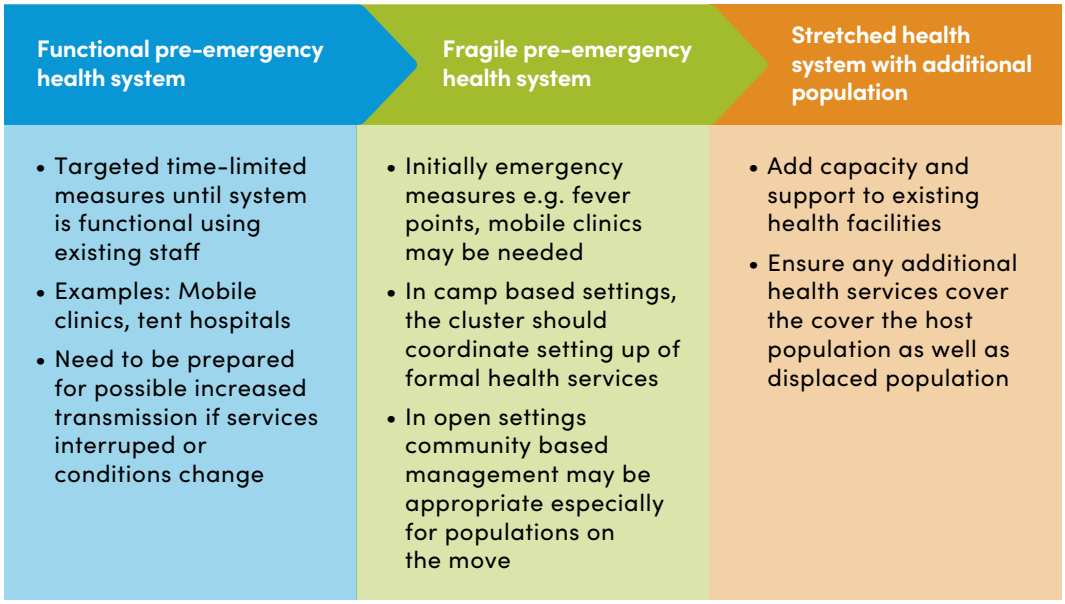


Fig. 18. Towards implementing an integrated health care management of patient illness from communities to referral health care facilities

Treating the patient in front of you

In emergencies, as in other contexts, patients may be infected with multiple causes for their illness but usually have much more limited access to care or less capacity to consult a variety of providers. A patient may test negative for malaria or test positive but still have other infections that need treatment.

Approaches such as Integrated Management of Childhood Illness and Integrated Management of Adolescent and Adult Illness algorithms can be used to guide and facilitate diagnosis and treatment *(11,52, 53)*.

Outside health facilities, Integrated Community Case Management (iCCM) is a life-saving strategy to enable CHWs to assess and treat malaria, pneumonia and diarrhoea in children aged under 5 years within their own communities. They use simple algorithms relying on basic diagnostics, such as malaria RDTs and respiratory rate, and limited treatments (ACTs, oral antibiotics and oral rehydration solution) *(11)*.

- If iCCM sites existed before the emergency, it will be important to ensure their supply chains are replenished, and their protocols may need to be modified depending on stocks (e.g. if no RDTs are available). CHWs often may be on the move with their own displaced community members and provide an opportunity for continuous care.
- iCCM /Integrated Management of Childhood Illness are difficult to set up in the acute phases of an emergency, but CHWs can be trained and deployed in the short to medium term. Appropriate sites and numbers can be determined by the level of need and the specific context.
- Importantly, populations in humanitarian emergencies with limited access to care and multiple comorbidities may present to community or primary points of care already in a severe state. This can be very challenging.
- Both Integrated Management of Childhood Illness and iCCM protocols have clear algorithms for the recognition of danger signs and patients beyond their capacity to treat, including when to use pre-referral artesunate. Where possible, include planning for referral along the health system pathway, depending on the context (e.g. from communities to health facilities or from facilities to referral hospital). In areas with severely limited access, it may be necessary to facilitate referral (e.g. providing vouchers or payment for taxis or bicycles).

3.8 Monitoring and evaluation of case management

In an acute phase, a reduced set of data (usually based on symptoms) should be reviewed frequently and regularly (e.g. weekly) and then progressively transitioned into more sophisticated routine reporting (based on essential diseases). The purpose of data collection should be clear. Suggested indicators are:

- rapid assessment of disease burden and surveillance in case of epidemics (key indicators), for example:
  - » proportion of confirmed malaria cases treated of total patients treated – can be disaggregated by outpatient and inpatient (i.e. number of malaria cases/ total cases treated for all causes);
  - » percentage of RDTs that are positive (i.e. number positive/number tested); and
  - » number of confirmed/suspected malaria-attributable deaths (may be challenging to collect given many cases die in the community in some settings); and
- assessment of quality of care, for example:
  - » percentage of positive RDT cases receiving an ACT; and
  - » in-hospital malaria-attributable mortality (if hospital care is provided).

See Chapter 8.2.1 for further malaria case management indicators. Where possible, patient data should be recorded and disaggregated by age, sex and pregnancy status. In later stages, additional indicators may be added. Details on useful indicators are available in the WHO reference manual on malaria surveillance, monitoring and evaluation *(18)*. Care should be taken to coordinate with all field actors' data aggregation categories by age in line with national/emergency surveillance system standards.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

Diagnosis

- How malaria RDTs work [website]. World Health Organization; (https://www.who.int/teams/global-malaria-programme/case-management/diagnosis/rapid-diagnostic-tests/how-malaria-rdts-work).
- Malaria rapid diagnostic test performance: results of WHO product testing of malaria RDTs – round 8 (2016–2018). Geneva: World Health Organization; (https://iris.who.int/handle/10665/276190).
- Prequalification of medical products: WHO public reports for in vitro diagnostics [website]. World Health Organization; (https://extranet.who.int/prequal/vitro-diagnostics/prequalification-reports/whopr).
- Universal access to malaria diagnostic testing: an operational manual. Geneva: World Health Organization; 2011 (https://iris.who.int/handle/10665/44657).

Case management

- Guidelines for administration of injectable artesunate for severe malaria: job aid (poster) [website]. Medicines for Malaria Venture; (https://www.mmv.org/our-work/access-medicines/antimalarial-drug-toolkits/artesunate-injection-dosage-administration).

- The Sphere handbook: humanitarian charter and minimum response standards in humanitarian response Geneva: Sphere Association; 2018 (https://handbook.spherestandards.org/en).

Drug resistance and monitoring

- Malaria chemoprevention efficacy study protocol. Geneva; 2022 (https://iris.who.int/handle/10665/360908).

- Malaria threats map [website]. World Health Organization; (https://apps.who.int/malaria/maps/threats/).

- Report on antimalarial drug efficacy, resistance and response: 10 years of surveillance (2010–2019). Geneva: World Health Organization; 2020 (https://iris.who.int/handle/10665/336692).

- Strategy to respond to antimalarial drug resistance in Africa. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/364531).

Chapter 4.
Chemoprevention

4.1 Overview

Malaria chemoprevention is the administration of full dose antimalarials with the goal of preventing malaria infection or the development of severe disease. Chemoprevention strategies can be applied in humanitarian emergency contexts as a tool to target and prevent increases in malaria burden or mortality. Interruption of existing chemoprevention interventions in emergency contexts can be one of the causes of increased malaria burden and mortality, and they should be reinstated as soon as possible. It is important to note, however, that while chemoprevention may contribute to malaria control and/or elimination, its implementation should not be to the detriment of appropriate access to diagnosis and treatment for malaria.

A summary of the different chemoprevention strategies and their role in humanitarian emergencies is provided in Table 9 and further details are described below. The full WHO recommendations for chemoprevention strategies can be found in the *WHO Guidelines for malaria (11)* and other information is available in the resources listed in the further reading. Annex 2 provides quantification and costing templates for some chemoprevention strategies. Planning, procurement and deployment of commodities for chemoprevention are outlined in Chapter 2.

Table 9. Malaria chemoprevention strategies for emergency settings

Strategy	Target population	Recommended drug	Delivery	Pertinence in humanitarian emergency
Mass drug administration (MDA)	Whole population (at least 80%) (for verification)	ACT (in some settings outside sub-Saharan Africa, CQ is being used)	Usually campaign	Yes, but consider reinforcing access to care
Targeted drug administration (TDA)	Specific vulnerable population	ACT	According to population needs	Yes, if specific vulnerable population (e.g. people coming from low transmission to high transmission areas, people with higher risk exposure)
Intermittent preventive treatment for pregnant women (IPTp)	Pregnant women (about 4% of population)	SP	Antenatal care or community	Maintain where possible, or include as soon as access is possible

Strategy	Target population	Recommended drug	Delivery	Pertinence in humanitarian emergency
Perennial malaria chemoprevention (PMC)	Children under 2 years (about 7% of population)	SP	Expanded Programme on Immunization (EPI), community, other	Maintain where possible, or include as soon as access is possible
Seasonal malaria chemoprevention (SMC)	Children 3–59 months (about 20% of population; age range can be adapted according to vulnerable population)	SP-AQ	Campaign	Reinstate or introduce if seasonal component and/or high child mortality
Intermittent preventive treatment for school children (IPTsc)	School-aged children	ACT	Schools	Less pertinent in emergencies, but school can be used as delivery method
Post-discharge malaria chemoprevention (PDMC)	Children admitted to hospital with anaemia	ACT	Hospital/ home-based care	Can contribute to reduced malaria mortality if hospitalization rates are high

ACT: artemisinin-based combination therapy; CQ: chloroquine; SP: sulfadoxine-pyrimethamine; SP-AQ: sulfadoxine-pyrimethamine plus amodiaquine

4.2 Mass drug administration

Mass drug administration (MDA) is a crucial response to drastically reduce malaria morbidity and mortality in the short term or transmission during malaria outbreaks, or in the early phase of emergencies. MDA serves as an effective measure even when vector control methods are in place. MDA involves giving, preferably, a long-acting combination malaria treatment course to all individuals in affected communities, along with single low-dose primaquine treatment to halt transmission.

In high transmission areas, it is vital that MDA of children under 5 years is followed by effective malaria case management to sustain the gains of the MDA and prevent excess mortality.

The cost–effectiveness of MDA should be viewed in relation to the significant role it plays in saving lives during emergencies. MDA is highly effective if antimalarial medicines have been pre-positioned and implemented early enough at high coverage (> 80%) *(54)*.

Key considerations for implementing MDA for malaria chemoprevention in humanitarian emergencies include the following.

- **Target at-risk groups:** define target groups based on local epidemiology and vulnerability, focusing typically on children aged under 5 years and pregnant women. Utilize demographic studies and historical malaria incidence data to identify at-risk populations.
- **Access to the population:** assess logistic challenges in reaching the population, considering conflict, displacement and geographical barriers. Develop and implement strategies such as mobile health teams and temporary health settlements to ensure comprehensive coverage.
- **Drug choice and availability:** select antimalarials based on local drug-resistance patterns, efficacy and safety profiles. Secure a reliable supply chain through coordination with suppliers, health agencies and government bodies, ensuring pre-positioning and contingency planning.
- **Implementation workforce:** deploy a trained workforce including health care workers and CHWs. Training should cover drug protocols, adverse reaction management and community engagement. Ensure workforce safety, particularly in conflict zones, through collaboration with local and international organizations (see Chapter 6 for further strategies on community engagement).
- **Finance:** secure funding for all implementation stages, including drug procurement, logistics, workforce, training and monitoring. Potential funding sources include international donors, NGOs and government agencies. Maintain transparent financial management to ensure sustained support.
- **Pharmacovigilance capacity:** Establish a robust pharmacovigilance system to monitor and manage drug safety. Train health care providers in adverse reaction reporting, set up reporting mechanisms and ensure rapid response capabilities. Collaborate with local health authorities and international networks to enhance pharmacovigilance.

Drawing on the malaria risk assessment done at the start of the intervention, any of the following would be a sufficient criterion for implementing MDA:

- risk of or confirmed high mortality attributed to malaria;
- incapacity of the health system to serve the vulnerable population and deliver case management;
- effective vector control not available or unable to be quickly implemented; or
- the presence of other outbreaks such as viral haemorrhagic fever, where presenting with malaria at health services could increase exposure to nosocomial infections or overburden the health system (see also Section 1.4.4 and Case study 5).

Case study 5. Mass drug administration and ITN distributions in the epicentre of an Ebola outbreak in Beni, North Kivu, Democratic Republic of the Congo

The second largest Ebola outbreak since the virus was discovered spanned the period from May 2018 to June 2020, impacting the north-eastern highland provinces of the Democratic Republic of the Congo. It posed significant challenges, exacerbated by a radical Islamist insurgency and nosocomial infections among children and adolescents. Suspecting a surge in Ebola cases due to heightened malaria activity in the epicentre city of Beni, an MDA campaign against malaria was initiated by partners. The objectives included rapidly reducing clinical malaria infections, protecting the population from new infections, minimizing outpatient consultations, decreasing the risk of nosocomial infections, and enhancing trust in public health authorities. Within 6 weeks, necessary supplies were procured, including 500 000 doses of AS-AQ for children and AL for adults, alongside 120 000 ITNs provided by UNICEF, the World Food Programme, the U.S. President's Malaria Initiative and the Global Fund.

The operational challenges were substantial, including hiring and training 4805 auxiliary health staff, overcoming community distrust, addressing misinformation and ensuring door-to-door distribution in the context of Ebola infection risks. Despite these hurdles, the campaign achieved remarkable coverage, with 97.0% for MDA and 97.9% for ITNs among the target population of 450 000 within five consecutive days. The intervention reduced recorded clinical fever cases diagnosed as malaria by 40%, eased the burden on health services, and contributed significantly to the acceptance of Ebola response interventions. The combined MDA and ITN campaign emerged as a confidence-building measure, demonstrating sustained impact on malaria control, particularly in unstable transmission areas such as Beni, suggesting its viability as a proactive measure in future outbreaks (such as COVID-19), where malaria burden and health system strain are imminent concerns.

Fig. 19 presents a behaviour management messaging example from the campaign in North Kivu. The text translates to, "Let's protect ourselves from malaria by taking the recommended medicines and by sleeping each night under an insecticide-treated net."

Fig. 19. Social behaviour change message and delivery pictures from North Kivu, Democratic Republic of the Congo, 2018

Source: PNLP DRC, 2020 *(55)*.

4.2.1 Mass drug administration in *P. falciparum* contexts

The WHO field manual for MDA in *P. falciparum* settings *(54)* should be used to determine the pertinence, feasibility and practical implementation aspects of MDA in a given context. It is important to note that with the ACTs currently available, the protective effect for malaria after an MDA cycle lasts a maximum of 4–5 weeks and after this period cases will increase according to ongoing transmission. There is no evidence of transmission reduction through MDA in high-burden contexts. If MDA is implemented, consider implementation of other strategies such as ITN distribution or malnutrition screening concomitantly.

4.2.2 Mass drug administration in *P. vivax* contexts

MDA for prevention of *P. vivax* in the context of emergencies is rare. However, there are two WHO-recommended strategies for MDA in *P. vivax* contexts *(11)*:

1. **MDA to reduce transmission:** the choice of drug will depend on the setting and drug sensitivity; and
2. **MDA to prevent mass relapse:** use of an 8-aminoquinoline (although use of a schizonticide + an 8-aminoquinoline is preferred).

Where mixed infections are prevalent, strategies using drugs that target *P. falciparum* should be used *(11)*.

4.3 Targeted drug administration

Targeted drug administration (TDA) involves administering antimalarial drugs to specific high-risk groups within the population rather than to the entire community. This approach is particularly beneficial when resources are limited, logistic challenges are significant and the at-risk groups are clearly identifiable. By focusing on vulnerable subpopulations, TDA maximizes the impact of the intervention while conserving resources.

In humanitarian emergency settings, the decision to implement TDA for malaria chemoprevention hinges on several critical factors, described below.

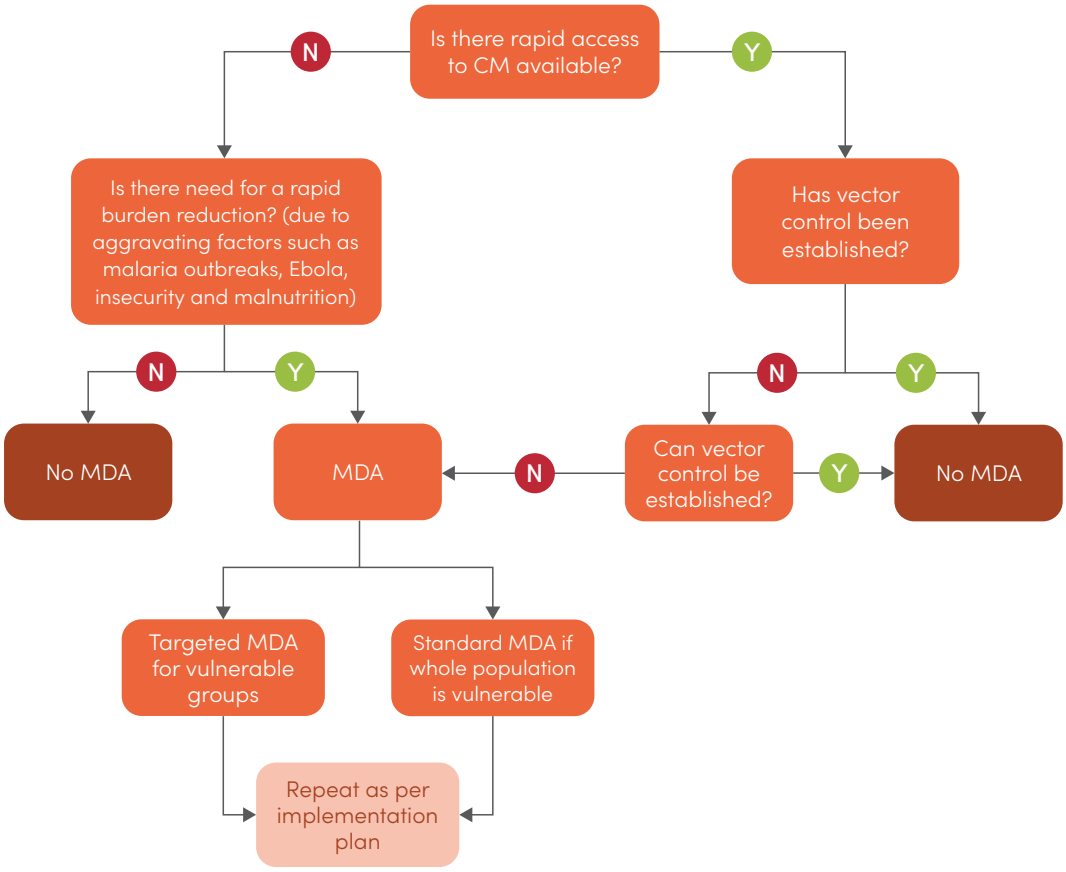
TDA is often chosen in settings where epidemiological data indicates that certain groups, such as children under 5 years, pregnant women or people living in densely populated shelters, face a disproportionately high risk of malaria. These groups are prioritized because they are more likely to suffer severe consequences from malaria, including higher morbidity and mortality rates. In such contexts, TDA can provide immediate protection from infection to those most in need, reducing the overall disease burden and preventing outbreaks.

The implementation of TDA in humanitarian emergencies is also influenced by logistic considerations. In conflict zones or areas with significant displacement, reaching the entire population may be infeasible due to security concerns or accessibility issues. TDA allows health workers to concentrate their efforts on accessible and high-impact areas, often utilizing mobile clinics or temporary health posts to deliver treatment. This targeted approach not only improves operational efficiency but also enhances the feasibility of monitoring and evaluating the intervention's outcomes.

Additionally, TDA is a strategic choice when there are constraints on the availability of antimalarial drugs. By limiting administration to high-risk groups, health authorities can ensure that the available drug supply is used judiciously, avoiding stockouts and ensuring that those most in need receive timely chemoprevention. This is particularly important in emergencies where supply chains are disrupted and replenishing drug stocks may be challenging.

Fig. 20 presents a process for deciding whether MDA, TDA or neither is appropriate given the specific circumstances.

Fig. 20. Decision tree for MDA and TDA in humanitarian emergency settings with a high burden of *P. falciparum*



4.4 Intermittent preventive treatment for pregnant women

Intermittent preventive treatment for pregnant women (IPTp) involves giving antimalarial medication at specific intervals during pregnancy to reduce risks to both mother and baby. WHO recommends using SP in the second and third trimester of all pregnancies. Gravidity, malaria transmission intensity and SP resistance are considered for optimal effectiveness *(11)*.

The delivery of IPTp, specifically using SP, depends significantly on the functionality of the existing health system. In regions with a functional health system, IPTp can be effectively delivered through routine antenatal care services. Health workers can administer the recommended SP doses during regular antenatal care visits, ensuring pregnant women receive necessary protection against malaria *(11)*. Additionally, providing ITNs during these visits can enhance malaria prevention. Training health care providers to stress the importance of ITN usage and adherence to SP regimens is crucial in such settings.

