Guide to introducing malaria vaccine into national immunization programmes

Information for policy-makers, programme managers, and health workers on malaria vaccine introduction for children living in regions with moderate-to-high malaria transmission

About this guide

The purpose of this guide is to summarize current global recommendations and programmatic considerations for the vaccination of children living in regions with moderate-to-high malaria transmission as defined by the World Health Organization (WHO). The guide aims to support immunization programme decision-makers and managers, immunization partners and stakeholders, and national malaria control programmes (NMCPs) considering or planning a malaria vaccine introduction and/or expansion.

As of 25 July 2023 (finalization of this guide), there was one malaria vaccine (RTS,S/AS01) recommended by WHO for programmatic use (2021) and prequalified by WHO for country regulatory reviews (2022). A second malaria vaccine, R21/Matrix-M, is currently being assessed by WHO and its relevant advisory bodies for regulatory prequalification and for recommendation on its public health use (the latter through the Strategic Advisory Group of Experts on Immunization (SAGE) and the Malaria Policy Advisory Group (MPAG)). This guide will be updated as relevant for this or any other malaria vaccine as they become available.

The guide outlines:

1. key considerations for country decision-making and roll-out of the malaria vaccine based on global recommendations and pilot implementation experience (including lessons learned from the malaria vaccine pilot countries —Ghana, Kenya and Malawi);
2. the importance of collaboration between the national immunization programme and malaria control programmes, as well as integration with other health services; and
3. ways in which malaria vaccination strategies can be planned, communicated, delivered and monitored.

WHO's 2014 guidance document[1] ***Principles and considerations for adding a vaccine to a national immunization programme: from design to implementation and*** **monitoring** provides additional helpful general guidance on planning for a new vaccine introduction.

This document was developed by WHO in consultation with immunization and malaria programme experts including those involved in the RTS,S/AS01 malaria vaccine implementation programme (MVIP). It follows the format of prior new vaccine introduction guides and incorporates published malaria vaccine recommendations as well as lessons learned and experience from the pilot introduction.

[1] Principles and considerations for adding a vaccine to a national immunization programme: from decision to implementation and monitoring. Geneva: World Health Organization; 2014 (https://www.who.int/publications/i/item/9789241506892, accessed 23 June 2023).

Abbreviations

ACSM	Advocacy, Communications, Social Mobilization
AEFI	Adverse Event Following Immunization
CCE	Cold chain equipment
CSO	Civil society organization
DHIMS	District Health Information Management System
DHIS2	District Health Information System version 2
DHS	Demographic and Health Survey
DTPCV3	Third Dose of Diphtheria, Tetanus, Pertussis (DTP)-containing vaccine
EIR	Electronic immunization registry
EMA	European Medicines Agency
EPI	Essential Programme on Immunization
FAQ	Frequently asked questions
GSK	GlaxoSmithKline
HepB	Hepatitis B
Hib	Haemophilus influenzae type b
HIV	Human Immunodeficiency Virus
HMIS	Health Management Information System
ICC	Interagency Coordinating Committee
IEC	Information, Education and Communication
IPTp	Intermittent preventive treatment of malaria in pregnancy
IRS	Indoor Residual Spraying
ITN	Insecticide-Treated Net
MCH	Maternal Child Health
MCV2	Second Dose of Measles-Containing Vaccine
MoH	Ministry of Health
MPAG	Malaria Policy Advisory Group
MV	Malaria Vaccine
MVIP	Malaria Vaccine Implementation Programme
NIP	National Immunization Programme
NIS	National Immunization Strategy
NITAG	National Immunization Technical Advisory Group
NMCP	National Malaria Control Programme
NRA	National Regulatory Agency
ODK	Open Data Kit software
PCV	Pneumococcal conjugate vaccine
Penta	Pentavalent vaccine
PIE	Post-Introduction Evaluation
PIRI	Periodic Intensified Routine Immunization
PMC	Perennial Malaria Chemoprevention
RDT	Rapid Diagnostic Test
SAGE	Strategic Advisory Group of Experts on Immunization
SMC	Seasonal Malaria Chemoprevention
TWG	Technical Working Group
UHC	Universal Health Coverage
WHO	World Health Organization

Contents

1. Introduction

1.1 Malaria epidemiology and disease

Malaria is a potentially deadly disease transmitted through the bite of a female *Anopheles* mosquito that has been infected with the *Plasmodium* parasite. According to the *World malaria report 2022*, there were an estimated 247 million malaria cases and 619 000 deaths globally in 2021. Almost all malaria deaths are caused by *Plasmodium falciparum*, and approximately 96% occur in sub-Saharan Africa – mostly in children under 5 years of age. With an estimated 470 000 deaths due to malaria in children under 5 years in 2021, malaria is one of the leading causes of childhood illness and deaths in Africa.[2]
In many endemic areas, malaria parasite transmission occurs throughout the year, often with seasonal variation. In areas of high malaria transmission, young children often experience multiple episodes of clinical malaria each year, even while utilizing available malaria control tools. The intensity of malaria transmission is usually heterogeneous within a country; there may be areas with very high transmission where malaria is a prominent cause of childhood mortality, areas with variable transmission where sporadic epidemics affect all age groups, and areas with little or no malaria transmission.[3] In areas of highly seasonal malaria, transmission may be limited primarily to several months per year, influenced largely by rainfall patterns.

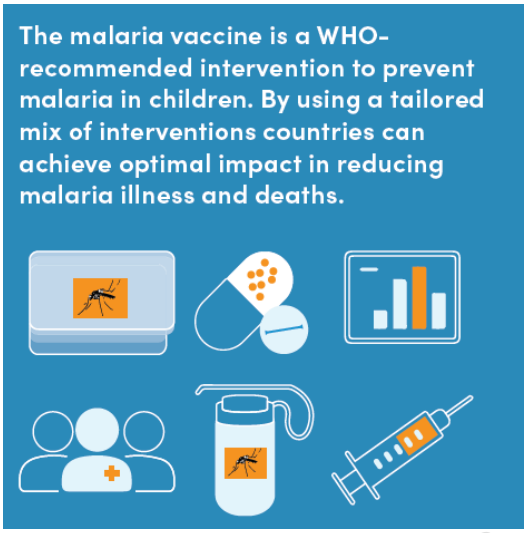
The signs and symptoms of malaria are non-specific. Malaria is suspected clinically primarily on the basis of fever or a history of fever. Severe malaria may present as life-threatening anemia, respiratory distress, reduced level of consciousness or coma. Malaria symptoms usually appear 10 to 15 days after the bite of an infected female *Anopheles* mosquito. If left untreated, malaria can progress to severe illness and death within 24 hours. Caregivers should therefore seek prompt diagnosis, testing and treatment for a child with fever.

Natural immunity to malaria is acquired gradually with repeated exposure to *Plasmodium* infection. With increasing age, there is progressive protection first against severe malaria and ensuing mortality, then against uncomplicated malaria and, much more slowly, asymptomatic parasitaemia. Unfortunately, many children die as a result of malaria before they have developed immunity. In areas of moderate-to-high transmission, malaria mortality rates begin to fall by around 2 years of age, with the incidence of acute febrile malaria falling later in childhood. In areas of highly seasonal malaria transmission, acquired immunity may take longer to develop. Most malaria prevention strategies are directed towards protecting young children to diminish their exposure and risk of death from malaria.[3]

The burden of malaria in Africa has reduced substantially in recent decades as a result of scaled-up malaria control measures. However, since 2015, the rate of progress in reducing both malaria cases and deaths has slowed, and in some countries with the highest burden, the annual number of malaria cases has risen. Increased use of current control and prevention tools and the addition of new tools, strategies and enhanced problem-solving approaches are needed to further improve malaria control.

[2] World malaria report 2022. Geneva: World Health Organization; 2022, accessible from: https://www.who.int/teams/global-malaria-programme/reports/world-malaria-report-2022
[3] Malaria vaccine: WHO position paper. Weekly Epidemiological Record. 2022;97(9):61–80 (https://www.who.int/teams/immunization-vaccines-and-biologicals/policies/position-papers/malaria, accessed 11 June 2023).