To enhance uptake of IPTp, especially in areas where the health system is non-functional or severely compromised, alternative delivery methods must be used. This includes the delivery of IPTp at the community level. Mobile health clinics and outreach programmes become essential in reaching pregnant women who cannot access traditional health facilities. CHWs play a vital role in these scenarios, bringing IPTp and ITNs directly to those in need. This approach requires careful logistics planning to ensure a reliable supply of SP and ITNs, even amidst supply chain disruptions. Establishing strategic stockpiles and contingency plans for rapid distribution can help maintain consistent coverage.

In both scenarios, ensuring effective delivery of IPTp to protect pregnant women and their unborn children from malaria requires a multifaceted approach and the adaptation of strategies to local conditions. This involves robust collaboration and coordination between the health cluster team and maternal, newborn and child health stakeholders.

Coordination is vital for integrating IPTp into broader maternal health services and ensuring that pregnant women receive comprehensive care despite the disruptions caused by emergencies. Key stakeholders, including local health authorities, international health agencies and NGOs, must work together to design and implement strategies that facilitate the consistent delivery of IPTp. Regular meetings and clear communication channels between these stakeholders can help align efforts, share resources and address challenges promptly.

4.5 Perennial malaria chemoprevention

Perennial malaria chemoprevention (PMC) involves giving full antimalarial courses at set intervals to children in moderate to high malaria transmission areas, regardless of their current malaria status. PMC is a critical intervention in areas with perennial malaria transmission, where the risk of infection remains consistently high year-round. It seeks to protect children aged under 24 months from severe malaria by maintaining preventive drug levels in their bloodstream to clear and prevent infections. In emergency settings, where health care infrastructure may be disrupted, and populations are often displaced, PMC can provide a crucial buffer against the high morbidity and mortality associated with malaria.

Implementing PMC in emergency settings requires meticulous planning and coordination. Ensuring a continuous supply of antimalarial drugs is a primary challenge, necessitating robust supply chain mechanisms and strategic pre-positioning of drugs in accessible locations.

Effective delivery of PMC hinges on integrating it with other health and humanitarian services. This can be achieved through mobile health clinics, CHWs and outreach programmes that ensure coverage even in hard-to-reach areas. Training and deploying local health workers to administer PMC and monitor for potential adverse reactions is vital for the success of the intervention.

Coordination with international health agencies, local health authorities and NGOs is crucial to harmonize efforts, optimize resource allocation and ensure the sustainability of PMC programmes in these challenging environments.

4.6 Seasonal malaria chemoprevention

Seasonal malaria chemoprevention (SMC) is the systematic administration of antimalarial treatment to children during the transmission periods in areas of highly seasonal malaria transmission. Highly seasonal transmission is particularly prevalent in regions with distinct seasonal rain and temperature patterns (see Section 1.3). During acute humanitarian emergencies where pre-positioning of antimalarial medicines has been in place, rapid deployment of SMC can swiftly mitigate the burden of malaria among vulnerable groups, notably children, in areas experiencing elevated transmission rates.

The implementation of SMC in emergency settings demands meticulous planning and coordination among diverse stakeholders, including local health authorities, international health agencies and NGOs. Strategically pre-positioning antimalarial drug supplies, SMC specific pre-combined SP and amodiaquine (AQ), ensures timely availability for distribution during peak transmission seasons *(56)*. Comprehensive training programmes are required for health care personnel, encompassing efficient drug administration techniques and the management of potential adverse reactions. Community engagement initiatives are essential to foster understanding and adherence to the treatment regimen among caregivers. This should be facilitated through targeted health education campaigns and the involvement of community leaders in programme design and execution.

Deployment of mobile health units and outreach teams is a viable strategy to overcome logistic challenges to reach displaced and remote populations. Integration of SMC with existing humanitarian interventions, such as nutritional support and routine immunizations, amplifies the impact and operational efficiency of the response effort.

Robust monitoring and evaluation frameworks should be put in place to track coverage, adherence and health outcomes, and thus enable timely adjustments to optimize intervention efficacy.

By instituting SMC within emergency contexts, health authorities can execute a rapid, evidence-based intervention that bolsters the resilience of vulnerable populations against malaria, contributing to the stabilization of public health amidst crisis scenarios. See Case study 6.

Case study 6. Seasonal malaria chemoprevention implementation among IDPs in Borno State, Nigeria

In 2017, due to the surge of IDPs with limited access to basic health care services, resulting from the Boko Haram insurgency, malaria became the number one killer disease in Borno State, accounting for 50% of deaths according to WHO estimates.

To curb the high death toll resulting from malaria, WHO supported the Borno State Ministry of Health and other health delivery partners in Borno to launch an SMC campaign in July 2017.

From 2017 to 2019, the SMC campaign was implemented across selected local government areas in Borno, targeting about 1.1 million children (aged 3–59 months). In 2020, the SMC campaign in Borno was extended to all 27 local government areas, reaching more than 2 million children. The SMC campaign faced significant challenges due to insecurity, population displacement, limited access to hard-to-reach areas, and logistical constraints in delivering drugs to conflict-affected communities.

The Borno State Ministry of Health and WHO decided to implement digital and geospatial tools to enable better planning, tracking of teams, data collection and coverage accountability during the implementation of SMC campaigns. Geospatial processes and tools were deployed to support the planning and monitoring of the SMC campaign in Borno for Cycles 1 to 3 of the 2020 round of the SMC campaign. The geospatial tools were able to improve the SMC campaign through:

- improved planning: microplanning was possible based on the geospatial listing of settlements from the Nigeria data portal; and
- improved tracking and accountability: geographic information systems (GIS)-enabled mobile devices were deployed to community volunteer teams across all settlements where SMC activities were implemented.

Source: Planfeld, 2020 *(57)*.

4.7 Intermittent preventive treatment for school-aged children

Intermittent preventive treatment for school-aged children (IPTsc) involves administering a full therapeutic course of antimalarial medication at specific intervals to reduce the malaria burden in children aged 5–15 years living in areas with moderate to high malaria transmission. This approach aims to protect school-aged children, who are often overlooked in malaria control programmes but can still suffer significant morbidity from the disease. WHO's conditional recommendation for IPTsc is based on low certainty evidence, but recognizes the potential benefits in reducing malaria incidence among this age group, especially in emergency settings where malaria transmission is high and resources may be limited *(11)*.

WHO does not presently have a guidance document on how to implement IPTsc. Implementing IPTsc in emergency settings requires careful consideration of local malaria epidemiology and resource availability. NMCPs can consider integrating IPTsc if it does not compromise existing interventions targeting younger children who are at higher risk of severe disease. Schools may serve as efficient, low-cost distribution channels for chemoprevention, although alternative delivery methods might be needed to address seasonal transmission patterns and ensure equitable access. The timing and dosing schedule for IPTsc should align with periods of greatest malaria risk, and the use of first- and second-line malaria treatments for IPTsc should be avoided if safer, effective alternatives are available.

Overall, IPTsc can be a valuable addition to malaria control strategies in emergency settings, providing significant protection against infection for school-aged children and contributing to broader public health efforts.

4.8 Post-discharge malaria chemoprevention

Post-discharge malaria chemoprevention (PDMC) is a targeted intervention designed to prevent recurrent malaria in children recently treated for severe malaria. PDMC involves administering antimalarial drugs at regular intervals following discharge from a health care facility to reduce the risk of subsequent malaria episodes, which are particularly common and dangerous in the post-treatment period.

PDMC is especially relevant in emergency settings where the disruption of health care services and increased exposure to malaria vectors can exacerbate the vulnerability of recovering patients. By providing sustained chemoprevention, PDMC aims to enhance recovery outcomes and reduce overall malaria morbidity and mortality in these high-risk populations *(11)*.

Implementing PDMC in emergency settings necessitates a well-coordinated effort among health care providers, CHWs and humanitarian organizations to ensure timely and consistent delivery of the chemopreventive regimen. The choice of antimalarial drugs for PDMC should be guided by local drug-resistance patterns and safety profiles. Common regimens include dihydroartemisinin-piperaquine (DHAP) or sulfadoxine-pyrimethamine plus amodiaquine (SP-AQ). Effective PDMC requires robust patient tracking systems to monitor adherence and manage any adverse effects, alongside community education campaigns to raise awareness about the importance of completing the preventive treatment. In emergency settings, where health care infrastructure is often compromised, leveraging mobile health units and community-based distribution can enhance the reach and impact of PDMC, ultimately contributing to the resilience of affected populations against malaria.

4.9 Monitoring and evaluation of chemoprevention

Monitoring and evaluation of chemoprevention strategies for malaria during emergencies are critical for ensuring the effectiveness and efficiency of interventions. The information flow for monitoring and evaluation, as described in Fig. 21, follows

a systematic process involving data collection, reporting, uploading, and analysis followed by feedback and action. Key high-level indicators are employed to measure both coverage and impact, enabling stakeholders to make informed decisions and adjustments in real time.

Fig. 21. Systematic monitoring and evaluation for chemoprevention

By systematically monitoring and evaluating relevant indicators, health authorities and humanitarian organizations can ensure that chemoprevention strategies for malaria are effectively implemented during emergencies, ultimately improving health outcomes and reducing the disease burden in vulnerable populations.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Aregawi M, Smith SJ, Sillah-Kanu M, Seppeh J, Kamara ARY, Williams RO et al. Impact of the mass drug administration for malaria in response to the Ebola outbreak in Sierra Leone. Malar J. 2016;15:180 (https://doi.org/10.1186/s12936-016-1493-1).

- Implementing malaria in pregnancy programs in the context of World Health Organization recommendations on antenatal care for a positive pregnancy experience. Geneva: World Health Organization; 2018 (https://iris.who.int/handle/10665/259954).

- Intermittent preventive treatment for infants using sulfadoxine-pyrimethamine (SP-IPTi) for malaria control in Africa: implementation field guide. Geneva: World Health Organization; 2011 (https://iris.who.int/handle/10665/70736).

- Malaria threats map [website]. World Health Organization; (https://apps.who.int/malaria/maps/threats/).

- Malaria Toolkit app [mobile application]. World Health Organization; (https://www.who.int/teams/global-malaria-programme/malaria-toolkit-app).

- Mass drug administration for falciparum malaria: a practical field manual. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/259367).

- Seasonal malaria chemoprevention with sulfadoxine–pyrimethamine plus amodiaquine in children: a field guide, second edition. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/368123).

- WHO guidelines for malaria [website]. World Health Organization; (https://app.magicapp.org/#/guideline/LwRMXj).

Chapter 5.
Vector control

5.1 Overview

Vector control is a highly effective way to reduce malaria transmission, including in humanitarian emergency settings. Vector control tools should be deployed as a priority to save lives and reduce suffering among the most vulnerable. Vector control tools reduce the malaria reservoir by preventing mosquitoes from biting and becoming infected, thereby disrupting the human-mosquito transmission cycle. In emergency settings, WHO therefore underscores the importance of implementing well-designed and integrated vector control strategies that prioritize the most suitable and impactful vector control tools.

WHO recommends two interventions for large-scale deployment for the prevention and control of malaria in children and adults in areas with ongoing malaria transmission affected by a humanitarian emergency:

- insecticide-treated nets (ITNs)
- indoor residual spraying (IRS) *(58)*.

Larviciding is also recommended for the prevention and control of malaria in children and adults as a supplementary intervention to ITNs or IRS in areas with ongoing malaria transmission where aquatic habitats are few, fixed and findable. As the evidence base evolves, the recommendations may be updated; therefore the latest version of the WHO guidelines for malaria should be consulted *(11)*.

The evidence base on the efficacy of other vector control interventions has so far not been sufficient to garner a full WHO recommendation for large-scale deployment. However, recognizing that in some humanitarian emergency phases and settings deployment of ITNs or IRS deployment is not feasible, alternative vector control interventions have been developed and are undergoing evaluation (refer to Section 5.6). The appropriate use of these other tools – either alone or in combination – will depend on factors including logistics, human population behaviours and vector insecticide susceptibility and behaviour. With the best available information, the correct tools and optimal delivery methods for interventions targeting malaria vectors can be defined for both acute and protracted emergency settings.

Determinations regarding malaria vector control will be contingent upon:

- the risk of malaria infection;
- the behaviour of the human population (e.g. mobility, sleeping habits, exposure to vector mosquitoes);
- the behaviour of the local vector population (e.g. indoor resting, indoor biting, biting times such as early evening or night);

- the nature of available shelter (e.g. ad hoc refuse materials, plastic sheeting, tents, more permanent housing);
- actual or potential changes in the emergency situation; and
- feasibility of deploying interventions given the available infrastructure, resources and human capacity.

The decision-making process for selecting vector control interventions for emergency situations should consider all these factors along with WHO guidelines and guidance, national strategies and practical guidance, such as that provided by humanitarian relief partners. It is crucial that these decisions are made by the relevant national authorities in collaboration with NMCPs to ensure alignment with national strategies and available resources, and in consultation with the WASH, shelter and health clusters. A collaborative approach to informed decision-making enhances the likelihood of achieving successful vector control outcomes in humanitarian emergencies, so long as this does not undermine the timeliness of response.

This chapter discusses considerations for vector control deployment in emergency settings and provides actionable insights for practitioners and policymakers alike. This chapter will help guide stakeholders on when to intervene and where to focus efforts for controlling Anopheles vectors in areas affected by a humanitarian emergency to prevent malaria.

A summary of considerations for deployment of vector control interventions in humanitarian emergency settings is provided in Annex 3 and further information is available in the resources listed in the further reading.

5.2 Operationalizing vector control

Proactive planning is required prior to the occurrence of emergencies wherever they can be anticipated, whether they stem from adverse weather events such as hurricanes or floods or from conflict situations. Advance planning allows for the identification of potential risks, the establishment of robust distribution channels, and the stockpiling of essential resources to ensure swift and efficient response when emergencies arise. By anticipating challenges and developing contingency plans, organizations responsible for emergency response can mitigate the impact of emergencies on malaria transmission, thereby safeguarding the health and well-being of affected populations.

During emergencies, vector control strategies often need to be adapted to ensure effective protection of vulnerable individuals in malaria endemic areas. For instance, these should consider the heightened exposure to mosquito bites due to the use of different shelter types or a lack of shelter. Changes to vector control interventions and deployment methods will be needed for displaced and host communities residing in settlements, towns, villages or rural homes and those who are sleeping outdoors without adequate shelter. In acute emergency settings with displaced populations and inadequate shelter, neither IRS nor standard ITNs may be optimal. In such cases, other vector control measures may become more relevant (see Fig. 22).

During humanitarian emergencies there may not always be sufficient information and coordination to promote high access and use of vector control interventions among

displaced populations. Stakeholders should consider conducting rapid assessments to understand the specific malaria transmission risks and vulnerabilities in the affected area and to develop or tailor comprehensive plans to the emergency context (see below). Likewise, stakeholders should understand what resources are available for the purchase, delivery and monitoring of vector control interventions and for the training of health workers and volunteers. Additional operational adaptations may be needed for engaging with local communities to raise awareness about malaria prevention measures, gain their support and encourage participation in vector control efforts.

Adaptations to operational plans should include creating faster systems for monitoring vector populations and their susceptibility to insecticides, allowing for targeted interventions. Stakeholders should consider changes that might be needed to train local health workers and volunteers on vector control techniques, safety protocols and surveillance methods. Adaptations to training materials and styles may include use of digital tools where and when appropriate, as was seen during the COVID-19 pandemic. Finally, methods of collaboration with relevant stakeholders, including cluster systems, government agencies, NGOs and international partners, may be different in emergency settings.

All operational adaptations for deployment of vector control tools in emergency settings should include strategies to transition from emergency response to long-term malaria control efforts, integrating vector control activities back into routine health systems where possible.

Fig. 22. Shelters and types of vector control tools that could be used in emergency settings

No/partial shelter + movement

Potential vector control tool: treated blankets, tropical repellent, non-mesh net etc.

Photo Credit: Elizabeth Juma

Partial shelter (e.g. tarpaulin over ridge pole with partial walls)

Potential vector control tool: spatial emanators

Photo Credit: EU Civil Protection and Humanitarian Aid

Tent like structure

Potential vector control tool: IRS, spatial emanator, potentially ITNs, LSM if permanent encampment

Photo Credit: MENTOR Initiative

Full shelter/normal housing

Potential vector control tool: IRS, spatial emanator, potentially ITNs, LSM

Photo Credit: MSF

ITN: insecticide-treated net; IRS: indoor residual spraying; LSM: larval source management

5.2.1 Joint assessments for vector control

In the context of humanitarian emergencies, a joint assessment is needed to evaluate key parameters to help select vector control interventions and appropriate adaptations to operational procedures (see Table 10). Some data may already be available and some may need to be collected. It is important to collect as much information as possible to guide informed decisions on the deployment of vector control interventions in the specific emergency setting.

Table 10. Joint assessment parameters, potential data sources and the actions for specific areas

Parameters	Potential data source	Action for the specific area
Vector control coverage rates	Malaria indicator survey (MIS) NMCP data	Evaluate access and use rates of existing vector control tools, such as ITNs and IRS.
Malaria transmission and seasonality	National malaria strategy Peer-reviewed literature	Gather comprehensive information on the local dynamics of malaria transmission, including peak seasons and variations in transmission intensity. Consider other vector-borne diseases that may be affected by interventions.
Sleeping habits and prior ITN use	National malaria strategy Peer-reviewed literature	Explore the sleeping habits of the population at risk, including nocturnal activities and communal sleeping arrangements. Understand cultural acceptance of ITN use from previous distributions.
Malaria vector species and behaviour	Entomological assessments Published literature	Identify the local main malaria vector species and their specific biting and resting habits, including vector abundance and distribution.
Insecticide resistance	WHO Malaria Threats Map *(16)* Peer-reviewed literature Unpublished reports	Determine the level of insecticide resistance in the main malaria vector species and identify whether tests are needed.
Local availability of vector control supplies	Logistic management information system registers Cluster system logistic partners	Assess local availability and lead time for delivery of essential vector control supplies, including insecticides, ITNs, IRS equipment and other interventions such as spatial emanators, treated blankets and treated tents.
Additional vector control supplies	Stock and commodities from vector control partners International manufacturers and suppliers	Evaluate funding availability and procurement timelines for additional vector control supplies. Include the requirements within emergency proposals and budget requests to suitable emergency donor organizations. Ensure waivers for importation (where required for unregistered products) are obtained from national authorities. Ensure rapid procurement and shipping of the needed interventions and materials to the site of the emergency for onward deployment.
Availability of suitable structure	Shelter cluster system On-the-ground assessment	Investigate the changing availability and timelines for introduction of emergency shelters suitable for IRS. Assess the adequacy of shelter space, shape and structure for deploying ITNs at the recommended ratio of one net for every 1.8 persons.
Changing security situations	Cluster system situation reports	Monitor and analyse the evolving security situation. Evaluate the impact of security conditions on the feasibility and safety of deploying vector control interventions.
Potential for implementation research	Published literature Applied methodology from research partners	Develop a clear understanding of how vector control use can be effectively monitored and evaluated to help make informed decisions on effectiveness and to guide actions in future emergencies. Put in place basic monitoring capacity for vector control intervention deployment and usage and, where possible, entomological impact.

5.2.2 Logistic considerations for IRS and ITNs

Deployment requirements associated with interventions must be thoroughly considered to ensure interventions are safe, effective and implemented to high quality in a targeted and timely fashion. Distribution, storage and disposal requirements for the insecticides must be considered. An adequate supply chain is required to deliver them where and when they are needed, and storage conditions must ensure they retain efficacy (see Chapter 2). Specialized equipment and trained personnel may be necessary for their appropriate deployment *(59)*. Disposal of packages or containers, old ITNs, unused insecticides, washing water and personal protection or other equipment must follow national requirements to maximize environmental protection and human safety.
By carefully coordinating these logistic elements, vector control can achieve greater impact against malaria in emergency settings *(60)*.

Logistical issues to be considered for specific pesticide product include the following.

1. **Planning and buying – negotiation of flexible stock:** conduct comprehensive stock assessments and negotiate procurement agreements that offer flexibility in buying stock, adapting to evolving vector control needs and market dynamics for optimal cost–effectiveness.
2. **Procurement with lead time and import processes:** align procurement practices with emergency donor organization regulations, considering lead times and implementing contingency plans to mitigate potential delays in production, shipping and customs clearance.
3. **Registration (or country approval/waivers):** if vector control products are not already used or registered within the country affected by the emergency, waivers can be obtained from national authorities for local use of internationally tested and approved products.
4. **Importation:** develop a detailed plan for customs clearance, ensuring accurate documentation (including any waivers) and collaborative coordination with authorities to expedite the importation process.
5. **Transport and storage:** optimize transportation routes. Secure suitable storage and in-country transport facilities to avoid exposing products to excessive heat, direct sunlight, water or other damaging elements. Implement robust tracking mechanisms to ensure timely and secure delivery, maintaining supply chain visibility throughout. The Alliance for Malaria Prevention toolkit on vector control logistics are helpful.
6. **Deployment and use:** implement training programmes for proper product application, establish monitoring and evaluation systems to assess and ensure ongoing effectiveness, and engage local communities to foster awareness and adherence.
7. **Disposal:** adhere to environmentally responsible disposal practices, explore recycling opportunities and develop comprehensive plans for the proper disposal of packaging, containers, leftover insecticide and washing water.