1.2 Malaria prevention



Malaria is both preventable and curable. All malaria control interventions provide partial protection against malaria and the highest impact is achieved when interventions are strategically layered and used together (Table 1). To achieve the highest impact and save the most lives with available resources, packages of tools are identified for different subnational settings. The appropriate mix of interventions is defined by national malaria control programmes (NMCPs) on the basis of the local malaria epidemiology (e.g. transmission intensity, age pattern of severe disease, vector species, insecticide resistance patterns) and contextual factors (e.g. structure and function of the formal health system, population acceptance or use of particular interventions).

Table 1. WHO-recommended malaria prevention and control measures (WHO *Guidelines for malaria*, 2022).

Prevention – Vector control	• Insecticide treated nets (ITNs) • Indoor residual spraying (IRS) • Larviciding[4]
Prevention – Chemotherapies	• Intermittent preventive treatment of malaria in pregnancy (IPTp) • Seasonal malaria chemoprevention (SMC) • Perennial malaria chemoprevention (PMC) • Post-discharge malaria chemoprevention (PDMC) • Intermittent preventive treatment in school children (ITPsc) • Mass drug administration (MDA)
Prevention – Vaccine	• Malaria vaccine for children
Case management	• "3T" approach – Test fever or history of fever, Treat, Track outcomes • Parasitological diagnosis (using rapid diagnostic test [RDT] or microscopy) • Treatment of uncomplicated malaria (artemisinin-based combination therapy) • Treatment of severe malaria (parenteral artesunate or alternatives)

[4] Larviciding is recommended where optimal 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. See: WHO Guidelines for malaria – 3 June 2022. Geneva: World Health Organization; 2022 (https://www.who.int/publications/i/item/guidelines-for-malaria, accessed 11 June 2023).

2. Malaria vaccine

Key Resource 1: Malaria vaccine: WHO position paper – March 2022
(https://www.who.int/teams/immunization-vaccines-and-biologicals/policies/position-papers/malaria, accessed 11 June 2023).

Key Resource 2: WHO guidelines for malaria (Section 4.3 Vaccine)
(https://www.who.int/publications/i/item/guidelines-for-malaria, accessed 11 June 2023).

2.1 WHO position

The RTS,S/AS01 vaccine is the first malaria vaccine to be recommended for use by WHO.

The RTS,S/AS01 malaria vaccine should be used for the prevention of *P. falciparum* malaria in children living in regions with moderate to high malaria transmission, as defined by WHO. The RTS,S/AS01 vaccine should be provided in a 4-dose schedule in children from 5 months of age.

- WHO recommends that the first dose of vaccine be administered from 5 months of age.
- There should be a minimum interval of 4 weeks between doses.
- The vaccine should be administered in a 3-dose primary schedule, with a fourth dose provided approximately 12–18 months after the third dose to prolong the duration of protection.
- However, there can be flexibility in the schedule to optimize delivery, for example, to align the fourth dose with other vaccines given in the second year of life. Children who begin their vaccination series should complete the 4-dose schedule.

The additional visits needed for RTS,S/AS01 are opportunities to provide other integrated and preventive health services.

- Efforts should be made to take advantage of these visits to catch up on missed vaccinations, administer vitamin A, carry out deworming and other preventive interventions, and remind parents of the importance of continuing to use an ITN [insecticide treated net] every night and seeking prompt diagnosis and treatment for fever.
- The RTS,S/AS01 malaria vaccine should be provided as part of a comprehensive malaria control strategy.

Optional schedule: Countries may consider providing the RTS,S/AS01 vaccine seasonally, with a 5-dose strategy, in areas with highly seasonal malaria or with perennial malaria transmission with seasonal peaks.

- This strategy seeks to maximize vaccine impact by ensuring that the period of highest vaccine efficacy (just after vaccination) coincides with the period of highest malaria transmission.
- The primary series of 3 doses should be provided at monthly intervals, with additional doses provided annually, prior to peak transmission season.
- Countries that choose seasonal deployment of the RTS,S/AS01 vaccine are strongly encouraged to document their experience including the vaccine effectiveness, feasibility and occurrence of

any adverse events following immunization, to provide additional input for future updates to the guidance.

Co-administration: The RTS,S/AS01 vaccine may be administered simultaneously with other vaccines of the childhood immunization programme.

Vaccine safety: The RTS,S/AS01 vaccine is safe and well tolerated. There is a small risk of febrile seizures within 7 days (mainly within 2–3 days) of vaccination. As with any vaccine introduction, proper planning and training of staff to conduct appropriate pharmacovigilance should take place beforehand.

Vaccination of special populations[5]: Malnourished or Human Immunodeficiency Virus (HIV)-positive infants may be vaccinated with the RTS,S/AS01 vaccine using a standard schedule. The vaccine should be provided to infants and young children aged 5–17 months who relocate to an area of moderate to high transmission, including during emergency situations.

Surveillance: As for all new vaccines, the effectiveness and safety of the RTS,S/AS01 vaccine should be monitored post-introduction. Countries that choose seasonal deployment of the RTS,S/AS01 vaccine are strongly encouraged to document their experience, including adverse events following immunization.

Box 1. How are moderate-to-high malaria transmission settings defined?

Areas of high transmission are characterized by an annual parasite incidence of 450 or more cases per 1000 population and a *P. falciparum* prevalence rate of ≥35%.

Moderate transmission areas have an annual parasite incidence of 250–450 cases per 1000 population and a prevalence of *P. falciparum/P. vivax* malaria of 10–35%.

Areas of low transmission have an annual parasite incidence of 100–250 cases per 1000 population and a prevalence of *P. falciparum/P. vivax* of 1–10%. It should be noted that the incidence of cases or infections is a more useful measure in geographical units in which the prevalence is low, given the difficulty of measuring prevalence accurately at low levels.

Very low transmission areas have an annual parasite incidence of < 100 cases per 1000 population and a prevalence of *P. falciparum/P. vivax* malaria that is > 0 but < 1%.

Source: WHO Guidelines for malaria, 2022 (https://www.who.int/publications/i/item/guidelines-for-malaria, accessed 11 June 2023).

[5] The vaccine has been developed for use in young children living in malaria-endemic settings, and has not undergone full clinical testing in adults, nor is it recommended for adults. The vaccine is not indicated for travellers, who should use chemoprophylaxis and vector control methods to prevent malaria when travelling to endemic settings.

Table 2. RTS,S/AS01 malaria vaccine characteristics

Vaccine group	Malaria
Serotypes	Plasmodium falciparum
Vaccine trade name	Mosquirix™
Vaccine type	Subunit recombinant protein (RTS,S) adjuvanted with AS01E
Number of doses required	Four (or up to five if provided seasonally in areas with highly seasonal malaria or areas with perennial malaria transmission with seasonal peaks)
Minimum dosing interval	4 weeks between all vaccine doses
Route of administration	Intramuscular injection
Presentation and vaccine vial monitor (VVM) type	Two vial set (active + active), clipped together to reduce chance of reconstitution error (not to be stored separately) providing two doses (0.5mL/dose): a) Antigen RTS,S: Lyophilized (freeze dried powder) (red ring vial) b) AS01 adjuvant: clear liquid diluent (green ring vial) with VVM14
Preservative and handling of opened multi-dose vials	No preservative; opened vials of this vaccine should be discarded six hours after opening or at the end of the immunization session, whichever comes first
Reconstitution and dosage	Once reconstituted, the vial contains TWO doses of vaccine (0.5mL/dose): 1 vial contains 1 mL or 2 doses of vaccine after reconstitution; suspension containing the adjuvant (green ring vial) is used as a diluent to reconstitute the powder (red ring vial) Important: The diluent for the malaria vaccine contains the adjuvant and therefore cannot be used to reconstitute other lyophilized vaccines; similarly, diluents from other vaccines cannot be used to reconstitute the malaria vaccine.
Storage requirements	2–8°C; should not be frozen; protect from light; shelf-life 36 months