5.2.3 Insecticide resistance in choosing effective vector control tools

Insecticide resistance in malaria vectors poses a significant challenge in selecting the most suitable vector control tools for emergency settings Pyrethroids have traditionally been used in ITNs and IRS; however, widespread pyrethroid resistance among malaria

vectors in most malaria endemic countries, has raised concerns about the effectiveness of these interventions when pyrethroid insecticides are used exclusively. In areas where pyrethroid resistance is prevalent, relying solely on pyrethroid-based interventions can lead to suboptimal outcomes and may further exacerbate the problem by selecting for increased resistance *(61)*. Consequently, incorporating interventions that utilize non-pyrethroid insecticides should be prioritized.

When selecting vector control tools for emergency settings in regions with pyrethroid resistance, it is essential to assess the resistance status of local vectors. In the absence of local efficacy data, evidence from neighbouring areas and countries can provide valuable guidance for initial insecticide selection. In such contexts, the default choice of insecticides for vector control interventions in humanitarian emergencies should favor non-pyrethroid options to counteract resistance and maximize impact. This approach ensures that interventions remain effective despite resistance challenges. Additionally, regular monitoring of resistance patterns is critical for adapting strategies and maintaining their long-term effectiveness.

Furthermore, integrated vector management approaches, which involve combining multiple complementary interventions tailored to local conditions, offer promise in mitigating the impact of pyrethroid resistance. By diversifying control measures and minimizing reliance on any single insecticide class, integrated vector management can enhance the resilience of vector control efforts against resistance *(62)*.

In summary, addressing insecticide resistance is paramount when selecting vector control tools for emergency settings. By prioritizing evidence-based decision-making, monitoring resistance trends and embracing integrated approaches, public health authorities and their international and national NGO partners can optimize malaria control strategies and better protect vulnerable populations in emergency contexts.

5.3 Insecticide-treated nets

An insecticide-treated net (ITN) is a net that has been treated with insecticide to kill or repel mosquitoes and other insects that can transmit disease. These nets are designed to be used over sleeping areas, such as straw or cloth mats, beds or cots, providing a protective barrier between the sleeper and the insects. By sleeping under an ITN, individuals avoid mosquito bites during the night, which is when many of the malaria vectors are most active in their host seeking. When mosquitoes come into contact with the net while host seeking, they are exposed to the insecticide, which is either on or impregnated on the net.

In addition to protecting those sleeping under the net, ITNs can also lower the overall disease burden by reducing the population of pathogen-carrying insects in the community.

ITNs should be deployed for the prevention and control of malaria in children and adults in areas with ongoing malaria transmission affected by a humanitarian emergency.

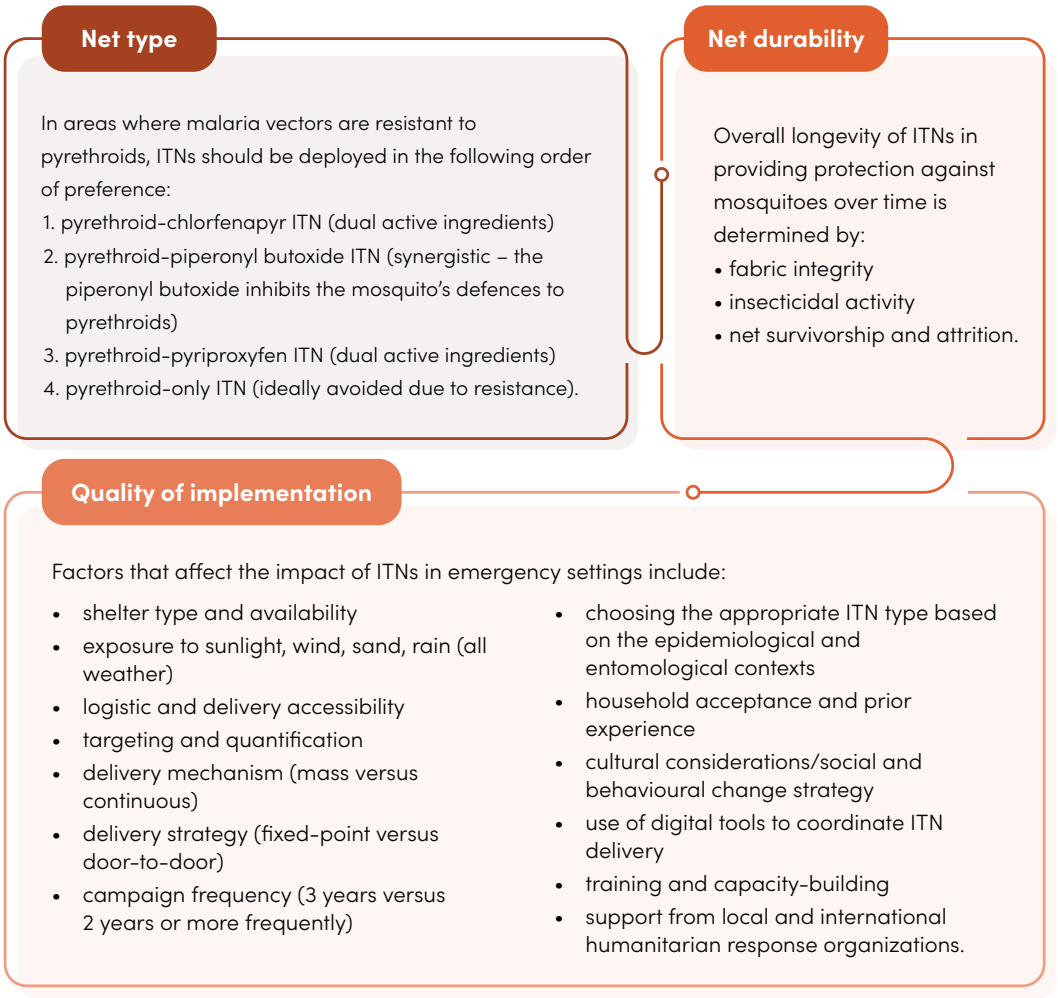
Resistance of malaria vectors to pyrethroid insecticides commonly used in ITNs is now a major problem in Africa and Asia (see Section 5.2.3). ITNs are available in versions that contain two active ingredients that work together to target mosquitoes through

different mechanisms. Additionally, some ITNs are treated with substances that enhance the effectiveness of the insecticide by creating a synergistic effect, making them more effective at killing or repelling mosquitoes.

In areas where malaria vectors are resistant to pyrethroids, or in any emergency context where there is no recent insecticide efficacy data, and with a view to maximizing impact, pyrethroid-chlorfenapyr ITNs should be prioritized, followed – in order of preference – by pyrethroid-piperonyl butoxide ITNs or pyrethroid-pyriproxyfen ITNs. The deployment of pyrethroid-only ITNs is least preferred and should ideally be avoided.

When considering deployment of ITNs in humanitarian emergencies, in addition to the preferred chemicals, the infrastructure, access, net durability, logistic capacity and resources available must be considered (see Fig. 23), as these may influence the feasibility and cost of procuring and deploying ITNs *(11)*.

Fig. 23. Maximizing the impact of ITNs in emergency settings



5.3.1 Practical information

When determining whether ITNs are suitable for a specific emergency setting, the factors outlined in Fig. 23 must be carefully considered. ITNs are most effective in areas where the primary malaria vectors bite at night, after children and others have taken shelter under their nets, and where mosquitoes are susceptible to the insecticides used on the nets. Different data sources can help evaluate whether these conditions are met (see Chapter 7).

In addition to assessing whether ITNs are appropriate, the feasibility of deploying nets in a particular emergency setting must be considered. Depending on the infrastructure, access to householders, logistic capacity and resources available, procuring and distributing nets may be more challenging than in more stable settings. Insecurity and instability in such settings may challenge long-term planning needed for procurement of nets from international manufacturers, resulting in shorter lead times for production, and consequently higher costs.

It is also important to determine whether the shelters or housing structures in such settings are suitable for hanging a net. In some situations, the structure may have nowhere to hang a net or the shelter may be too small to adequately accommodate a net.

Three key decisions are required once it is deemed appropriate to proceed with ITN deployment.

- **Selection of net type:** in humanitarian emergency settings where vectors are resistant to pyrethroids, an alternative to pyrethroid-only ITNs should be prioritized as specified in Section 5.2.3. ITN selection should be made in conjunction with the NMCP and other relevant emergency stakeholders.

- **Fabric integrity of netting material:** the integrity of the netting material varies with the fibre type, denier, weight and other net characteristics such as knit pattern. Due to the harsh conditions faced in humanitarian emergency settings, ITN denier of 100 or above may be preferred. ITN durability should be monitored to ensure that timing of replacement campaigns in protracted emergency settings is appropriate, as this may need to be shortened to cater for the harsher conditions that reduce the useful lifespan of ITNs.

- **Colour and shape preference:** ITNs are available in rectangular and conical shapes and several colours. Some colours may be refused or misused by recipients because of the cultural significance of certain colours. White ITNs show dirt and therefore may be washed more often than coloured nets. Opaque cotton (non-mesh) sheeting has been preferred in some settings, such as South Sudan (see Section 5.6.2).

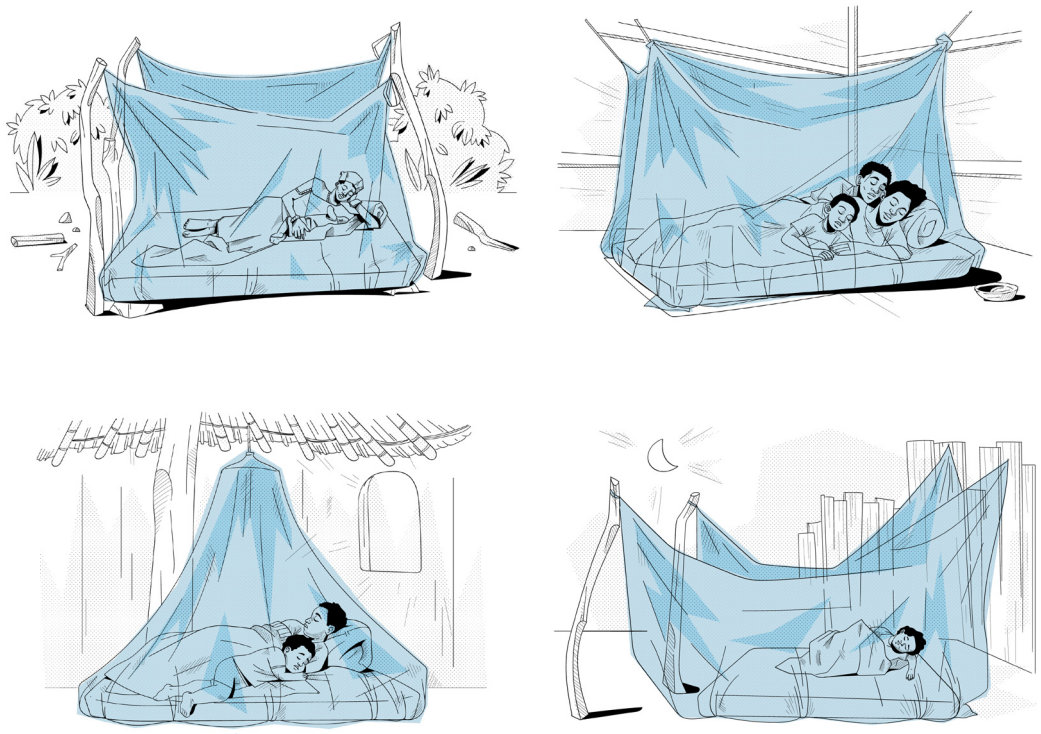
5.3.2 Planning and procurement

Planning should consider different ITN distribution channels (e.g. mass campaign, continuous distribution, targeted distribution) based on the type and severity of the emergency. Net quantification will differ depending on the target population (e.g. most vulnerable, under 5 years, pregnant women or universal coverage). For universal coverage, the number of ITNs required is determined from population data. Because many households have an odd number of members, a ratio of one ITN for every 1.8 persons in the target population should be used to estimate quality of ITN needed, unless data to inform a different quantification ratio are available. Non-emergency campaigns are generally repeated every 3 years, but this frequency should be adjusted if empirical evidence (which can include conditions in humanitarian emergencies) justifies the use of a shorter interval between campaigns. Population displacement, inadequate shelter, and harsh living conditions can limit access to effective ITNs, accelerate the wear and tear of ITN materials, and heighten the risk of infection and potential outbreaks.

It is important to identify the population at risk during an emergency (see Section 1.5). In emergency settings, displacement means population numbers often fluctuate, and census data may not be available, so a buffer of nets should be factored for new arrivals. At least a 20% buffer stock should be included in ITN procurement to account for changing populations. When supplies are insufficient to cover the entire population, ITNs can be targeted to provide personal protection to vulnerable groups (e.g. young children and pregnant women) although coverage of all at-risk individuals is preferred to ensure communitywide protection. Annex 2 includes a planning tool to help determine the requirements and costs of ITNs.

Where possible, ITNs should be ordered well in advance of planned distribution, to ensure timely delivery and to reduce procurement and transportation costs, especially in emergency settings. ITNs can be used indoors or outdoors, wherever the population normally sleeps, but appropriate installation should be explained to the users. It is important to organize and implement an effective behaviour change communication campaign prior to distribution (Chapter 6). Messaging to beneficiaries should explain that ITNs may be used outdoors with appropriate means of physical support (see Fig. 24), but should not be exposed to direct sunlight due to potential degradation of the insecticide.

Fig. 24. Example approaches to hanging an ITN indoors and outdoors



Awareness of the traditions, beliefs and practices of populations in affected areas is crucial because these factors can influence the acceptance or rejection of ITNs or specific types of ITN. This is particularly important in emergency settings, where populations may be displaced. Understanding cultural variations in correct use of nets involves recognizing the specific settings where the use of nets may not be culturally appropriate. The design and materials of the ITNs might clash with cultural aesthetics or practical needs, and preferred sleeping arrangements in the emergency setting are important. Engaging with community leaders and members to gain insight into these cultural nuances is essential for ensuring that ITN distribution is both respectful and effective. This cultural sensitivity can enhance the acceptance and correct use of ITNs, thereby improving their efficacy in preventing malaria and other vector-borne diseases in emergency situations.

5.3.3 Distribution and coverage

A combination of campaign and continuous distribution can be sufficient to sustain coverage in normal settings; however, adaptations may be needed for emergency settings. In emergencies, ITNs may be delivered through national systems in which plans have been adapted for displaced populations or through humanitarian response partners (e.g. to displaced populations in camp settings). WHO recommends a combination of mass free distribution campaigns complemented by other locally appropriate delivery mechanisms such as continuous distribution through antenatal clinics, immunization programmes and similar appropriate channels *(11)*.

ITN campaigns use a proven approach consisting of the following stages: macroplanning, microplanning, training, household enumeration and distribution. Each of these stages needs to be adapted in emergency settings to account for the unique challenges and dynamics present.

- Macroplanning involves large-scale strategy development, which must consider the instability and mobility of populations in crisis situations.
- Microplanning requires detailed logistic arrangements that address local security risks and access issues.
- Training must be adjusted to ensure that campaign staff are prepared for the complexities and dangers of working in an emergency context.
- Household enumeration, the process of counting and recording households, must be flexible to account for displaced populations and unconventional living arrangements.
- Distribution must be carried out with heightened sensitivity to security concerns, ensuring that ITNs reach all intended recipients despite the challenges posed by the emergency setting *(63)*.

There are several ways to distribute ITNs, each with varying levels of effectiveness. In emergencies, mass fixed-point distribution is an option where beneficiaries are invited to a central location to receive ITNs based on household size. This method also allows for community sensitization activities and information, education and communication/ social and behavioural change communication programming to be conducted while

people wait to receive their ITNs. Alternatively, door-to-door distribution involves delivering ITNs directly to each household. Although this method is slower, it often achieves higher retention and use rates and encourages community participation. Both modalities have their advantages and disadvantages, and the choice between them should be based on feasibility, security, logistic considerations and time constraints. Case study 7 highlights some of these issues in practice.

Implementing continuous distribution of ITNs in protracted emergency settings is essential to ensure sustained protection against malaria for vulnerable populations. This approach should integrate with existing health services, such as antenatal care and immunization programmes, and utilize CHWs and local volunteers for distribution. Schools and mobile clinics can serve as additional distribution points, reaching students and displaced populations. Effective supply chain management is crucial to prevent stockouts, while continuous monitoring and evaluation helps track progress and identify gaps. Community engagement and education are vital for promoting ITN acceptance and proper use. Flexibility and adaptability to changing conditions, including security situations and population movements, are necessary for maintaining effective distribution in unstable environments *(64)*.

If insufficient ITNs are available, vulnerable groups should be prioritized, including pregnant women, children under 5 years and populations living in hotspot transmission zones. Catch-up distribution campaigns can be planned ahead in protracted emergency settings to maintain coverage and correct use. In low transmission areas, ITNs should only be distributed in clinical settings (e.g. antenatal care or inpatient facilities) to vulnerable groups *(65)*.

In emergency settings, incorporating digital tools into ITN distribution can significantly enhance the efficiency and effectiveness of the process. Digital tools can support various aspects of ITN campaigns, from planning and logistics to monitoring and evaluation. For example, digital mapping and mobile applications can improve household enumeration and registration, while digital platforms can provide training materials and resources to distribution teams. Additionally, mobile messaging and social media can communicate distribution schedules and locations to communities. However, it is crucial to ensure that the community accepts and is comfortable with the use of these digital tools. Efforts should be made to engage with community leaders and members to build trust and ensure the tools are culturally appropriate and user-friendly. While there are challenges such as connectivity issues and the need for digital literacy, the benefits often outweigh these obstacles, making digital tools an asset in emergency ITN distribution efforts *(66)*.

Case study 7. Insecticide-treated net distribution in North-West Region, Cameroon

In Cameroon is one of the countries engaged with a "high burden to high impact" response to malaria. This approach is driven by political will, strategic information, better guidance, policies and strategies, and a coordinated national response *(67)*. Cameroon accounts for 3% of the malaria cases in the 11 highest burden countries. Since 2017, the armed conflict between non-state armed groups and the Cameroon Armed Forces has led to 670 000 IDPs and 58 000 refugees in Nigeria. Despite families fleeing and deserting some health areas, some people remained in all health districts. The armed conflict caused population movements out of villages, while the COVID-19 pandemic led to a return to villages due to the high prevalence of COVID-19 in larger cities. According to the North-West Regional Delegate of Public Health, about 25 of the 416 health facilities were destroyed, and health workers deserted many more. CHWs and humanitarian NGOs provided basic services in most areas.

The North-West Region was allocated 1 162 050 ITNs. The campaign was planned for December 2019, but delayed to 2020 due to the sociopolitical crisis. Two distribution strategies were identified: fixed-point "hit and run" (involving making an appointment to collect ITNs from a fixed distribution point) and door-to-door (involving delivery of distribution teams close to households), chosen during health area advocacy meetings based on security conditions. These strategies were adapted to the COVID-19 pandemic by limiting gatherings, ensuring physical distancing and quickly getting ITNs into households.

Lessons learned include the importance of adapting strategies to risk areas, ensuring community participation through advocacy meetings, and collaborating with organizations such as the World Food Programme for transportation despite access limitations. The training duration for new strategies was short, but proximity supervision was helpful. Understanding the settlement patterns of displaced populations, who often moved in with family members, was crucial. Ultimately, the distribution of 1 026 101 ITNs, covering 1 797 112 people including 104 130 IDPs, is commendable under the challenging conditions of insecurity and the pandemic.

Source: The Alliance for Malaria Prevention, RBM Partnership to End Malaria *(68)*.

5.4 Indoor residual spraying

When implemented properly, indoor residual spraying (IRS) is a highly effective intervention that provides protection by reducing mosquito survivorship and population size. IRS involves applying residual insecticide to potential vector resting sites on the interior surface of human dwellings or other buildings where vectors are likely to come into contact with the insecticide. The basic preconditions for IRS are target mosquitoes that enter and rest inside houses (an endophilic vector) long enough to encounter the insecticide. Targeted spraying can be used to protect

populations in areas with ongoing malaria transmission affected by a humanitarian emergency, in transmission foci in low transmission settings or where there are reports of a high level of *P. falciparum* drug resistance.

Strategic decisions may be needed about where to deploy IRS in relation to transmission ecology, vector behaviour and resistance, and malaria endemicity in emergency settings. This information should be collected in the malaria risk assessment (Chapter 1).