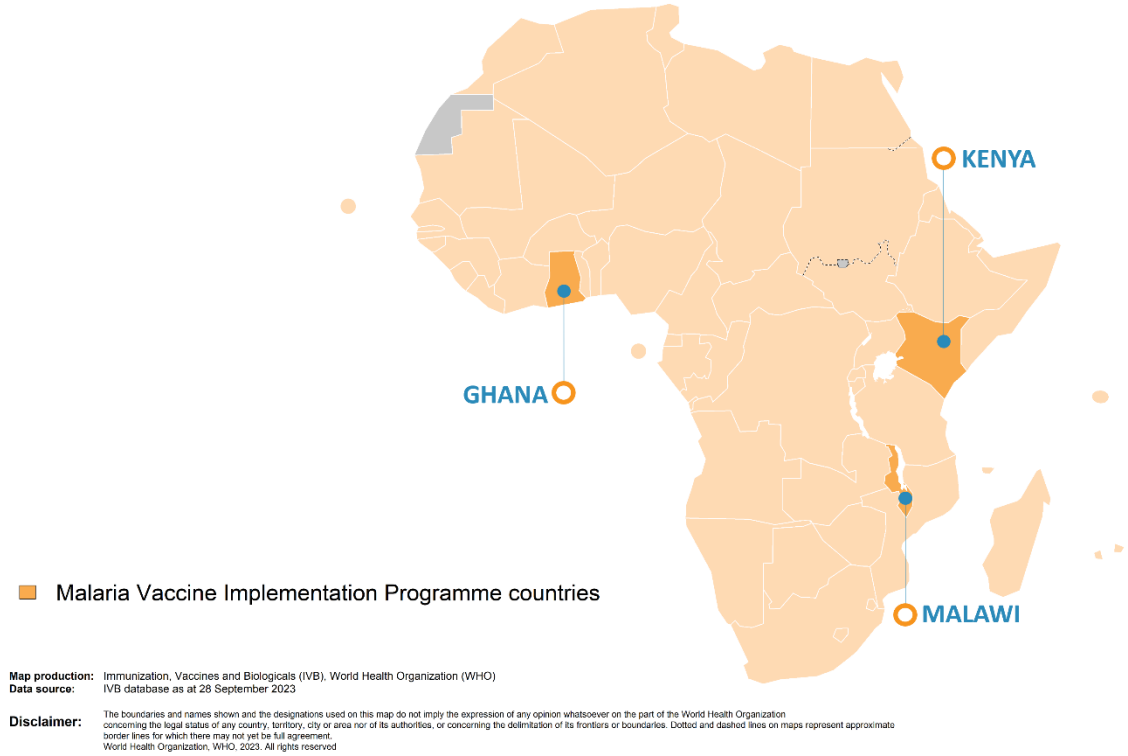
Additional information on the RTS,S/AS01 malaria vaccine's characteristics is available from WHO here: https://extranet.who.int/pqweb/content/mosquirix (accessed 12 June 2023).

- **Antigen RTS,S**: lyophilized powder (red ring)
- **Adjuvant AS01**: liquid clear diluent (green ring)

Lessons from the pilot introduction of the malaria vaccine (2019–2023)

The RTS,S/AS01 malaria vaccine implementation programme (MVIP) began in 2019 in Ghana, Kenya and Malawi to evaluate the public health use of the vaccine when introduced into routine immunization programmes. More than 3 years after its launch in subnational areas of these three countries, evidence has shown that the malaria vaccine is safe, can reach children with high uptake, and has an important public health impact in routine use. In the areas where the vaccine was introduced, there was a substantial reduction in children being hospitalized with severe malaria and a decrease in child deaths.

This guide presents lessons, best practices, and examples from the ministries of health of Ghana, Kenya and Malawi to support future malaria vaccine introductions.



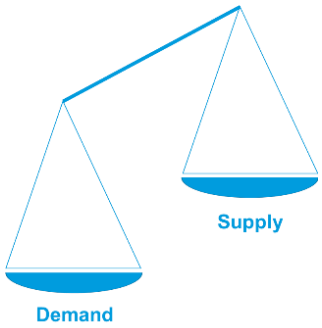
Malaria Vaccine Implementation Programme (MVIP) webpage

See: https://www.who.int/initiatives/malaria-vaccine-implementation-programme/

***WHO malaria vaccines* webpage: evidence, tools, publications and information resources**

See: https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/malaria

2.2 Malaria vaccine supply and allocation



Supply of the malaria vaccine will be constrained at the start of vaccine rollout, which will have an impact on initial access to the vaccine. The supply and demand situation is described in WHO's *Malaria vaccine global market study*, UNICEF's document, *Malaria vaccine: questions and answers on vaccine supply, price, and market shaping update*, and Gavi's *Market shaping roadmap for malaria vaccines* (See Key Resource 3 and Key Resource 4). Increasing vaccine supply is a key priority for WHO, countries and partners.