When deciding whether IRS may be appropriate for prevention and control of malaria in areas affected by a humanitarian emergency, programmes should consider whether:

- the main malaria vectors in the area are endophilic and thus the majority of the vector population is likely to come into contact with insecticides on sprayed interior surfaces;
- the human populations in the area mainly sleep indoors at night;
- the acceptance of spraying by the population is good, which enables high access rates for spray teams;
- the structures are suitable for spraying (some shelters provided in emergency settings may not be suitable, such as open-sided structures);
- high coverage of IRS can be feasibly achieved in the setting and protection can be provided throughout the transmission season, such as with multiple spray rounds if needed; and
- there are sufficient resources to cover the relatively intensive and expensive operations associated with an IRS programme – in such settings, transport of commodities to hard-to-reach areas, coupled with the need to quickly procure items and establish human capacity to deliver the intervention, is likely to incur additional complexities and higher costs than when deploying IRS in more stable settings.

5.4.1 Practical information

IRS is usually effective for at least 3 months and often for up to 6 months or longer depending on the insecticide product used, type of surface sprayed and quality of spray application. Only WHO prequalified products (see Table 11) should be used, as these have been assessed for efficacy, safety and quality. Insecticides currently used for IRS fall into six insecticide classes, which are grouped according to five modes of action based on their primary target site in the vector. As of December 2024, IRS products prequalified by WHO include five of the six classes (with no organochlorine product prequalified) *(58)*. The latest prequalified insecticide classes will be added online when approved.

Table 11. Insecticides in WHO prequalified products for IRS

Mode of action	Insecticide class	Examples of insecticides in prequalified products
Sodium channel modulators	Pyrethroids	alpha-cypermethrin deltamethrin lambda-cyhalothrin etofenprox bifenthrin
Acetylcholinesterase inhibitors	Organophosphates	pirimiphos-methyl
	Carbamates	bendiocarb
Nicotinic acetylcholine receptor allosteric inhibitors	Neonicotinoids	clothianidin
GABA-gated chloride channel allosteric modulators	Meta-diamides	broflanilide
Juvenile hormone mimics	Insect Growth Regulator (IGR)	pyriproxyfen

Note: dichlorodiphenyltrichloroethane (DDT) has been classified as a persistent organic pollutant. The decision to use DDT for malaria vector control needs to be based on a detailed analysis that considers all other potential options for vector control and provides clear reasoning for choosing DDT over the other options. WHO considers DDT to be a last resort, not a first choice *(69)*.

As with ITNs, it is important to ensure that the local malaria vector populations are susceptible to the insecticide selected for spraying. Therefore, pyrethroid IRS is not appropriate in many humanitarian emergency settings, such as in Africa or Asia where there is widespread pyrethroid resistance. Products with insecticides with different modes of action should be used in rotation, ideally with a different product for each spray round, to reduce the risk of development of insecticide resistance in local malaria vectors.

In humanitarian contexts, additional spray rounds may be required to ensure continuous protection throughout the transmission season. This would normally need to be done after 4–12 or more months depending on the expected efficacy in the local setting, considering the insecticide product and surfaces sprayed, and the length of the transmission season.

Insecticides applied by IRS may remain available on various surfaces in emergencies, including plastic sheeting and tents. Residual efficacy will vary depending on insecticide formulation and surface substrate (commonly polyethylene, polyester or natural fibre canvas), and this should be taken into consideration when planning additional spray rounds to ensure continuous protection. For less permeable spray surfaces, such as plastic sheeting, the insecticide formulation is an important consideration to increase acceptance of spraying by residents and improve duration of efficacy.

5.4.2 Planning and procurement

Planning and procuring for IRS in emergency settings, whether due to conflict or natural disasters, require careful consideration95 National programmes, first responders and cluster/sector leads should be aware of the key considerations described in Table 12.

Table 12. Indoor residual spraying planning and procurement considerations in emergency settings

Assessment and planning	Collect data on the number and type of structures to be sprayed, number and type of rooms per structure (if applicable), size of rooms, surface material of the walls and ceilings, and names of residents. Identify facilities and locations for equipment and supply storage and waste disposal.
Coordination with health authorities	Establish effective communication channels with local health authorities and other relevant stakeholders. Collaborate with the WASH and health clusters/sector to align IRS activities with broader WASH and health response efforts.
Identification of targeted areas	Prioritize areas with high malaria or other vector-borne disease transmission or where vulnerable populations are concentrated. Consider factors such as population movement, settlement patterns and existing health care infrastructure.
Insecticide selection	Choose WHO prequalified products based on the resistance profile of the main vectors in the area and the type of wall surface to be sprayed (e.g. less permeable surfaces may need a different formulation).
Procurement and supply chain challenges	Anticipate and address potential challenges in procuring insecticides and equipment, such as supply chain disruptions, air-cargo regulations/limitations, other transportation issues and limited availability. Adhere to regulatory requirements and environmental regulations of national authorities and development partners related to transportation, storage, use and disposal.
Training and capacity-building	Recruit spray team workers from affected communities to maximize community acceptance and campaign access. Provide training to spray teams on good-quality application of IRS as well as correct use of personal protective equipment, equipment maintenance, and safe insecticide use, transport and disposal.
Community engagement	Engage with affected communities and community leaders to explain the purpose and benefits of IRS, and to agree campaign dates and times, to ensure maximum preparedness, acceptance, access and adherence. Address any concerns or misconceptions regarding the spraying process and human and animal safety of the insecticides.
Rotation of insecticides	When planning for multiple IRS spray rounds, integrate rotation of insecticides with different modes of action to mitigate the development of insecticide resistance. Monitor and assess the residual efficacy of different insecticides over time.
Data collection and monitoring	Establish a robust monitoring and evaluation system to track the progress, coverage and impact of IRS activities. Where possible, collect data on indoor vector density pre- and post-spraying.
Other logistic considerations	Ensure logistic support for the transportation of equipment, insecticides and personnel to the targeted areas. Ensure water is sourced or, where needed, transported to sites that can be easily accessed by IRS teams so it is available during campaign delivery. Plan for the disposal of waste generated during IRS activities in an environmentally acceptable manner and in line with national requirements.

IRS delivery in emergency settings should remain flexible in the planning process to adapt to changing circumstances, such as population movements and expansion in camp shelter numbers, especially in early-stage emergencies or where settlements or communities are absorbing influxes of displaced people. By addressing these aspects, national programmes, WASH and health responders and cluster leads can contribute to a well-planned and effective IRS intervention in emergency settings.

5.4.3 Distribution and coverage

IRS is dependent on the quality of spraying operations and at least 80% of dwellings should be properly sprayed. IRS will only achieve its full impact if walls are sprayed prior to the epidemic peak and this requires detailed advance planning and sufficient logistic capacity in spray teams. An IRS campaign is highly dependent on operational factors, including timely delivery of commodities, trained staff, supervision and, especially, community engagement (see Chapter 6).

In humanitarian emergency settings, the organization of IRS spray teams is critical to ensure efficient and effective operations. Typically, IRS spray teams consist of personnel recruited from among affected communities and trained on site. Experienced and skilled field supervisors manage and guide spray teams on the ground. Team leaders are appointed to oversee coordination and communication for each team. The teams are usually divided into specialized roles, including sprayers responsible for the application of insecticides; data collectors for monitoring and evaluation; logistics personnel to handle and maintain equipment, insecticide and water supplies; and people responsible for ensuring the regular washing of IRS personal protective equipment. Adequate training and ongoing supervision during campaigns is essential to equip and sustain team members with the necessary skills for safe and effective IRS application. Additionally, clear communication channels and regular briefings and debriefings ensure that the spray teams operate cohesively, adapting to the dynamic challenges of humanitarian emergencies. Coordination with local health authorities, community engagement and adherence to safety protocols contribute to the overall success of IRS interventions in these complex settings.

IRS in areas affected by a humanitarian emergency will normally involve the support, funding and campaign coordination of external agencies, such as an NGO with experience working in affected communities. In emergency settings, IRS models should be adaptable to cater to diverse situations, circumstances and target area needs. This flexible approach aims to reach vulnerable populations, optimize IRS coverage rates and manage costs effectively. The three main IRS models are district-based, community-based and hybrid.

- The district-based model, employing a top-down approach, involves local governments, community leaders and health management teams leading campaigns through the provision of technical assistance.
- The community-based model decentralizes planning and logistics, empowering local leaders who receive direct project support. Operations are distributed within target communities, utilizing local storage for IRS commodities.
- The hybrid model combines aspects of both, tailoring interventions to unique community circumstances, thus maximizing coverage, reducing costs and enhancing efficacy, with the support of a skilled and experienced organization.

This adaptive approach ensures the broadest protection, delivering results to those at the highest risk of malaria in diverse emergency contexts *(70)*.

Case study 8 describes a range of challenges and responses in providing IRS in refugee camps in Maban County, South Sudan.

Case study 8. Indoor residual spraying in Maban County, South Sudan

Malaria remains the leading cause of morbidity and mortality in South Sudan. In 2022, it accounted for 63% of all morbidities and 69% of all mortalities, particularly affecting children aged under 5 years, the most vulnerable age group without acquired immunity. Maban County, in Upper Nile state, hosts four refugee camps – Doro, Kaya, Yusuf Batil and Gendrassa – which collectively accommodate more than 200 000 refugees, mostly from South Kordofan and Blue Nile State in Sudan. Doro, the first camp, was established in 2011. The other camps followed shortly after. Most shelters in these camps are made of plastic sheeting, provided by UNHCR and the International Organization for Migration, combined with local materials such as mud, sticks or corrugated iron sheets (see Fig. 25).

Fig. 25. IRS application

Alongside entomological factors, consideration of non-entomological factors is equally important for implementing a successful malaria vector control campaign. Human behaviours (e.g. house repairs or migrations), the potential implications of concurrent activities by other actors (e.g. food distributions increasing food stocks in households), political tensions and security concerns are common challenges. The need for adaptability is underscored by the annual variation in the numbers of persons protected and structures sprayed during IRS campaigns in 2017–2018. Despite the inherent difficulties of the situation, a vector control programme based mainly on IRS was feasible in an open setting and refugee camp associated with a complex emergency. Excellent coverage was achieved for IRS in the 2017 and 2018 campaigns. After the IRS interventions in 2017 and 2018, there was a notable decline in malaria indicators compared to 2016. The total number of malaria cases in 2017 declined by 51.8% in Doro camp and 73.2% in the Bunj host community. Additionally, reductions in mortality and RDT-positive rates in children aged under 5 years and pregnant women were observed.

Source: contribution from MENTOR Initiative.

5.5 Larval source management

Larval source management (LSM) for malaria is the intentional alteration of natural or artificial water bodies that are confirmed or potential aquatic habitats of the immature stages of *Anopheles* mosquitoes (eggs, larvae and pupae). This aims to prevent the development of the immature stages to adult mosquitoes. There are four types of LSM:

1. **habitat manipulation:** aquatic habitat alterations by recurring changes such as flushing;
2. **habitat modification:** aquatic habitat changes by permanent alteration to the environment, such as drainage;
3. **biological control:** the introduction of natural predators into water bodies; and
4. **larviciding:** the regular application of biological or chemical insecticides to water bodies.

Larviciding is recommended as a supplementary intervention for malaria prevention and control in areas where high coverage with ITNs or IRS has been achieved, where aquatic habitats are few, fixed and findable, and where its application is both feasible and cost-effective. The use of LSM is applicable in certain emergency situations.

5.5.1 Practical information

LSM is a valuable vector control tool in specific contexts. Of the LSM approaches, larviciding is generally the most feasible in an emergency setting. WHO recommends that larvicide only be applied in areas where mosquito aquatic habitats are easy to identify, map and access. In settled encampments, the effectiveness of other LSM approaches such as habitat modification relies on the collaboration between camp engineering and WASH initiatives to ensure proper drainage and surface water management. This preventive measure aims to eliminate potential vector larval habitats around key areas such as roads, water points, brick holes and borrow pits.

The application of larvicides is more feasible in areas where there is a lower number and smaller surface area of potential habitats. Larvicides can be administered using various equipment for both individual source treatments and wider-area applications. LSM is crucial to address the threat of vectors of malaria (and arborviral diseases) inhabiting artificial containers, such as rain-filled tires, solid waste, domestic water containers, and large communal water tanks in arid areas. Additionally, in emergencies where refugees excavate material for construction, borrow pits can inadvertently become mosquito breeding grounds.

The impact of larviciding is usually effective for 3 months, and often longer, depending on the epidemiologic setting, product, formulation, and target aquatic habitat. Only WHO prequalified products should be used because these have been assessed for efficacy, safety and quality. Larvicides currently fall into six insecticide classes, which are grouped according to modes of action based on their primary target site in the vector. As of December 2024, mosquito larvicide products prequalified by WHO include examples from all six groups (see Table 13).

Table 13. WHO-prequalified mosquito larvicide products

Mode of action	Examples of active ingredients in prequalified products
Acetylcholinesterase inhibitors	organophosphates: pirimiphos-methyl, temephos
Nicotinic acetylcholine receptor allosteric modulators	spinosad
Juvenile hormone mimics	pyriproxyfen
Microbial disruptors of insect midgut membranes	*Bacillus thuringiensis* (Bt) and the insecticidal proteins they produce *Bacillus sphaericus* (Bs) and the insecticidal proteins they produce
Inhibition of chitin synthesis (Benzoylureas)	diflubenzuron novaluron
Nonspecific mechanical disruptors	polydimethylsiloxane

5.5.2 Planning and procurement

A well-coordinated and expedient planning and procurement strategy for LSM is crucial to swiftly address vector control needs and support public health interventions during emergency situations. Planning and procuring LSM in emergency contexts demand a focused and rapid approach. The initial phase involves a swift assessment of the emergency area, pinpointing potential larval habitats that are few, findable in relation to displaced populations and fixable, and determining immediate LSM interventions. Collaborating with local authorities and experts is critical for quickly adapting strategies to unique emergency conditions.

Planning includes the rapid selection of larvicides, equipment and deployment methods tailored to the dynamic and challenging environment of an emergency. Procurement involves expedited acquisition from reliable suppliers, ensuring adherence to quality standards despite logistic challenges. Rapid capacity-building and personnel training are essential to ensure the quick and effective application of larvicides, considering the urgency and unpredictability of emergency settings.

5.5.3 Distribution and coverage

In emergency situations, the distribution and coverage of LSM demand a targeted and efficient approach. The distribution strategy involves identifying key areas with a concentration of potential larval habitats and targeting those locations that pose the highest risk of adult vector production. Prioritizing a limited number of such high-risk sites ensures a manageable and effective deployment of resources. Its important to emphasizes the need for quick and accurate identification of larval habitats through rapid assessments. This involves leveraging available data, collaborating with local experts and utilizing technology for efficient mapping and surveillance. Once identified, the "fixable" principle comes into play, emphasizing immediate and targeted interventions to eliminate or treat the identified larval habitats.

This focused approach ensures that resources are allocated where they can have the most significant impact, swiftly addressing vector proliferation in emergency contexts.

5.6 Other vector control tools that may be applicable in emergency settings

There are several additional vector control interventions in various stages of development and evaluation for which WHO recommendations have not been formulated due to the absence of sufficient evidence. In specific settings or circumstances, such as where ITN and IRS are not feasible, deployment of these other interventions may be considered. While the products are under review or not yet reviewed for WHO recommendation, based on the best existing evidence, emergency responders may use these products in large-scale pilot implementations and operational research to maximize life-saving in emergency settings. It should be recognized that these products and other promising products are undergoing stringent prequalification and Guidelines development group (GDG) processes. Wherever feasible, the safety and efficacy of any such products deployed should be monitored and documented (see Chapter 7).

5.6.1 Spatial repellents (passive emanators and mosquito coils)

Passive emanators are vector control tools that are placed in and around human dwellings and passively diffuse volatile pyrethroids to repel mosquitoes from entering the treated space and/or disrupt human biting and feeding habits, possibly impacting their survival and reproductive behaviour. Designed as thin plastic sheets impregnated with slow-release transfluthrin or metofluthrin, passive emanators are compact and relatively easy to transport and deploy. One potential product designed as thin plastic sheets impregnated with a slow-release pyrethroid is installed with 2 pieces per 9 m2 of a permanent structure and two are installed per temporary structure (see Fig. 26). Depending on the type of product, residual efficacy can vary from 1 to 12 months, which impacts on feasibility and cost of the intervention.

Passive emanators may have a role in early emergency response scenarios, especially when conventional vector control measures such as ITNs or IRS face logistic challenges. Their portability, compactness and ease of deployment allow swift and adaptable use in temporary or transitional shelters and they can be transported by affected populations that exhibit high mobility or dispersion. Emanator products with sustained efficacy may provide protection in emergency settings throughout critical phases of response and recovery efforts. As of December 2024, spatial repellents are under review by WHO and the latest WHO Malaria guidelines and prequalification list for vector control products should be consulted to determine their public health value.

Mosquito coils work by releasing active ingredients into the air through combustion, disrupting mosquito behavior and reducing bites. They are inexpensive, portable and easy to deploy but their short duration of efficacy necessitates frequent replacement. There is limited evidence on their effectiveness against malaria in humanitarian emergency settings either to complement other interventions or as a standalone intervention. Cost-effectiveness, health risks from smoke inhalation, fire and environmental waste management in these settings requires evaluation.

Fig. 26. Hanging of a passive emanator

5.6.2 Non-mesh insecticide impregnated net

Non-mesh ITNs may play a role in malaria prevention, particularly in addressing the challenges posed by mobile populations. Unlike traditional mesh ITNs, non-mesh ITNs are specifically designed to be used outdoors, offering an effective barrier against malaria vectors for displaced populations. They are made from an opaque bedsheet-like fabric treated with an insecticide (pyrethroid historically) and a protector material to make the insecticide more durable under sunlight. Non-mesh nets have been tested in Kenyan nomadic populations and proved to be well accepted and durable. There are an estimated 50 million people living a nomadic or semi-nomadic pastoralist lifestyle residing mainly in semi-arid regions where this type of nets could be used. As of June 2024, there is no non-mesh ITN product that has been submitted to WHO for assessment of public health value or prequalification, and global supply is unknown.

5.6.3 Attractive targeted sugar baits

In addition to periodic blood meals, mosquitoes feed on nectar and plant juices. Attractive targeted sugar baits (ATSB) are "bait stations" that attract sugar-feeding mosquitoes and aim to deliver a lethal dose of insecticide to the mosquitoes that feed upon the bait. ATSBs are more effective when there are fewer natural alternative nectar sources available, such as in arid and urban environments and in encampments where much of the vegetation has been cleared. ATSBs have been effective against malaria vectors in drier climates with fewer succulent plants, such as in the Sahel and in emergency settings, including in Bidi Bidi refugee camp in Uganda. Trials are ongoing in tropical areas. ATSBs have also been successfully used indoors against pyrethroid-resistant mosquitoes in the presence of pyrethroid ITNs (see Chapter 7). ATSBs are at an earlier stage of development but may have potential for use in emergency settings.

5.6.4 Topical repellents

Topical repellents are substances applied directly to the skin or clothing to deter insects from landing or biting. These repellents often come in the form of lotions, sprays or creams containing active ingredients such as DEET (diethyltoluamide), picaridin (icaridin) or IR3535®. Topical repellents may protect users against malaria in emergency settings. For instance, where the rapid deployment of more permanent vector control measures might be challenging, topical repellents may provide a portable and effective means of personal protection. However, there is no indication of a broader community effect that protects those who are not using repellents; in fact, the risk of bites may increase for non-users. WHO currently has a conditional recommendation against the communitywide deployment of topical repellents for protection against malaria, based on low certainty evidence. There is no recommendation either for or against the use of topical repellents for personal protection from mosquito bites; reliable data has been lacking to inform any such recommendation, often due to issues of compliance with regular administration of the repellent during trials. Successful use of topical repellents requires personal discipline in application, so may depend on cultural norms. They are not expected to work everywhere in every culture or climate.

5.6.5 Insecticide-treated clothing and other materials

Textiles may be treated with a specific insecticide, often a pyrethroid, by either incorporation into the fibres or coating onto the fibres. The insecticide acts to repel insects or kill them after contact, providing an additional layer of defence against insect bites. Insecticide-treated clothing, top sheets or blankets may be especially beneficial for displaced populations living in temporary shelters or exposed outdoor environments, where the risk of vector-borne diseases is heightened. Testing in Afghanistan showed the impact of permethrin-treated blankets and top sheets against malaria and cutaneous leishmaniasis. Etofenprox is used to treat military uniforms in several countries and is being adapted for civilian use for the treatment of blankets and sheeting for emergencies. The method does require personal discipline in use for maximum benefit. Prototype permethrin-treated clothing and blanket products have been submitted to the WHO Vector Control Advisory Group (VCAG) for review and advice for ongoing evidence generation given that epidemiological data for assessment of public health value is awaited *(70)*.

5.6.6 Treatment of domestic animals

In areas where vectors are highly zoophilic, the treatment of domestic animals, particularly cattle or goats, may prove effective when these animals are reservoirs of Plasmodium species. Treatment may hold further significance in emergency settings where these animals serve as crucial sources of nutrition or income for the affected population. In a "One Health" approach, the consideration of the interaction between human and animal health is essential. Malaria vector mosquitoes often feed on domestic animals, presenting an opportunity to employ innovative interventions that simultaneously benefit both human and animal health. Research has demonstrated that treating these animals can effectively reduce malaria transmission.

Two primary methods have proven effective in this regard. Firstly, applying a veterinary-use insecticide on the coats of domestic animals, commonly through sponging or similar methods, acts as a deterrent and kills mosquitoes attempting to feed on the treated

animals. This method not only protects the animals from insect bites and improves milk and meat yields, but also contributes to lowering the overall mosquito population in the vicinity, dramatically reducing the risk of malaria transmission to humans.

Secondly, dosing domestic animals with veterinary-appropriate levels of ivermectin has shown promise in disrupting malaria transmission. Ivermectin, an antiparasitic medication, when administered to animals has a lethal effect on mosquitoes that feed on them. This approach not only targets the mosquitoes directly, but also hinders the development of malaria parasites within the mosquitoes, further curtailing transmission.

In emergency situations, where resources may be limited, the treatment of domestic animals provides a multifaceted solution that safeguards the livelihoods of the affected population, protects the animals against ectoparasites (ticks, lice and mites) and contributes to vector control efforts. The technique only works against mosquito species that are highly zoophilic, such as those in western and southern Asia.

Systematic endectocide treatments using ivermectin for control of malaria are still being evaluated in field trials and are not yet recommended by WHO as of December 2024.

For more on vector control operational research in emergency settings, see Chapter 7.

5.7 Monitoring and evaluation of vector control

Comprehensive monitoring and evaluation of vector control deployment offers measurable and detailed insights in emergency settings, including ITN coverage (access and use), IRS coverage (areas, structures and surfaces sprayed) and populations protected.

Entomological indicators can provide proxies for the efficacy of interventions in the absence of transmission and disease impact data. Multiple indicators will ensure comprehensive evaluation and continuous improvement of vector control strategies in dynamic and challenging emergency contexts. Further information on operational research for malaria vector control interventions in emergency settings is provided in Chapter 7.

Table 14 describes a selection of key indicators that may be applicable in emergency settings. For additional malaria vector control impact indicators see Chapter 8.

Table 14. Key indicators for monitoring and evaluation of vector control interventions

Type of Indicator	Indicator	Additional details
Household ownership	Percentage of households with at least one ITN and/or other vector control tool accessible within the household	Subcategories may include specific tools (e.g. ITNs, insecticide-treated clothing), providing a detailed breakdown of ownership.
ITN population access	Percentage of the population that could sleep under an ITN, assuming two people per net	Denominator is usually all population at risk. (e.g. population in refugee camp)
ITN usage	Percentage of the population reporting having used an ITN or other vector control tool the previous night	Differentiate between the types of vector control tools (e.g. ITNs, insecticide-treated clothing) to understand usage patterns.
IRS coverage	Percentage of eligible structures in the target area sprayed in the current spray cycle	Include spray team information and spatial distribution data to identify coverage gaps and understand impact.
Durability	Fabric integrity and/or bio-efficacy of vector control tools assessed through field evaluations and laboratory testing	Consider measuring insecticide residual efficacy and fabric integrity of materials at different points in time during field usage.
Presence/absence of vector adult and/or larval stages	Regular surveillance providing the presence or absence of adults or larvae of the main vector species in designated areas	Use systematic sampling to quantify the presence or absence, enabling more precise assessments.
Density of adults and/or larvae	Mosquito density measured as the number per defined unit (e.g. adults collected per trap-night, larvae collected per square metre of aquatic habitat)	Differentiate between indoor and outdoor densities for a more nuanced understanding of vector behaviour.

5.7.1 Entomological monitoring

Entomological monitoring in emergency settings is a crucial component of effective vector-borne disease control strategies. By systematically assessing vector populations and their behaviour, entomologic monitoring provides valuable insights into the dynamics of disease transmission and the effectiveness of control measures deployed during emergencies. Through methods such as surveillance of vector densities, insecticide resistance testing, and environmental risk assessments, entomological monitoring helps inform evidence-based decision-making, enabling timely adjustments to intervention strategies as needed. For further details on the implementation of entomological monitoring in emergency contexts, please refer to Annex 4.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Gore-Langton GR, Mungai J, Alenwi N, Abagira A, Bicknell OM, Harrison RE et al. Investigating a non-mesh mosquito net among outdoor sleeping nomadic communities in Kenya. Am J Trop Med Hyg. 2015;93(5):1002–9 (https://doi.org/10.4269/ajtmh.14-0458).

- Gore-Langton GR, Mungai J, Alenwi N, Abagira A, Bicknell OM, Harrison R et al. Investigating the acceptability of non-mesh, long-lasting insecticidal nets amongst nomadic communities in Garissa County, Kenya using a prospective, longitudinal study design and cross-sectional household surveys. Malar J. 2015;14:52 (https://doi.org/10.1186/s12936-015-0546-1).

- Larval source management: a supplementary measure for malaria vector control – an operational manual, second edition. Geneva: World Health Organization; (in press).

- Malaria entomology and vector control. Geneva: World Health Organization; 2013 (https://iris.who.int/handle/10665/85890).

- Operational manual on indoor residual spraying: control of vectors of malaria, Aedes-borne diseases, Chagas disease, leishmaniases and lymphatic filariasis. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/375978).

- WHO guidelines for malaria: 4.1 – vector control [website]. World Health Organization; (https://app.magicapp.org/#/guideline/LwRMXj/section/LkgQZL).

- World Health Organization, United Nations Children's Fund, United Nations Development Programme, World Bank, WHO Special Programme for Research and Training in Tropical Diseases. Global vector control response 2017–2030. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/259205).

- World malaria day 2017: malaria prevention works, let's close the gap. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/254991).

- Vector control product list [website]. World Health Organization; (https://extranet.who.int/prequal/vector-control-products/prequalified-product-list).

Chapter 6.
Risk communication and community engagement

6.1 Overview

Communities have a critical role in preventing and controlling malaria during emergencies. In addition to being informed, they need to be equipped and motivated to participate in and lead interventions, including for malaria prevention and control.

It is important to develop a risk communication and community engagement (RCCE) strategy for the malaria response, aligned with the broader malaria control strategic and operational plan. Its main components will include risk communication, social mobilization and, most importantly, community empowerment and participation. It will also include important communication channels and platforms, and indicators that responders may adapt to their context.

Effective social and behavioural change communication is critical to address the behavioural and social aspects of disease prevention and control. Effective communication can:

- provide accurate, clear, relevant and timely information to the public on prevention and control;
- identify and address myths and misconceptions that may lead to detrimental practices and hamper response;
- link people effectively to available services;
- maintain public trust;
- reassure the public;
- prepare communities for emergency preparedness and response actions; and
- support communities and countries to recover and rebuild after an emergency.

Effective social and behavioural change communication and community engagement need to consider issues of health literacy – the motivation and ability of individuals to access, understand and use health information. Useful guiding principles for effective malaria-related health communication during emergencies are to:

- establish mechanisms that enable representatives of the affected population/ community and local and international emergency partners to participate fully in malaria prevention and control;

- create awareness about how to identify malaria symptoms and promptly access diagnostic testing and complete treatment and supportive care;
- examine and identify the cross-cutting and underlying barriers to resilience and community well-being, including societal drivers of inequity, fragility and conflict; and
- ensure that community engagement efforts recognize how power relations affect access to information and the ability to use that information, and include interventions to address the barriers.

Risk communication and community engagement for malaria control in humanitarian emergencies are described below and further information is available in the resources listed in the further reading.

6.2 Key information for communities

Key information for populations includes, but is not limited to:

- groups that are particularly vulnerable to malaria;
- signs and symptoms of possible malaria infection;
- diagnosis and treatment of malaria, including the importance of diagnostic testing before initiating treatment;
- respect for a negative malaria diagnosis when febrile and the need to follow alternative diagnosis and treatment options;
- location and opening hours of health services – including where to access CHWs;
- understanding the signs and dangers of severe malaria and the need to attend or return to the health facility immediately;
- causes of malaria and the role of mosquitoes in transmission; and
- practical prevention measures, including use of ITNs, malaria vaccination (in eligible areas/populations), chemoprevention (SMC, IPTp), IRS if necessary, safe management of water (both waste and for home use) and other forms of personal protection *(71)*.

6.3 Community engagement, empowerment and participation

Engage communities in all stages of planning, decision-making, and implementation to foster ownership, build capacity, strengthen partnerships, support advocacy, and empower them to make informed decisions about their lives. The community includes members of the affected community; some responders and government representatives may be part of this community. Members of different groups will have

differing priorities, needs, perspectives and interests, and the purpose of bringing them together is to seek consensus.

Community engagement and participation are essential to the success of malaria interventions in all settings, especially in emergencies.

- Identify prior behaviour and knowledge from communities to guide adaptation.
- In displacement settings, ensure strategies and approaches reflect the differences between newly displaced persons and those in protracted emergencies regarding priorities and needs.
- Include risk communication and community engagement considerations in initial rapid assessments, as this provides the opportunity to gather baseline information.

Communities should be involved in all stages of planning and implementation of malaria control activities.

- Identify and engage CHWs and other community-based workers as quickly as possible to help mobilize communities to support the implementation of priority interventions, including iCCM, the delivery of ITNs, IRS and risk communication.
- Collaboration with other clusters/sectors is critical for addressing priority needs identified through community feedback.

Effective malaria control and prevention will require building trust and rapport within the affected communities.

- CHWs who live within and serve the community may be mobilized to implement various community-based interventions, including testing and treatment via the iCCM approach.
- Sensitivity, context-appropriate and culturally sensitive information and a wide canvassing of viewpoints should be used to identify the members of communities who are trusted and wield influence.
- Community leaders, influencers and those in local leadership positions represent viewpoints and needs within a community and should be treated as a primary audience.
- Dialogue with communities and community feedback processes should be considered as part of the process to strengthen collective or group participation and clarify needs and viewpoints of the community.

By raising awareness and strengthening the capacity of both rights holders and duty bearers to assess, plan, facilitate, implement and evaluate malaria control interventions, communities and social networks are enabled and empowered to reflect on and address a range of behaviours, issues and decisions affecting their lives. Case study 9 describes community engagement in malaria control interventions in refugee settlements in Uganda.

Case study 9. Community management of malaria in Uganda refugee settlements

Uganda provides a home to nearly 1.7 million refugees and asylum-seekers, most from South Sudan (57%), the Democratic Republic of the Congo (32%), Somalia (3%) and Burundi (3%). Refugees primarily live in settlements within 12 districts alongside host communities. The national community health strategy guides community health interventions in the refugee settlements, implemented through a network of more than 2500 CHWs. Part of this strategy is to implement an interagency malaria response framework for the new refugee arrivals. Malaria is the leading cause of morbidity, accounting for 37% of all consultations and 17% of mortality in the settlements in 2023; moreover, it is one of the leading causes of illness and death in at least three of the refugee countries of origin.

Within the malaria refugee response framework, CHWs are identified from among the displaced population by refugee shelter leaders at reception centres and transit centres. CHWs conduct household visits, risk communication and community education (including appropriate use of ITNs), identification, and referral of sick refugees to the health post in or near the reception centre.

When the new arrivals are moved to the refugee settlements, the selected CHWs join other CHWs (village health teams), and are responsible for disease surveillance, house-to-house visits, community sensitization, referral and treatment of malaria, diarrhoea and pneumonia as well as organizing community dialogues and mobilization for outreaches.

Communication, messaging and monitoring and evaluation are key aspects of successful community engagement and management in Uganda.

- **Communication:** peer-to-peer communication is the dominant approach because village health teams regularly visit individual households. They also use megaphones in the transit and reception centres, and to some extent at the community level. This is complemented by the refugee leaders who participate in mobilization, enforcement and overseeing the implementation of the malaria prevention interventions.

- **Messaging:** usually limited during new arrival phase at the transit centre to use of ITNs and early seeking of treatment but this is later expanded when the new arrivals are relocated to the settlements where comprehensive malaria intervention package is delivered. The messaging then focuses on malaria prevention, referral and treating those with malaria, and screening children for malnutrition and other infectious diseases. The village health teams support translation of the malaria communication materials developed by Uganda's Ministry of Health and then disseminate them to the households.

- **Monitoring and evaluation:** the work of village health teams is reported on a weekly, monthly and quarterly basis and this forms part of the refugee health information for the settlement, which also feeds into the national health information system of Uganda's Ministry of Health. The number of refugee children treated for malaria by village health teams has increased over time.

With these interventions, the rates of anaemia, malaria consultations and mortality from malaria has reduced by 78% (from 354 deaths in 2020 to 77 deaths in 2023).

The key lesson from this case is that investments in community health interventions reduce the pressure on the health care system and improve the health outcomes of communities.

Source: Uganda Ministry of Health, Public Health Emergency Operations Centre, NMCP and UNHCR (unpublished data).

6.4 Key principles for working with communities

The following key principles are useful for working effectively with communities.

- Listen to the concerns of displaced and host populations and be especially sensitive to concerns around gender and ethnicity.
- In some contexts, community leaders may not represent the views of women or members of other vulnerable or marginalized groups. Try to include representatives from these groups to ensure their concerns are heard and addressed.
- Work together to define problems, causes and possible solutions. Ensure there is always a feedback loop between communities and responders. Present solutions in local languages and with sensitivity to local norms.
- Relate malaria control activities to local ideas about cause, symptoms, cure and prevention.
- Provide clear information about how and where malaria control activities will take place. If possible, involve community representatives in implementation of interventions.
- Ensure staff are oriented on the local context and aware of social norms.
- Community norms and standards may influence the roles played by different groups and individuals, and influence attitudes and behaviours that impact on implementation of malaria control and prevention activities, including care-seeking behaviour.
- Within both displaced and host populations, it is essential to identify how social organization may have been changed by the emergency.

Table 15 provides a non-exhaustive list of common community structures and their potential roles.

Table 15. Structures with key roles in community engagement before, during and after emergencies

Organization/ Structures	Potential engagement	Parameters
Government (ministries of health, welfare, education, justice)	Collaborate with government ministries to integrate malaria response into broader health and social policies.	May be absent, run by non-state entities or focused on religious or other groups
UN and donors	Coordinate with United Nations agencies and donors to secure funding and technical support for malaria interventions.	May change over time, with different agencies leading and/ or supporting (e.g. the cluster approach)
International and National NGOs	Partner with NGOs for the implementation of malaria prevention and treatment programmes at the community level.	May change over time; initially, may be primarily acute humanitarian efforts
Religious leaders and faith-based organizations	Engage religious leaders to disseminate malaria prevention messages and promote health-seeking behaviours.	Often very respected and influential and need to be coopted in the response early
Political leaders and organizations	Advocate for political commitment to malaria control and allocation of resources for effective interventions.	Crucial for policy support, resource allocation and mobilizing communities
Community based organizations	Work closely with community-based organizations for community mobilization, service delivery and advocacy.	May be significantly involved throughout all phases; in an acute emergency, they are often the first to respond
Influencers ("gate keepers")	Identify and engage key influencers such as CHWs, traditional healers and teachers to disseminate malaria-related information.	Will differ by context and may include CHWs, health workers, traditional healers, teachers
Family networks	Utilize family networks to promote household-level interventions, encourage adherence to treatment and support behaviour change.	Family structures and dynamics will be impacted by emergencies
Social networks	Harness existing social networks and facilitate the formation of ad hoc networks to disseminate information and foster community resilience.	Existing networks may be strengthened or weakened; ad hoc networks may form through shared displacement or other experiences

6.5 Health communication plan

Malaria-specific risk communication and behaviour change should be integrated into an overall health communications strategy, adapted to the local context. It is important to have a framework in mind to develop the health communication strategy. Table 16 presents an outline of steps required to develop a health communication plan to achieve social and behavioural change. Of note, in an emergency/new displacement context, risk communication on malaria needs to start immediately through CHWs and other community mechanisms, even while the strategy is still being developed. This can be done utilizing previously trained displaced CHWs or rapidly training new CHWs. Implementation of such health communication plan should be context-dependent in emergency settings.

Table 16. Phases of building effective social and behaviour change messaging

Phase	Description	Steps
1.	Discovery	1. Build a team that includes the affected communities. 2. Align and understand partner comparative advantage and technical capacity. 3. Conduct an audience analysis to understand your audience. 4. Develop a situation analysis.[a]
2.	Design, development and testing	1. Outline the needs of affected groups. 2. Select appropriate social and behavioural change approaches and develop a theory of change. 3. Define a goal, results and select interventions. 4. Determine the budget, timeline, risks and roles. 5. Identify funding mechanisms and opportunities.
3.	Implementation, monitoring and evaluation	1. Conduct a baseline assessment to define needs and gaps. 2. Test and iterate. 3. Develop a plan for continued learning and iteration.

Note: A how-to guide on conducting a situation analysis is available from the Compass website *(72)*
Sources: UNICEF *(73)* ; Breakthrough Action *(74)*.

6.6 Communication channels, messages and methods

Ensure that appropriate communication channels, messages and methods are used. Timing of messaging and the channels of communication used can have an important influence on effectiveness and overall health literacy of the population. The following principles should be considered *(72)*.

- Adapt messaging and choice of channel in line with days or times when other activities are taking place (e.g. messaging while people queue for food or other distribution, cultural or religious events as appropriate).
- Take advantage of occasions when people are already meeting together.
- Alert communities in advance about campaigns or activities (e.g. IRS or distribution of ITNs).
- Use opportunities to target specific groups (e.g. pregnant women, mothers of young children, male heads of households).
- In many emergencies, carers will spend time waiting in outpatient clinics, supplementary feeding centres, or food aid distribution events. This time can be used for health communication about malaria (e.g. what to do when a child has fever).

6.6.1 Communication channels

Effective delivery of health communication messages depends on choosing communication channels appropriate to the community's culture, knowledge, beliefs, values and literacy level. In some cultures, community leaders and elders may be the best people to transmit messages, while in others, teachers, health workers or the media may have more credibility. Messages should thus be relayed through various channels as appropriate to the context.

Select media according to literacy level, preference and trust – interpersonal (CHWs, health workers, teachers, leaders, etc.), radio, boda-boda/moto-taxis, mosques and churches using speakers to broadcast messages, etc.

6.6.2 Malaria messages

Key principles should guide the development of messages to help communities recognize malaria symptoms, understand where and how to access care, and adopt effective prevention practices.

- Target the message to the lowest level of literacy (i.e. if the population is largely illiterate use pictures and spoken-word media).
- Explain the actions people are expected to take, why they are necessary and the expected outcomes.
- Adapt pre-existing messaging to ensure contextual and cultural appropriateness. As much as possible include malaria in the risk communication and community engagement message bank in broader humanitarian contexts. In many contexts, NMCP materials will already exist, and for refugee populations messaging may already be in place from their countries of origin.
    - » Ensure that messages are realistic and actions to be implemented are feasible.
    - » Understand local behaviours.

- » Use local language for the messages.
- » Ensure that messages are culturally acceptable.
- » Adapt messages to the changing situation.
- » Use creative messaging approaches (e.g. promoting ITNs as a way of "preventing insects from disturbing your sleep" as well as preventing malaria).

6.6.3 Communication delivery methods

The channel and media methods used must be appropriate and customized for the emergency setting. Printed messages are fine for literate populations, but oral and visual methods may be better for conveying messages to mixed-literacy populations. In most situations, it is useful to use a mixture of methods.

- **Print:** posters, flipcharts and picture guides can combine words and pictures. Posters should be displayed in places where people will see them (e.g. clinics, community). Flipcharts and picture guides are useful for face-to-face teaching (e.g. about how to give an antimalarial drug to a young child).
- **Oral:** talks, person-to-person communication, songs, poetry and informal conversations (e.g. to religious or women's groups, at times when people are waiting at the clinic, in the market).
- **Storytelling:** drama, role-play and dance use stories and similar approaches to engage audiences and communicate messages.
- **Demonstrations:** demonstrations are a useful way to show people how to do something, such as how to use an ITN.
- **Media:** public broadcasting or radio. Public announcements through loudspeakers or megaphones can be especially useful in the acute phase of an emergency.

The primary communication objective should be identified through discussions with the community and messaging developed to communicate effectively. Visual messages should be clear and pretested to ensure that their content can be readily understood and is culturally appropriate. Written messages should be short, simple and targeted to capture the interest of the intended audience.

6.7 Monitoring and evaluation

Monitoring and evaluation is crucial to understand the effectiveness of communication and engagement activities and to enable continuous improvement and responsiveness to change. Several key principles should be used in monitoring and evaluation of communication and engagement activities.

- Identify and engage key stakeholders throughout the process of planning, data collection, analysis and dissemination of findings.

- Align and integrate indicators and reporting with the national or district community health information system.

- Conduct baseline and regular follow-up surveys to monitor changes in knowledge, attitudes and practices, measure impact and inform adjustments to community health programmes based on the findings. Where possible, integrate relevant questions in other surveys to reduce costs, duplication and community fatigue.