Anticipating the initial gap between high demand for the vaccine and available supply, a framework has been developed – with expert advice and broad stakeholder consultation – to guide allocation of limited supply in a fair, transparent, and equitable way Initially, countries might have to consider a phased approach to vaccine introduction, starting at the subnational level in areas with highest need. As supply constraints ease, implementation can be expanded to other areas of moderate-to-high malaria transmission.

During a period of limited vaccine supply, countries should where possible use the best available local data and contextual information to target and prioritize the vaccine subnationally as part of a tailored mix of interventions to maximize the impact on malaria transmission and the burden of disease. Consult the WHO Global Malaria Programme and the *Framework for allocation of limited supply* (See Key Resource 5) for suggested data and methods to inform the identification and stratification of subnational areas.

Key Resource 3: WHO Malaria vaccine global market study (September 2021)

More than 25 million children are born each year in regions with moderate-to-high malaria transmission. Based on anticipated demand, the 2021 WHO *Malaria vaccine global market study* found that supply would potentially be constrained during the first 4–6 years following the first introductions in 2023. For details, see: WHO Malaria Vaccine Global Market Study – September 2021. Geneva: World Health Organization; 2021 (https://www.who.int/publications/m/item/who-malaria-vaccine-global-market-study-september-2021, accessed 13 June 2023).

Key Resource 4: Malaria vaccine: Questions and answers on vaccine supply, price, and market shaping

The Malaria Vaccine Questions and Answers document was developed by UNICEF in collaboration with WHO, Gavi, and PATH. It provides general information on malaria vaccine supply, price and ongoing market shaping efforts. The information includes the outcome of UNICEF's first tender for malaria vaccine and will be updated with new information as market dynamics continue to evolve. For details, see: New York (NY): United Nations Children's Fund (https://www.unicef.org/supply/documents/malaria-vaccine-questions-and-answers, accessed 13 June 2023).

Key Resource 5: Framework for allocation of limited malaria vaccine supply

The Framework offers guidance on the global allocation of malaria vaccines among countries, and guidance on prioritization of areas for vaccination within countries until supply constraints are fully resolved. The first priority aim is to allocate the malaria vaccine to countries with areas of greatest need – i.e. areas where the malaria disease burden in children is highest and the risk of death is also highest. The second priority aim is to allocate the malaria vaccine for use in areas where the expected health impact is greatest – i.e. where most lives can be saved with the limited available doses. For details, see: Framework for the allocation of limited malaria vaccine supply. Geneva: World Health Organization; 2022 (https://www.who.int/publications/m/item/framework-for-allocation-of-limited-malaria-vaccine-supply, accessed 13 June 2023).

3 National decision-making: introducing malaria vaccine

3.1 Decision-making process

A systematic decision-making process, led by the National Immunization Programme (NIP) in collaboration with the NMCP, is an important component for countries considering adopting a malaria vaccine into the NIP. A key initial step of the decision-making process is the review of available data on malaria burden and local transmission.

Countries should work through their nationally established procedures for decision-making. Below are some important steps. See also Key Resource 6: Principles and considerations for adding a vaccine to a national immunization programme: from decision to implementation and monitoring.