- Ensure that the purpose and value of each indicator is clear to reduce the risk of overburdening communities and CHWs. Consider the amount of staff time to be dedicated to data collection, the level of training required, the design of the collection tools (digital or paper-based) and how the data will be utilized.

- Collect and collate evidence of risk communication and community engagement effectiveness from community feedback, knowledge, attitude and practice surveys, focus group discussions, community rapid assessments and specialized tools such as the Malaria Matchbox *(75)*.

6.7.1 Risk communication and community engagement indicators

Various risk communication and community engagement indicators are available. Countries and partners should choose indicators relevant to their context. Examples include:

- number/proportion of people reached with malaria health promotion interventions in the community, disaggregated by activity/channel, age and gender;
- proportion of affected people who know where to go for malaria prevention/ treatment services;
- proportion of people who know the main symptom of malaria;
- proportion of people who practise the recommended behaviours (e.g. ITN usage, early treatment-seeking);
- proportion of people who are confident in their ability to perform a specific malaria-related behaviour; and
- proportion of people who recall hearing or seeing any malaria messages within the past 6 months.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and practice. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/259807).

- Community Engagement in Humanitarian Action (CHAT) Toolkit: updated version. New York: United Nations Children's Fund; 2022 (https://www.corecommitments.unicef.org/kp/community-engagement-in-humanitarian-action-(chat)-toolkit%3A-updated-version).

- Community Engagement Toolbox. Geneva: The Global Fund; 2023 (https://www.theglobalfund.org/media/10734/ccm_communityengagement_toolbox_en.pdf).
- Managing epidemics: key facts about major deadly diseases, second edition. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/374062).
- Minimum quality standards and indicators for community engagement. New York: United Nations Children's Fund; 2020 (https://www.unicef.org/mena/reports/community-engagement-standards).
- Operational guidance: community health in refugee settings 2022. Geneva: United Nations High Commissioner for Refugees; 2022 (https://www.unhcr.org/media/operational-guidance-community-health-refugee-settings-2022).
- The Malaria Elimination Initiative. Implementing effective community engagement for malaria control and elimination [website]. University of California San Francisco; 2020 (https://shrinkingthemalariamap.org/resources/background-papers/implementing-effective-community-engagement-malaria-control-and-elimination).
- The SBCC emergency helix [website]. The Compass; 2020 (https://thecompassforsbc.org/sbcc-tools/sbcc-emergency-helix).
- The Sphere handbook: humanitarian charter and minimum response standards in humanitarian response Geneva: Sphere Association; 2018 (https://handbook.spherestandards.org/en).
- The strategic framework for malaria social and behaviour change communication 2018–2030. Geneva: RBM Partnership to End Malaria; 2018 (https://endmalaria.org/related-material/strategic-framework-malaria-social-and-behaviour-change-communication-2018-2030).
- Zero malaria starts with me: community engagement module. Zero Malaria Starts With Me; 2021 (https://zeromalaria.africa/resources).

Chapter 7.
Operational research

7.1 Overview

Consider operational research to identify effective approaches to malaria control in evolving phases of an emergency. There are many different approaches to malaria control, and no approach is 100% effective or appropriate in every situation. Operational research and pilot rollouts can help to make the best choice between control tools and improve their application and impact.

Operational research and implementation research, which involve the systematic investigation of strategies, interventions, tools, and approaches to improve the effectiveness, efficiency, and sustainability of malaria control efforts, should be distinguished from programmatic monitoring (Section 3.8), which is a routine activity for any malaria control programme.

Comparative research is needed when introducing a new and improved product in emergencies, to evaluate its effectiveness alongside the standard of care. This may involve either preventive or curative interventions. The process is similar to a medical trial, where a potentially better drug needs to be proven against the existing standard of care. In preventive and curative evaluations, the standard of care serves as the control arm. With appropriate monitoring of the control and the intervention arms, every individual or cluster is randomized, everyone will receive treatment, evidence of effect is generated, progress is made and the disease is controlled. This is the power of research in emergencies.

Strict criteria must be met before operational research is conducted in emergency contexts. The rights of individuals and communities must be protected and informed consent must be obtained. Approval is required from an independent and qualified ethics committee comprising wide membership from WHO, UNHCR, academia and public health implementing organizations. Where possible, especially in natural disaster emergencies (such as earthquakes or extreme flooding), the national research ethics committee must be engaged as soon as practicable. This may not be possible during the early acute phase of a humanitarian emergency, but in the post-acute, protracted (which may last several years) and recovery phases it is usually feasible to have external oversight and national representation.

Important areas of operational research for malaria control in emergencies include improving the effectiveness of prevention, testing and treatment, identifying social and behavioural determinants of effectiveness, and improving service delivery strategies and the cost–effectiveness of control activities.

It is widely recognized that research is essential for serving populations in humanitarian emergency settings, as their needs and circumstances differ significantly from those in stable or peaceful environments. Researchers will likely not come from the host community and the research subjects may be especially vulnerable. This requires

spokespersons from within the refugee/displaced community (e.g. senior doctors/nurses from the refugee community) to have a prominent role, alongside individuals appointed from outside the community (United Nations, WHO, NGO or ministry of health representatives). The ethical processes followed must be equal to – if not more stringent than – those in stable situations.

Good operational research in humanitarian emergencies can lead to remarkable far-reaching achievements. Use of combinations of preventive tools to maximize impact may require operational and comparative research before their use can be optimized or adopted and scaled up in pilot interventions. A special type of operational research in humanitarian emergencies is with the introduction and pilot rollouts of new products like ACTs and long-lasting insecticidal nets originally designed to serve the needs of displaced populations but later adopted by other communities and countries.

The development of ACTs for malaria case management came out of the need to overcome resistance to the antimalarial mefloquine in South-East Asia by combining it with artemisinin. Since then, ACTs have achieved accelerated worldwide acceptance and are the recommended first line treatment for malaria. The first trials of ITNs in South Asia were done by the NGOs MSF and HealthNet TPO in Afghan refugee villages with oversight from WHO. The use of ITNs came out of a need to provide Afghan refugees with the means of self-protection from *P. falciparum* and *P. vivax* malaria when they returned to Afghanistan from the refugee villages in Pakistan; lessons learned in situ during the 2-year study led to the successful scaling up of ITNs throughout Afghanistan and Pakistan in later years, despite continuing political turmoil.

The inadequacy of clinical diagnosis in emergencies has accelerated the development of improved RDTs, which has led to new tests that can differentiate between malaria species or distinguish malaria from other febrile diseases. New active ingredients for ITNs and materials for shelters for IDPs have been developed and evaluated by WHO, UNICEF and specialist NGOs working together with manufacturers, recognizing that little could be achieved without the other partners. This may lead to large-scale pilot implementation, where the activities may or may not be novel, but should receive an extra layer of monitoring and evaluation to develop best practice.

As time goes by, needs and resources change. New ITN and IRS formulations, designed to have a greater impact against vectors that are physiologically resistant to current insecticides, may need to be tested in anticipation they will be required. Shelters made of new materials may require bespoke IRS formulations to achieve longer adherence. New tools or approaches for vulnerable groups may be needed, such as preventive therapies for vulnerable women and children. Malaria vaccines may need to play a larger part in refugee health care. With the decline of *P. falciparum* malaria in South-East Asia, focus is turning towards radical treatment of *P. vivax* malaria which will require longer intermittent courses or higher dosages. Passive emanators (spatial repellents) have been designed for indoor or partial temporary structures. Attractive targeted sugar baits (ATSB) are being developed to target mosquitoes that primarily feed and rest outdoors and may not come into contact with ITNs or IRS.

So that research can be considered for proof of public health value or WHO prequalification, it is important to engage with WHO and academic specialists well in advance to ensure appropriate study design.

One aim of this chapter is to inform people in emergency settings who want to engage in research why it is important, what has been achieved and what still needs to be done in different disciplines.

7.2 Considerations for research in emergency settings

Operational research, implementation research, comparative research using randomization of interventions, and large-scale pilot implementation should be considered as part of programme implementation in emergency settings. Several standard malaria control tools were developed using comparative research and adopted for large-scale pilot implementation in the context of humanitarian emergencies.

While requiring a higher level of scientific rigour in implementation and evaluation, operational research and pilot implementation – as advocated by the RBM Partnership to End Malaria – can help inform how to improve the effectiveness of current tools in humanitarian response as well as provide a platform for the development, adaptation and evaluation of new tools *(76)*. In many cases, support or partnerships for protocol development and implementation are available with United Nations and relief agencies, including WHO, UNHCR and UNICEF, with local and regional training and research institutions, and with the NMCP.

A potential way forward is the establishment of a WHO expert review panel. While there is no expert review panel in place for vector control products in humanitarian emergencies, there is mention of the establishment of an expert review panel for vector control in collaboration with WHO in the Global Fund's vector control procurement policy, which is the main funder of vector control in emergencies *(77)*.

7.2 Diagnosis

Operational research can help to improve the effectiveness of malaria diagnosis. Clinical diagnosis (presumptive or with no laboratory testing) of malaria is inaccurate and unreliable, while laboratory confirmation using microscopy is not usually feasible in acute emergency contexts.

Despite the obvious advantages of malaria RDTs over clinical diagnosis, several operational challenges may remain. These include the scale-up of RDTs in different emergency contexts, stockouts and and deploying them effectively in settings where they have not been previously utilized. RDTs that distinguish between different *Plasmodium* species are needed in places where *P. falciparum* and *P. vivax* malaria coexist and require differential treatment for optimal case management. Community use of RDTs by CHWs or outreach services has been successfully tested in Afghanistan (see Case study 10). An operational problem which will grow in importance is the emergence of *falciparum* parasites with HRP2/3 deletions which enable the parasite to evade detection. Malaria case management relies heavily on the use of HRP2/3 based RDTs; however, the spread of HRP2/3-deleted mutants and increase in frequency in several endemic countries in South America, Asia and Africa is now threatening the utility, impact and cost–effectiveness of current RDTs that use HRP2/3 RDT in favour of those that utilize *Plasmodium* lactate dehydrogenase (pLDH) as the capture antigen, to which deletions have not been detected.

RDTs should be further explored where treatment of *P. vivax* and *P. falciparum* require differential treatment, or where the frequency of resistant HRP2/3 deletions is above a critical threshold (> 5%) which requires a switch to other types of RDT where pLDH is the antigen (see Section 3.3.2).

Case study 10. Use of malaria RDTs by community health services in Afghanistan

A cluster randomized trial was conducted in Afghanistan to assess the effectiveness of using malaria RDTs by CHWs linked to clinics. This study aimed to determine if RDTs could improve the diagnosis and treatment of malaria compared to the standard clinical diagnosis method. CHWs from 22 clinics received standard training on clinical diagnosis and treatment of malaria. Of these 22 clinics, 11 were also trained on use of RDTs and provided with an ample supply of RDT. The CHWs enrolled suspected malaria cases initially, and their diagnostic and treatment decisions were compared between the clinics using RDTs and those relying on clinical diagnosis alone. All suspected malaria cases were verified using polymerase chain reaction to ensure accuracy and the possible spread of parasites which can evade RDT-detection.

A total of 2400 patients were enrolled and 2154 (89%) tests were evaluated. In the RDT arm, 75% of patients (828/1099) received appropriate treatment compared to only 17% (185/1055) in the clinical diagnosis arm, resulting in an adjusted risk ratio of 3.7 (CI 95%, 2.4–5.8, $P < 0.001$). The clinical diagnosis arm showed significant overuse of antimalarials, with 88% (813/928) of non-malaria patients being treated with antimalarials versus 10% (95/947) in the RDT arm ($P < 0.001$). The concordance between RDT results and CHW prescription decisions was high at 87% (826/950). However, the intervention arm saw a significant increase in antibiotic prescription, with 63% of malaria-negative febrile patients receiving antibiotics (co-trimoxazole) compared to 15% in the control arm. While RDTs reduced the overuse of antimalarials and improved malaria treatment, they led to probable overuse of antibiotics for undiagnosed illnesses.

Source: Leslie, Rowland, Mikhail, Cundill, Willey, Alokozai, Whitty et al *(78)*.

7.3 Treatment

Resistance to antimalarials and treatment service delivery (including treatment-seeking behaviour, access to health facilities, adherence to treatment and quality of care) impact on the effectiveness of malaria treatment.

Drug resistance to SP has become widespread in Africa over the past 20 years and, more alarmingly, resistance to artemisinin has emerged in countries in the Greater Mekong subregion of South-East Asia and in Africa (Rwanda and Uganda) since 2021, where most malaria persists in countries affected by instability or where conflict occurs (see Chapter 1). In the Greater Mekong subregion, country and regional technical advisory groups reasoned that the only way to eliminate artemisinin resistance from South-East Asia was to eliminate all *P. falciparum* malaria. This effort has achieved considerable success in Mekong countries that have seen limited emergencies and displacement, and with low malaria transmission. Transmission is much higher in malaria endemic Africa, which makes malaria elimination there far more difficult, especially in countries that experience political instability.

A therapeutic efficacy study, using a global standardized protocol, should be considered in the acute phase of an emergency if treatment failures raise suspicions of drug resistance. In protracted emergencies, longer-term therapeutic efficacy testing should be conducted to determine whether the first-line treatment remains effective. This will require several weeks of patient follow-up, stable populations, and a good-quality accredited diagnostic reference laboratory that is familiar with supporting specific operational research projects using microscopy and polymerase chain reaction.

Operational research can identify factors that prevent people from accessing malaria treatment and operational activities that improve the access of diagnostic and treatment services. This type of operational research can ensure the quality of treatment is adequate and that health workers adhere to recommended treatment protocols. This research, together with training and accreditation of new CHWs and microscopists, can help to improve standards, enable people to make informed choices about different health providers and assist the ministry of health to regulate standards post-conflict.

With better diagnosis and treatment of *P. falciparum* malaria, attention is turning to improved radical treatment for *P. vivax* malaria. New evidence indicates that 7-day intensive therapy using primaquine appears effective in Papua New Guinea *(79)*. It is long known that weekly single-dose primaquine over 8 weeks in Afghan refugees is effective without directly observed therapy and is well tolerated *(80)*. Blister packs are available in India and Pakistan. Simple comparative research with appropriate blister packaging of primaquine with suitable health messaging at clinics may determine which is the preferred format for clinicians and patients. This operational research should be a collaboration between WHO regional offices, NGOs, pharmaceutical manufacturers and community leaders to maximize range and utility of preferred options.

7.4 Prevention

Operational research can help to assess the effectiveness of prevention measures and identify ways to improve delivery and usage.

Owing to the widespread selection of pyrethroid resistance, the past decade (2015-2025) has seen radical change in the type of active ingredients used in ITNs and the development of new classes of ITNs. Pyrethroids are still used, but are partnered with: the synergist piperonyl butoxide, which inhibits enzymes that cause metabolic pyrethroid resistance; an alternative insecticide to which mosquito susceptibility is expected, such as the pyrrole insecticide chlorfenapyr; or the insect growth regulator pyriproxyfen which may reduce mosquito fecundity. Other new active ingredients are under development, and should be piloted in emergencies and evaluated alongside the former active ingredients.

When deploying ITNs in humanitarian emergencies, ITN products that contain two active ingredients (e.g. mixtures of pyrethroid-piperonyl butoxide or pyrethroid-chlorfenapyr) should be deployed as default in preference to standard pyrethroid-only ITNs in areas with widespread pyrethroid resistance, which includes much of Africa and South Asia. Note that pyrethroid resistance is still quite rare in areas of the Americas, Europe and the Western Pacific, where pyrethroid resistance has not been detected in the principal malaria vectors; in these locations, pyrethroid-only nets can be used.

ITN insecticide and textile durability during emergencies is a current operational research issue. In emergency settings, ITN lifespan is likely to be shorter, but how much shorter is not widely known nor routinely documented. Quality control of textile and insecticide durability is seen as an issue both in humanitarian and stable countries. To inform product selection and replacement, durability assessment should be considered as a routine programme monitoring activity in accordance with WHO guidance *(81, 82)*. With the introduction and scaling up of synergist and dual active ingredient ITNs, the user perception of efficacy durability may change. User perception of durability is an important topic for operational research on new generation ITNs and should be monitored to determine the length of replacement cycles.

With the rapid scaling up of ITN coverage globally, insecticide resistance to pyrethroid insecticides is widespread and increasing rapidly. Insecticide resistance testing may be necessary in emergency settings as an operational research activity. Specialist help on insecticide and piperonyl butoxide durability testing of nets may be sought externally and should be regarded as good quality control. ITNs are designed to last for at least 3 years of standard use, but in emergency settings the active ingredients and textile may not survive more than 1–2 years.

Operational research has helped to formulate guiding principles on the use of IRS. More research is needed to determine the effectiveness of IRS with WHO prequalified products, and whether IRS with these compounds can have a sustained impact on malaria transmission in emergency settings. New IRS compounds and formulations are active areas of research and development in manufacturers. Comparative research in protracted emergencies with the standard of care IRS active ingredient and new active ingredient/formulation can demonstrate whether the new candidate is superior or non-inferior to the older standard. More operational research should be done inside acute emergency settings to inform the selection of the ideal product in terms of cost, efficacy and durability.

More comparative research with IRS and ITNs in combination is also desirable. Most combinations are likely to interact positively to enhance toxicity against mosquitoes, but some may act antagonistically depending on their component active ingredient. For example, the IRS organophosphates pirimiphos-methyl and malathion require activation to their active metabolites by mosquito oxidase enzymes. Piperonyl butoxide, a synergist used in some ITNs, may antagonize activation of the organophosphate in the IRS and reduce its potency *(83, 84)*. This must not be confused with another group of mixed-function oxidases that cause metabolic pyrethroid resistance, which is the major technical constraint for controlling malaria. In some instances resistance has rendered pyrethroid-only treated materials redundant. Considerable research has been done with insecticide-treated tents and ITN wall hangings, and a start has been made with testing long-lasting organophosphate formulations such as IRS on the surfaces of tents or on the walls of experimental huts and wall linings. New long-lasting formulations for partner active ingredients in ITN is an intense area for manufacturer research and development. UNHCR tents made from polyethylene and polyester materials can be sprayed on interior surfaces with a long-lasting organophosphate insecticide (capsule suspension formulation) and possibly other WHO prequalified products. In several West African countries there is high resistance to organophosphates which means a single class of insecticide cannot be relied on over a prolonged period, but instead different IRS options must be used sequentially in rotation. Other IRS formulations in the pipeline include broflanilide or pyrethroid-clothianidin mixtures. Whether the new IRS formulations will adhere to the new tent materials is a matter for future comparative research.

Operational research and large-scale pilot implementation are also needed to assess the potential of expanded vector control approaches to ITNs and IRS in emergencies, including passive emanators, topical repellents, ATSBs, animal treatments and treated materials such as tents, tarpaulins and blankets. These research questions are also emphasised in Chapter 5.

The research strategies outlined above and below serve as examples of the tools and methodologies that exist and may be suitable for humanitarian settings. It is imperative to emphasize that the operational and implementation research conducted within these contexts should be developed and guided by the needs, priorities and perspectives of those affected by the humanitarian emergency as well as the countries' governments, research institutions and local communities. Malaria research should be conducted in humanitarian emergencies when questions cannot be adequately addressed outside of an emergency crisis setting. They should respond to recognized gaps and needs and ensure direct benefit to participants while minimizing risks.

7.4.1 Seasonal malaria chemoprevention

No major studies of SMC have been conducted in emergency settings. SMC with SP and ACT plus amodiaquine could be expected to be useful for other target groups such as IDPs in protracted emergencies, but has not yet been evaluated for this purpose *(85)*.

SMC should be considered in areas of seasonal malaria transmission. SMC is now given to more than 40 million children in Africa each year. SMC could be delivered in protracted refugee populations provided treatment was done comprehensively and sustained in both refugee and nearby local populations.

7.5 Expanded vector control tools

The additional classes of vector control interventions in advanced stages of development may be considered for large-scale pilot implementation in humanitarian emergencies. For the current status of these and other emerging vector control tools, refer to the WHO guidelines for malaria *(11)*. Efficacy may depend on vector resistance, mosquito behaviour, ambient conditions or cultural norms.

7.5.1 Passive emanators (spatial repellents)

Passive emanators are in the final stages of evaluation in multicentre trials. They show promise for vector control in acute emergencies. Passive emanators use volatile pyrethroids, which provide both personal and community protections through repellence, interruption of the vector feeding cycle and lethality. Designed as thin plate-sized plastic sheets impregnated with slow-release transfluthrin or metofluthrin, passive emanators are compact, relatively inexpensive ($0.30 per unit) and effective for 1 month.

Case study 11 describes the deployment of passive emanators amid a dengue epidemic.

Case study 11. Passive emanator deployment in Puerto Rico to address dengue emergency

In March 2024, the Secretary of Health of Puerto Rico declared a dengue epidemic following a dramatic surge in cases across the island. Cases within the first 5 months of 2024 exceeded the total number reported in 2023.

In response, the Environmental Protection Agency of the United States of America issued a public health emergency exemption, under Section 18 of the Federal Insecticide, Fungicide and Rodenticide Act, to the Puerto Rico Department of Agriculture for the use of the Guardian™ passive emanator. This product, a hanging polyester mesh emanator that passively releases transfluthrin, is intended to control mosquitoes that may transmit dengue (*Aedes* spp.) in high-risk communities.

The intervention includes the distribution of this specific emanator through household visits and central locations. The research emphasis is on evaluating acceptability and proper use and mosquito impact. Additionally, a research cohort in southern Puerto Rico will assess the efficacy of these passive emanators, with households randomized to: the emanator intervention; an outdoor IRS; or an outdoor IRS plus an earlier shorter-lasting form of passive emanators. Monthly follow-up visits over 12 months will measure the impact on dengue incidence and mosquito presence inside homes.

While awaiting full WHO endorsement and registration in the United States of America, the Environmental Protection Agency granted the exemption due to the urgent public health threat. Deployment of up to 750 000 units was scheduled to begin in August 2024. A report summarizing the programme's results was to be submitted to the Environmental Protection Agency within 6 months post-expiration or before requesting further exemptions.

Source: Contribution from CDC Dengue Branch, 2024.

7.5.2 Topical repellents

Topical repellents (e.g. aerosol spray or lotion applied to the skin or clothes) have been shown to be protective against malaria in individual randomized trials in some emergency situations but not in others. Adherence to regular use seems to be a problem in South-East Asia *(82)*, but not in Pakistan and Afghanistan *(86)*, where they are well accepted. In combination with ITN, topical repellents are additive in effect *(87)*. Because their effectiveness seems to depend on human behaviour and cultural norms, further pilot interventions are desirable in Africa and other locations, in combination with the primary interventions of ITNs and IRS. Topical repellents provide personal protection rather than community protection, unlike spatial emanators. They be sprayed on skin or clothes.

7.5.3 Attractive targeted sugar baits

In addition to blood, mosquitoes feed on nectar and plant juices for energy. Attractive targeted sugar baits (ATSB) can be used outdoors and indoors *(88)* and can draw upon a wide variety of stomach acting toxic compounds developed for the agricultural pesticide market. ATSBs are in early-stage development, but have been shown to be an effective vector control tool in environmentally degraded emergency settings, including in the Bidi Bidi refugee settlement, Uganda.

7.5.4 Insecticide-treated textiles

Insecticide-treated textiles are fabrics, such as clothing, that are treated with insecticides to repel or kill insects, providing protection against vector-borne diseases such as malaria. Insecticide-treated textiles may be used for top sheets, blankets or clothing. Work in Afghanistan showed the impact of permethrin-treated blankets and top sheets against malaria and cutaneous leishmaniasis *(89)*. More recently, permethrin has been joined by etofenprox, which has lower dermal absorption and better wash resistance than permethrin but is less available commercially. Etofenprox is used to treat military uniforms and is being adapted for civilian use, ideally for humanitarian treatment of UNHCR blankets and sheeting for emergencies.

In areas of resistance, pyrethroids such as permethrin show less repellence. Recent research shows that the addition of the synergist piperonyl butoxide to permethrin restores toxicity and repellence against resistant mosquitoes on UNHCR-style blankets if sprayed on the upper surface *(90)*. It has proven difficult to create a viable market for treated blankets in emergencies, so spray-on long-lasting formulations of pyrethroid with piperonyl butoxide and alternative repellent insecticides may be the best approach.

7.5.5 Treatment of domestic animals

Domestic animals, such as cattle or goats, are important sources of income for populations in emergency settings. If malaria vector mosquitoes will feed on these animals, a One Health approach can be considered. It has been shown that treating domestic animals, either by sponging or dousing their coats with veterinary-use insecticides or treating them with veterinary doses of ivermectin, will kill mosquitoes that come to feed and thereby reduce malaria transmission. This technique is only effective against highly zoophilic mosquitoes such as those found in southern and western Asian refugee populations *(91)*. It is not effective against mosquitoes that feed only on humans such as *An. gambiae*, *An. funestus* and *An. dirus*. Treatment of domestic animals may show promise of elimination of *An. stephensi*, which has invaded Africa from Asia, from African cities. It is very cheap due to the small quantities of insecticide required to douse domestic animals.

7.6 Vaccines

There are two WHO-recommended malaria vaccines against *P falciparum malaria*, RTS,S/AS01 and R21/Matrix-M. Both are pre-erythrocytic vaccines, which induce an immune response targeting the circumsporozoite protein. They reduce malaria, including severe malaria by 50% - 66% during the first year after vaccination when given in 3 doses from 5 months of age *(92, 93, 94)*. A fourth dose is provided to prolong protection. When given seasonally, in areas of highly seasonal malaria, the vaccines reduce malaria, including severe malaria, by 75% *(93, 94)*. There has been no head to head trial, and no evidence that one vaccine works better than the other.

In the acute phase of humanitarian emergencies, vaccination would be a low priority. In protracted emergencies with a population at high risk of malaria, vaccination of children becomes a credible option, especially if given to both refugee and local populations. There is efficacy between the first and third dose, with highest efficacy following the third dose and again after booster doses. A cold chain would be required to transport and store the vaccines, but this would be no different from requirements for routine vaccines.

For highest impact and protection, a mix of interventions should be delivered. Thus children at risk should receive ITNs (or IRS), malaria vaccine, and where indicated, chemoprevention.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Messenger LA, Furnival-Adams J, Chan K, Pelloquin B, Paris L, Rowland M. Vector control for malaria prevention during humanitarian emergencies: a systematic review and meta-analysis. Lancet Glob Health. 2023;11(4):e534–45 (https://doi.org/10.1016/S2214-109X(23)00044-X).

- Response plan to pfhrp2 gene deletions, second edition. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/379469).

- Malaria vaccines: WHO position paper. Weekly Epidemiological Record, 2024, vol. 99, 19 (https://iris.who.int/handle/10665/376738).

Chapter 8.
Surveillance and monitoring and evaluation

8.1 Overview

This chapter focuses on surveillance, monitoring, and evaluation of malaria control interventions during emergencies, mainly to measure prevalence of malaria, outcome, and impact of interventions. In each chapter specific indicators are provided for measurement of quality of intervention (ex. quality of care, diagnosis, and vector control tools). Surveillance is the ongoing systematic tracking of disease burden (and related metrics, such as entomological surveillance). Monitoring and evaluation is tracking of programmatic intervention implementation and impact and is specific to an intervention or intervention mix.

Malaria surveillance, monitoring and evaluation in a humanitarian emergency can differ significantly from that in stable environments for various reasons.

- **Shifting populations:** the affected population in a humanitarian emergency is usually fluid. This makes computation of the desired malaria metrics such as malaria incidence difficult to establish due to fast changing estimates. Additionally, the results obtained may also not align with historical information and trends.
- **Breakdown in access to care:** disruption of health facilities and community-based treatment will also disrupt the routine flow of information on diagnosis and treatment of malaria cases. Alternative mechanisms may need to be set up for priority disease monitoring.
- **Breakdown in referral systems:** there is a high likelihood that in a humanitarian emergency, the referral systems are broken; hence the ability to track and report severe malaria may be compromised.
- **Movement between transmission areas:** displacements could lead to populations from areas of low or no malaria transmission moving into areas of moderate to high transmission and vice versa. Populations moving from areas of low or no transmission to areas of higher transmission are more vulnerable to severe malaria and death. Therefore, tracking severe malaria cases and deaths is essential. On the other hand, population movements from areas of moderate to high transmission to areas of low or no transmission create potential for increased malaria transmission (high receptivity with malaria vector species and the parasites present) and an outbreak among the local population in the low or no transmission areas.
- **Changes in access and use of some malaria prevention measures:** the suitability and feasibility of some malaria prevention measures may differ depending on the humanitarian emergency; for example, access to and use of ITNs or IRS may be limited by the types of shelter in use. This could reduce the level of protection and increase the risk of malaria outbreaks.

Malaria surveillance in a humanitarian emergency needs to be cognizant of the above considerations to inform effective planning, implementation and monitoring of emergency responses.

Key steps include to:

- ensure malaria is included in the public health situation analysis;
- ensure malaria indicators are included within early warning systems;
- ensure malaria is included within the priority disease monitoring systems and information products generated – the simplest approach is including malaria in the priority list of the diseases being monitored rather than setting up a malaria-specific disease monitoring system;
- assess referral systems and re-establish reporting through all government and nongovernmental points of care and establish reporting systems from new sources of care, such as organization-specific clinics;
- ensure emergency actors providing community health services are trained on reporting and that the data they report can be identified as community surveillance data;
- include malaria in health evaluations such as nutrition and household assessments; and
- where necessary and feasible, conduct malaria-specific evaluations.

This chapter will cover critical information to ensure that malaria is included and prioritized in public health assessments. It will discuss which malaria indicators should be included in early warning systems and when routine surveillance is re-established, as well as provide information for health cluster assessment and malaria-specific assessments (Table 2 Malaria Assessment, Chapter 1). This chapter also provides detailed information that can be included in a malaria situation assessment and details on malaria indicators, their calculation and interpretation. Further information is available in the resources listed in the further reading.

8.2 Public health situation analyses

The WHO emergency response framework *(95)* provides guidance on how WHO manages the assessment, grading and response to public health events and emergencies with health consequences. Following confirmation of the emergency, a public health situation analysis will be conducted to determine the level of response. Malaria must be included in this analysis.

Any initial response in emergencies is guided by a risk assessment for public health events and public health situation analysis for emergencies. A review of the existing documentation or a rapid assessment should inform the importance of malaria in the emergency response.

In malaria endemic areas, information can be gathered on the risk of malaria through reviewing documents and information sources, including:

- the country's national strategic plan for malaria from the NMCP
- routine malaria data from the affected region
- the country's malaria operational plan (for partner countries in the U.S. President's Malaria Initiative)
- the Global Fund funding request for malaria.

Other health sector needs assessment approaches that could provide relevant information for the malaria response include:

- the Health Resources and Services Availability Monitoring System *(96)*
- mortality surveys
- nutrition surveys (e.g. UNICEF Nutritional Assessment Survey and UNHCR Standardised Expanded Nutrition Survey) *(97)*.

8.2.1 Malaria-specific assessments and evaluations

If malaria is not assessed in the integrated surveys mentioned above and the local malaria situation (presence and level of transmission) is not clearly understood, a rapid initial assessment should be undertaken (see Table 2). The aim of the assessment is to determine the nature and scale of malaria, its health risks and consequences, the gaps in available response and coordination capacities, and the need for an operational response.

Where malaria information is limited or outdated, it may be necessary to carry out rapid surveys or random testing of the affected population to assess the situation and the relative importance of malaria. Rapid surveys can help to assess whether malaria is, or may become, a significant problem and to monitor trends.

Rapid surveys assess basic clinical signs and symptoms and the presence of parasites using RDTs or microscopy. Malaria surveys should be conducted at the same time as other rapid surveys (e.g. nutritional status, vaccination coverage) where possible.

Rapid malaria surveys can be clinic-based (among patients attending a health facility) or population-based (through a cross-sectional prevalence survey of the affected population).

To inform the situation analysis, information should also be collected on the emergency context, population demographics, malaria epidemiology, burden of disease and response capacity. These are summarized in Table 17.

Table 17. Malaria-specific indicators for monitoring coverage effectiveness of interventions

Category	Requirements	Sources of information
Emergency context and situation	Priorities and health threats • Partner locations and activities (4W matrix – who, what, where, when) • Coordination mechanisms	OCHA WHO/health cluster
Population at risk	Affected population size and breakdown by age and gender • Origin of displaced or refugee populations • Groups at risk of malaria (by age, gender, socioeconomic status) • Knowledge, attitudes and beliefs about malaria and its causes, prevention and treatment • Use of protective measures such as ITNs • Treatment-seeking behaviour and access to health services	Ministry of health/NMCP OCHA IOM Displacement Tracking Matrix[a] UNHCR (in refugee settings)

Category	Requirements	Sources of information
Malaria epidemiology	Risk factors • Movement of non-immune people into areas of high transmission • Increased larval habitat • Drug resistance • Insecticide resistance Malaria parasite species present – to inform diagnostic and control measures Malaria vector species, including feeding habits, larval habitat and susceptibility to insecticides Environmental data and seasonality of risk (e.g. climate, season, rainfall, temperature)	Ministry of health/NMCP Published literature
Malaria burden of disease	Trends in malaria morbidity and mortality	Ministry of health/NMCP Hospital records
Response capacity and control efforts	Types of health facilities, including those set up by NGOs and mobile structures Number of health workers and level of training Availability of diagnostic testing (e.g. RDTs, microscopy) Referral services Treatment protocols for malaria Drugs and equipment, including blood transfusion facilities Surveillance, monitoring and information management systems	Ministry of health/NMCP

a. Displacement Tracking Matrix *(98)*

Information collected on the emergency context and situation should include surveillance, monitoring and evaluation capacity, partner activities and coordination mechanisms. Such information can be collected through the health cluster and from other partners, including OCHA (see Chapter 2).

8.2.2 Cluster evaluations

The multi-cluster/sector initial rapid needs assessment was developed by the IASC as a method to establish the basis of a joint strategic plan for emergency response. The assessment is conducted within the first few days of a disaster. It seeks to address the problem of siloed information-gathering within clusters or sectors and to facilitate a better-coordinated assessment culture. It enables all partners to reach a common understanding of the situation to agree on intersectoral strategies. The IASC has published manual to guide multi-cluster/sector initial rapid needs assessment *(99)*.

8.3 Malaria surveillance

Malaria surveillance should include the ability to track the proportion of fever cases due to malaria, the incidence of malaria in the affected areas, and the proportion of deaths that have malaria infection as a key factor. These indicators should be collected using routine health facility data, community health workers, or other emergency facilities. Data collection and aggregation should be conducted either daily, weekly, or monthly depending on the emergency situation and burden of malaria.

Area-specific standardized malaria case definitions are available from national guidelines. Key case definitions for disease notification systems should include the following.

- **Suspected malaria:** a suspected malaria presentation usually includes fever. All patients with suspected malaria should be tested by RDT or microscopy.
- **Confirmed malaria:** a suspected case of malaria in which malaria parasites have been demonstrated by RDT or microscopy.
- **Confirmed severe malaria:** a patient with laboratory-confirmed acute malaria with signs of severity and/or evidence of vital organ dysfunction.
- **Confirmed malaria death:** death of a patient who has been diagnosed with severe malaria, with confirmation of parasitaemia by RDT or microscopy.
    - » Number of confirmed/suspected malaria-attributable deaths (may be challenging to collect given many cases die in the community in some settings)
- **All-cause outpatient:** outpatient cases due to various health conditions including malaria.
- **All-cause inpatient (admission):** admission due to various health conditions including malaria.
- **All-cause deaths:** deaths due to various health conditions including malaria.

The key data elements in an early detection surveillance system should at least include:

- number of people presenting in outpatient clinics
- number of febrile cases
- number of malaria RDTs performed or slides read (microscopy)
- number of RDT and microscopy tests that were positive for parasites
- (in the absence of diagnostics) number of cases clinically determined to be malaria.

These indicators enable tracking of the burden of malaria and measurement of changes (impact) over time.

The above indicators ideally should be disaggregated by age (ideally < 2, 2–5 and 5+ years, but at least < 5 and 5+ years), and should distinguish pregnant women.

8.3.1 Analysis of indicators

Ideally every fever should be tested for malaria in malaria endemic areas. In the absence of malaria diagnostics, the number of clinically determined cases and number of febrile cases should be recorded and reported, especially for children aged under

5 years. Key indicators are described in Fig. 27. Additional indicators to be used in emergencies can be found in Annex 5. Malaria surveillance should be integrated into a routine health surveillance system where possible.

Fig. 27. Key measurement indicators for daily or weekly disease notification systems

8.3.2 Establishing surveillance systems in humanitarian emergencies

Some settings will have established surveillance systems. If no malaria surveillance system is in place or the existing system is inadequate, it is essential to establish a functional malaria surveillance system in coordination with partners.

Effective malaria surveillance in humanitarian emergencies requires compilation of information from the malaria risk assessment, disease surveillance reports, surveys and response monitoring in order to develop information products that allow partners and stakeholders to track progress and monitor the effectiveness of the malaria response. This is usually done by the information management function of the emergency response unit.

A key information product is the situation report, which contains updated epidemiological information. Situation reports should be shared regularly with all partners and stakeholders to inform the progress and impact of malaria control interventions. Key data elements and indicators mentioned above (Section 8.2) will be similarly needed to assess the situation of malaria as part of establishing a routine early detection and monitoring system. Early warning systems using climatic data in the context of malaria (ex. perception data) are used to forecast long term risk of malaria in a country or region. However, the sensitivity of such measurements is often poor. There early detection using surveillance systems and entomologic assessments are more predictive to detect malaria epidemics in emergency settings.

8.3.3 Monitoring and reporting of trends

Daily or weekly notification systems should include reports of key trends, mapping of cases and context for malaria outbreak systems.

Trends to be monitored and reported in daily or weekly notification systems, based on the indicators described in Fig. 27, include:

- malaria cases by day, week, month and year;
- disaggregated number of malaria cases, admissions, and deaths by age, pregnancy status, time and location;
- test positivity rate (by RDT or microscopy);
- number of malaria patients as a proportion of all-cause outpatients and all-cause inpatients; and
- number of malaria deaths as a proportion of all-cause deaths.

By assessing these trends, responders can understand the malaria situation in a given setting at a point in time and over time.

Mapping of malaria cases by locality and time will show any clustering of cases, which could indicate a focus of local transmission or area of higher risk.

8.3.4 Early outbreak detection

Collection of data, calculation of indicators and reporting supports early detection of an outbreak.

- If historic data allows, graph the number of malaria cases over time and establish a 75th percentile threshold for each given area (3–5-year baseline). This is more applicable in protracted emergency settings.
- Determine the seasonality and normal curves of malaria cases for the area.

Any trend above the threshold indicates an outbreak or epidemic that requires an immediate response *(18)*. If historic trends in the same area cannot be established, seasonality can be established from the closest available data by graphing by week and month. This will indicate when cases will likely be highest. In climate emergencies, the presence or absence of rain that is unseasonable will affect the seasonality patterns. Available data around the area should be used to determine the proportion of confirmed malaria cases in the outpatient data. If the proportion of malaria cases to all-cause outpatients is higher, track closely for an outbreak.

Case study 12 describes the use of WHO's Early Warning, Alert and Response System (EWARS) *(100)* used Borno State Nigeria in 2020 which included multiple disease and malnutrition assessments of which malaria was included.

Case study 12. Implementing an EWARS to improve detection and reporting of malaria in northern Nigeria 2014

Context

Borno State in northern Nigeria has experienced protracted conflict, insecurity and the collapse of its health system. Routine surveillance has been disrupted, including in IDP settlements, making it difficult to detect and quickly respond to epidemic-prone diseases, including malaria.

Interventions

An EWARS was established in affected areas to monitor public health events, including malaria. The weekly reporting system used mobile phones to enable remote reporting of data from insecure areas, including IDP settlements.

Results

Nearly 50% of the 240 reporting sites (including 20 sites in IDP settlements) submitted reports (75% on time and 100% complete). This information was instrumental in determining that malaria was the leading cause of morbidity (54%) and to help design and implement malaria control interventions.

Source: WHO Global Malaria Programme; MEASURE Evaluation *(101)*.

8.4 Monitoring and evaluation

Monitoring and evaluation involve tracking the implementation and impact of processes and interventions to understand and improve performance and outcomes.

The indicators described above can be used, in conjunction with environmental data and other data, to evaluate the impact over time of interventions and intervention deployment strategies in emergency contexts. The key to understanding impact, however, is the ability to look at historical differences in trends. In protracted emergency contexts with stable populations, historical trends can be analysed using the same community over time and interventions can be staggered in rollout to evaluate their impact in emergency contexts. In acute emergencies, or protracted emergencies where populations are shifting rapidly, the same population cannot be used and analyses become more complex. In these situations, consider the use of historical data from a larger administrative unit that has a more stable population that includes the population in question. For example, if people are moving from rural areas into a district centre, using the whole district population as a unit of analysis over time may be possible.

Table 18 summarizes malaria-specific indicators that can be used to monitor the coverage and effectiveness of interventions used in the malaria operational plan.

Further reading

The following resources provide valuable further information or access to relevant tools related to this chapter's content. The latest *WHO Guidelines for malaria* should always be consulted. They can be accessed via the website or mobile app.

- Epidemiological approach for malaria control, second edition. Geneva: World Health Organization; 2013 (https://iris.who.int/handle/10665/96351).
- Health Resources and Services Availability Monitoring System (HeRAMS) [website]. World Health Organization; (https://www.who.int/initiatives/herams).
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Annex 1.
WHO Emergency Response Framework and Protracted Emergency Framework

Table A1. Comparison between the ERF and PEF

Framework	Emergency Response Framework (ERF)	Protracted Emergency Framework (PEF)
Overall objective	Save lives, protect the vulnerable and preserve dignity	Optimize coverage, quality and utilization of health services, and contribute to health system strengthening including risk management capacity
Focus	Event-specific health needs and risks (time-limited)	Restore and maintain essential services
Coordination	Incident Management System (IMS)	Health Cluster
Management system	IMS	Emergency Management system
Grading [a]	• Grade 1: Limited response needed; managed with in-country assets • Grade 2: Moderate response, requires external support from the regional level • Grade 3: Major response requiring mobilization of global organizational resources	• Protracted 1: Managed with in-country assets • Protracted 2: Moderate external support required • Protracted 3: Major external/ organizational support required
Health information	Event-specific risk analysis and situation assessments	Public health situation analysis
Resource mobilization	Through the humanitarian response mechanisms	

a. Grading of emergencies in WHO involves input from the three levels of WHO, based on a prearranged agenda for discussion. Grading is decided based on situation analysis, risk assessment and an assessment of scale, urgency, complexity, capacity and risk of failure to deliver *(1)*.

Table A2. Stages for emergency preparedness and response

Stage	Key actions		Parties involved
Stage 1: Emergency preparedness for response			
	Preparedness activities	• Conduct extensive mapping of affected populations to identify vulnerable and at-risk groups, social and power dynamics, local capacities, and opportunities for and constraints on engagement, including barriers affecting minorities and vulnerable groups. • Identify key structures for collaboration with the community, ensuring representation of key stakeholders including vulnerable groups. • Develop or update message banks (pre-approved, evidence-based communication messages) and segment by target group (e.g. health workers, community health workers, leaders, community), ensuring that context, cultural appropriateness and literacy are addressed. • Identify the most trusted and accessible communication channels and use diverse engagement strategies to ensure that all groups are reached. • Identify and assess risks and take measures to ensure that vulnerable groups have safe, inclusive and equitable opportunities to engage. • Update mapping of existing social and behaviour change/risk communication and community engagement partners by area of mandate, expertise and geographical location covered (who, what, where). • Develop rapid assessment tools to understand community knowledge, behavioural and social drivers.	Government, public health institutions/ actors, humanitarian organizations in collaboration with clusters/ sectors, and academia
Stage 2: Needs assessment			
	Social data for action	• Conduct community engagement analysis as part of broader country risk analysis. • Conduct systematic mapping and assessment of needs, vulnerabilities and behavioural gaps of the at-risk and affected populations. • As much as possible, disaggregate data by age, gender, disability and other diversity factors. • Include operational problems and underlying causes, as well as an assessment of capacities, resources and gaps of implementing organizations to inform community engagement and social and behaviour change strategies.	Civil society organizations and research institutions in collaboration with programme staff and national institutions

Stage	Key actions		Parties involved
Stage 3: Strategic response planning			
	Strategic response plan and implementation	• Identify and prioritize expected results that contribute to agreed Humanitarian Response Plan objectives and programmes, processes and financial and human resources. • Use established results and interventions to build synergy and a shared vision while leveraging areas of mutual benefit across government, organizations, groups and individuals. • Identify partners who will conduct activities. • Define coordination mechanisms, roles and responsibilities with clear reporting structures that enable regular communication at all levels. • Establish a feedback and complaints mechanism to ensure that community concerns are addressed.	Government, public health institutions/actors, and humanitarian organizations in collaboration with clusters/ sectors
Stage 4: Implementation and monitoring			
	Monitoring, evaluation and learning	• Align ongoing monitoring and performance and impact assessment with standards and indicators to track whether interventions have the desired impact and are proceeding according to the plan. • Use findings to make systematic adjustments to interventions and programmes, targeted groups, costs, etc. • Integrate key insights into future planning.	Government, public health institutions/ actors, humanitarian organizations in collaboration with clusters/ sectors, and academia
Stage 5: Operational review and evaluation			
	Review to inform future preparedness and response	• Continue to collect continuous feedback from affected and at-risk communities to remain accountable to them. • Conduct/participate in the after-action review.	Government, public health institutions/ actors, humanitarian organizations in collaboration with clusters/ sectors, and academia

Reference

1. Emergency Response Framework (ERF): internal WHO procedures. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/375964).

Annex 2.
Costing templates

The costing templates provided in Annex 2 are designed to assist planners and emergency responders in integrating malaria-specific commodities into their preparedness and response planning. These tools help ensure that the appropriate commodities are accurately quantified, procured and delivered in a timely manner to the most vulnerable populations. The templates are available online in Excel format *(1)* with embedded formulas to facilitate quick and efficient preparation.

The package includes the following templates:

- General treatment costing for emergencies
- General diagnosis costing for emergencies
- Mass drug administration (MDA) programmatic costing
- Seasonal malaria chemoprevention (SMC) programmatic costing
- General intermittent preventive treatment in pregnancy (IPTp) costing for emergencies
- General insecticide-treated net (ITN) costing for emergencies
- General indoor residual spraying (IRS) costing for emergencies

Additionally, they can be customized to align with the specific context of each emergency and adapted to prioritize the most impactful interventions.

Reference

1. Costing tools for malaria commodities and interventions in emergency settings. Geneva: World Health Organization; 2025 (https://www.who.int/publications/m/item/costing-tools-for-malaria-commodities-and-interventions-in-emergency-settings).

Annex 3.

Considerations for deployment of vector control interventions in humanitarian emergency settings

Intervention	Examples	WHO Policy Status	Product Availability	Emergency Suitability	Population Suitability	Use with Population Movement	Vector Target	Deployment Considerations	Optimal coverage (population level)	Logistics Burden/ Community Distribution
ITNs	Sleeping mesh nets	Strong Recommendation FOR	WHO PQ available	All shelter types	Mainly indoor sleepers	Transportable	Indoor-seeking at night	Replace ≤ 3 yrs(normal settings)	≥80% of population	High/ Yes
Treated Blankets/ Clothing	Insecticide-treated items	Conditionally recommended AGANST	No PQ products	Transitional/ durable shelters	Any sleeping behavior	Transportable	Night-seeking	Depends on use/wash	70–90% of target population	Unknown/ Yes
IRS (Indoor Residual Spraying)	Selective/full spraying	Conditionally recommended FOR	WHO PQ available	All shelters	Mainly indoor	Fixed	Indoor-resting vectors	Re-spray every 3–6 months	≥85% of eligible structures	High/ No
Larval Source Management (LSM)	Larviciding, habitat modification	Conditionally recommended FOR (larviciding only)	WHO PQ available	All	Any	Fixed	Treatable larval habitats	Depends on method	100% of identified, manageable breeding sites	Varies/ No
Space Spraying – Indoor	Aerosol fogging	Conditionally recommended AGAINST	NA	All	Any	Fixed	Indoor host-seeking	Weekly	≥90% of targeted rooms in outbreak settings	High/ No

Intervention	Examples	WHO Policy Status	Product Availability	Emergency Suitability	Population Suitability	Use with Population Movement	Vector Target	Deployment Considerations	Optimal coverage (population level)	Logistics Burden/ Community Distribution
Space Spraying – Outdoor	Outdoor fogging	Conditionally recommended AGAINST	NA	All	Any	Fixed	Outdoor host/ sugar-seeking	Weekly	≥70–80% of at-risk population or shelters	High/ No
Spatial Repellents	Passive emanators	Not recommended (Conditional recommendation under review)	Under evaluation	All	Close to emanator	Transportable	Indoor-seeking	Replace every 3 months	≥70–80% of at-risk population or shelters	Unknown/ Yes
Topical Repellents	Skin application	Conditionally recommended AGAINST (only for high-risk)	Three WHO-recommended actives	All	Any	Transportable	Active period host-seeking	Frequent use/ day	≥80% daily use by target population	High/ Yes
Endectocides	Ivermectin (systemic)	Not recommended	Unknown	All	Zoophilic mosquitoes	Fixed	Animal-feeding vectors	Unknown	≥80% of eligible human/ animal population treated	Unknown/ No
Housing Modification	Eave tubes, screening	Conditionally recommended FOR (screening only)	WHO PQ for screening	Fixed, durable housing only	Indoor	Fixed	Indoor-seeking	Once only	≥80% of target households with improved features	Unknown/ No

References

1. WHO guidelines for malaria , 30 November 2024. Geneva: World Health Oranization; 2023 (https://iris.who.int/handle/10665/379635) .

Annex 4.
Entomological assessment and monitoring for humanitarian emergencies

Entomological assessment provides basic information on the threat of local malaria transmission and guides the choice of interventions at the refugee or displaced persons encampments. This annex focuses on *Anopheles* malaria vectors, but similar strategies should be used for other common vector threats in humanitarian emergencies, including *Aedes* vectors of dengue, yellow fever, chikungunya and Zika, as well as sandfly vectors of leishmaniasis. In more-established encampments, entomological assessment and vector control is often conducted by the WASH Cluster, who are also responsible for surface water management and prevention of larval habitats through maintained water access points, camp drainage systems and, for *Aedes*, reduction of non-essential water containers and the covering, regular cleaning or larval control of essential water containers, including for domestic animals should that be necessary.

Essential entomological indicators

Presence of malaria vectors in and around camp is the most essential indicator. From a positive identification, geographically specific information on preferred larval habitats, insecticide resistance, feeding, resting habits and optimum control techniques can often be available through World Health Organization (WHO), national and regional institutions.

Collection techniques

Basic field collection techniques for mosquito adults and larvae can be found in the WHO training manual for malaria entomology and vector control *(1)*.

For collection of adult mosquitoes, techniques range from indoor resting hand collection with a sucking tube to human and animal-baited traps as well as Centres for Disease Control light traps and CO_2 baited traps. Larval collections still rely mostly on use of dippers in the aquatic habitats. Details on equipment, techniques and surveillance protocols can also be found in the American Mosquito Control Association best practices for integrated mosquito management training programme *(2)*.

Identification

Three important mosquito genera are *Anopheles* (the vector of malaria), *Aedes* (the vector of dengue and other arboviruses) and *Culex* (the vector of lymphatic filariasis and arboviruses). These can be easily distinguished with the naked eye as illustrated in Fig. A4.1.

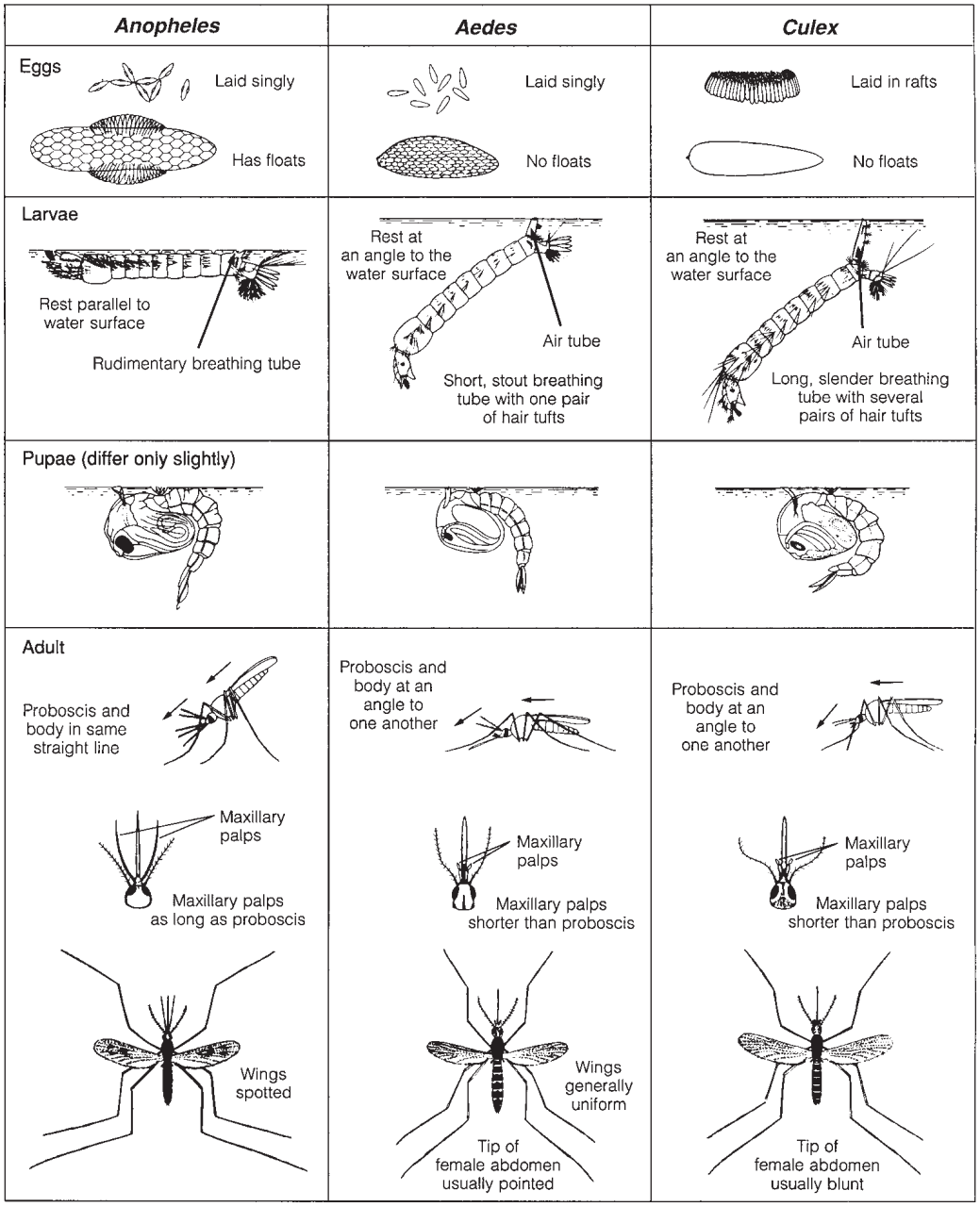
Traditionally, species identification was based on morphological identification supplemented by molecular identification. Morphological identification requires trained

staff, microscopes and use of a pictorial dichotomous key. Such a key can be found in "Key to the females of Afrotropical *Anopheles* mosquitoes (*Diptera: Culicidae*)" *(4)*.

Where identification cannot be done by staff at the encampment, arrangements can be made to package the specimens and send to regional institutions or programmes for morphological and molecular identification. An example of instructions for sample preparation for shipping can be found here *(5)*.

More recently, citizen science approaches to mosquito identification have been developed whereby individuals using a 60x clip-on lens for a smartphone can photograph and upload mosquito images for artificial intelligence-supported identification *(6)*.

Fig. A4.1. Some of the main characteristics for differentiating *Anopheles, Aedes* and *Culex* mosquitoes



Source: World Health Organization *(3)*.

Insecticide resistance status

The second important entomological indicator in addition to presence or absence of the vector is the insecticide resistance status. Vector and location-specific data is continually updated on the WHO Malaria Threats Map *(7)*. Additional site-specific insecticide resistance testing can be done using WHO protocols and equipment for phenotypic testing. Specimens can also be sent to national and regional reference centres for detection of molecular resistance markers.

Additional entomological indicators

Beyond presence/absence and insecticide resistance status, programmes may want to employ additional entomological surveillance indicators to monitor or evaluate control measures. The Entomological Surveillance Planning Tool *(8)* focuses on three primary areas: situation assessment, tailored responses, and programme management and sustainability.

Information management and decision-making

The WHO DHIS2-based entomology and vector control data collection and collation tools *(9)* have been developed to support countries and programmes to improve the collection and use of entomological and vector control interventions data and its use to inform programmatic decisions.

The modules contain a set of standard data collection forms, automatically calculated indicators, data visualizations and thematic dashboards that enable collection, visualization and interpretation of data from the following activities in line with WHO recommendations:

- insecticide-treated nets (ITNs) mass distribution campaigns and bio-efficacy monitoring
- indoor residual spraying (IRS) campaigns and residual efficacy monitoring
- insecticide resistance monitoring
- adult mosquito surveillance and identification, including the collection of individual mosquito data
- larval source monitoring and management.

References

1. Malaria entomology and vector control. Geneva: World Health Organization; 2013 (https://iris.who.int/handle/10665/85890).

2. AMCA's best practices for integrated mosquito management virtual training program [website]. American Mosquito Control Association; (https://amca.ce21.com/item/best-practices-mosquito-management).

3. Rozendaal J, World Health Organization. Vector control: methods for use by individuals and communities. Geneva: World Health Organization; 1997 (https://iris.who.int/handle/10665/41968).

4. Coetzee M. Key to the females of Afrotropical Anopheles mosquitoes (Diptera: Culicidae). Malar J. 2020;19(70) (https://doi.org/10.1186/s12936-020-3144-9).

5. Russell TL, Staunton K, Burkot T, Murphy A. Mosquito vector surveillance, processing and storage [website]. protocols.io; 2022 (https://dx.doi.org/10.17504/protocols.io.eq2lyn13qvx9/v3). Licence: CC BY 4.0.

6. Carney RM, Long A, Low RD, Zohdy S, Palmer JRB, Elias P et al. Citizen science as an approach for responding to the threat of Anopheles stephensi in Africa. Citizen Science. 2023;8(1) (https://doi.org/10.5334/cstp.616).

7. Malaria threats map [website]. World Health Organization; (https://apps.who.int/malaria/maps/threats/).

8. Entomological Surveillance Planning Tool [website]. University of California San Francisco; (https://shrinkingthemalariamap.org/tool/entomological-surveillance-planning-tool-espt).

9. DHIS2-based entomology and vector control data collection and collation tools [website]. World Health Organization; (https://www.who.int/teams/global-malaria-programme/prevention/vector-control/dhis-data-collection-and-collation-tools).

Annex 5.
Malaria surveillance indicators

Malaria intervention	Rates	Calculation	Interpretation	Source of data
Epidemiology	Crude mortality rate	No. of deaths/10 000 population per day	>1/10 000 or a doubling of the baseline crude mortality rate (ideally subnational) indicates an emergency.	Health facility data, local authorities/ United Nations agencies
	Malaria-specific mortality rate	No. of malaria deaths/100 000 population per day	Is malaria a health priority? Is malaria a significant proportion of overall crude mortality rate? Note that this will rarely be available or easy to calculate.	
	Number of hospital admissions	No. of admissions to inpatient health facilities	Reliability and use of data from health facilities will strongly depend on whether the population has access to care.	
	Malaria incidence rate	No. of new malaria cases/1000 population per week	Is malaria increasing? What action should be taken?	
Diagnostics	Malaria test positivity rate	No. of positive RDTs or microscopy/ Total RDTs or microscopy examined (if possible, include species)	What proportion of suspected malaria is actually malaria? What are the predominant species in the context?	Health facility data
	Monthly or annual testing rate (RDT or microscopy coverage)	No. of RDT or microscopy tests/Standard population	RDT or microscopy tests per standard population.	

Malaria intervention	Rates	Calculation	Interpretation	Source of data
Case management	Case fatality rate in all malaria cases	No. of confirmed malaria deaths/ confirmed malaria cases	Indicates quality of care and access to care.	Health facility data
	Case fatality rate in all admitted cases	No. of malaria deaths/admitted malaria cases	Indicates quality of severe case management	
	Proportion of cases treated with first-line antimalarials	No. of cases treated with first-line antimalarials/ Total no. of malaria cases	Can point to availability of first-line treatment and help identify stockouts. Can also help point in the direction of potential resistance to current treatment.	
ITNs	Coverage of ITNs among at-risk population	No. of ITNs distributed/target population size (%)	Are at-risk populations being adequately reached by ITNs?	Administrative data (local and national authorities) or United Nations agencies
	Usage of ITNs among at-risk population (if part of a survey)	No. of people using ITNs/No. of people surveyed (%)	Are at-risk populations using ITNs?	
	Durability of ITNs among at-risk population	No. of months since ITN distribution/ Durability rate based on latest or closest available data	Are ITNs providing substantial malaria protection?	
IRS	Coverage of IRS among at-risk population	No. of structures sprayed/No. of structures in the target areas (%)	Are sufficient dwellings being sprayed to achieve coverage?	Administrative data (local and national authorities or United Nations agencies
	Insecticide use of IRS among at-risk population	Amount of insecticide used/ No. of structures sprayed (%)	Is insecticide being used correctly?	
	Maintenance of IRS equipment	% of pumps correctly maintained at the end of the campaign	Is equipment being maintained correctly?	
	Acceptability of IRS among at-risk population	% of households that refused to have their homes sprayed	Are at-risk populations accepting IRS use in their communities?	

Malaria intervention	Rates	Calculation	Interpretation	Source of data
Chemoprevention	Coverage of chemoprevention among at-risk population	No. of people receiving chemoprevention/ Target population size (%)	Are at-risk populations being adequately reached by chemoprevention?	Administrative data (local and national authorities or United Nations agencies
	Effectiveness of chemoprevention campaign	Test positivity rate among at-risk population (before/after campaign)	How effective was the chemoprevention campaign in reducing malaria burden?	
Health promotion	Behaviour change among at-risk population	% of households that recall or understand message	Effectiveness of health education and community engagement programmes.	Administrative data (local and national authorities or United Nations agencies

IRS: indoor residual spraying; ITN: insecticide-treated net; No.: number; RDT: rapid diagnostic test

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