1) **Identify key immunization and malaria stakeholders** (See section 3.2, Key stakeholders)**.**
2) **Brief key stakeholders on WHO's recommendations for the introduction of malaria vaccine** (See section 2.1 WHO position)**.**
3) **Establish a malaria vaccine technical working group** (TWG) with representation from immunization, malaria, maternal and child health programmes, among other key stakeholders, as a forum for coordination and alignment between key stakeholders and to provide technical guidance for decision-making, planning, implementation and monitoring.
4) **Engage the National Immunization Technical Advisory Group** (NITAG) (or equivalent) for synthesis and review of evidence regarding decisions on introduction of malaria vaccine. Ensure that NMCP advisory bodies are included for well-informed discussions.
5) **Identify areas with moderate-to-high malaria transmission[6] for vaccine roll-out** (see Box 1). If global vaccine supply or other resources are constrained, define phases of vaccine roll-out through subnational stratification and prioritization by categories of need as defined in the *Framework for allocation of limited supply* (See Key Resource 5).
6) **Seek NITAG (or equivalent)** recommendation to the government on the introduction of the vaccine based on a review of the evidence.
7) **Government** makes the decision on whether and where to introduce the malaria vaccine.
8) Subsequent steps, including the inclusion of the malaria vaccine in the national strategic plan for malaria and the National Immunization Strategy, are detailed in Planning (See section 4.1. What plans need to be developed or revised?)

[6] As defined by current WHO guidance (https://www.who.int/publications/i/item/guidelines-for-malaria, accessed 11 June 2023).

Pilot lesson learned: Establishing a Technical Working Group (TWG)
At the start of the decision-making process, it is a recommended best practice to establish a TWG that includes the major stakeholders for vaccines, malaria, child health and other relevant areas. TWGs were instrumental in the success of the malaria vaccine introduction in the pilot countries on the basis of early stakeholder engagement and informed evidence-based decision-making. The TWGs were led by the NIP with close collaboration with the NMCP and drew on expertise from across the Ministry of Health (MoH) and partner organizations, including the national regulatory authority (NRA), academia, the U.S. President's Malaria Initiative (PMI), John Snow Inc., UNICEF, WHO and PATH.

Key Resource 6: Principles and considerations for adding a vaccine to a national immunization programme: from decision to implementation and monitoring

This guide describes and includes key references and tools for: vaccine decision-making; economic analyses; developing an introduction plan; cold chain and logistics; integrated disease control and health promotion; vaccine safety; communications; and monitoring.

Importantly, this guide highlights ways to leverage the opportunity to introduce a new vaccine to strengthen the immunization programme and health system (https://www.who.int/publications/i/item/9789241506892, accessed 23 June 2023).

3.2 Key stakeholders

Successful introduction of the malaria vaccine within a comprehensive malaria control strategy will require collaboration of the immunization and malaria programmes with a variety of stakeholders both within and across programmes of different levels of government and nongovernmental partners (Table 3). Delineation of roles and responsibilities between the immunization and malaria programmes, in addition to ongoing communication between stakeholders, is essential for effective coordination and successful implementation.

Table 3. Key stakeholders to include in the decision-making process (adapted from Programme considerations)

Stakeholder	Description/role in decision-making process
Interagency Coordinating Committee (ICC) or equivalent	- improves coordination between representatives of the MoH, WHO, UNICEF and other national and external partners in support of immunization programmes; - fosters a supportive environment with stakeholders' buy-in for malaria vaccine introduction.
MoH NIP	- leads all aspects of malaria vaccine decision-making, planning and delivery.
MoH NMCP	- as lead of the analytical work, strengthens decision-making on where the malaria vaccine should be introduced on the basis of local data and in the context of subnational tailoring of malaria interventions (likely to be completed by NMCP manager and monitoring and evaluation focal points);

Stakeholder	Description/role in decision-making process
	- fosters a supportive environment for successful planning and introduction of the malaria vaccine – through close collaboration and partnership with the NIP; - recommends the delivery strategy (e.g. seasonal vaccination in areas with highly seasonal malaria and/or perennial malaria with seasonal peaks).
NITAG[7] (or equivalent)	- analyses and synthesizes the available evidence and considers other relevant issues in making recommendations to the government; - reinforces credibility of evidence-based recommendations due to the independence of the group of experts.
TWG or equivalent	- supports the function of the NITAG by collecting and synthesizing the available evidence for decision-making; - provides a forum for immunization, malaria, maternal and child health programmes to convene among other key stakeholders.
Malaria advisory groups and other advisory bodies	- support decision-making and planning for malaria vaccine introduction.
Other MoH departments (i.e. health education/promotion, community health, statistics, surveillance, maternal and child health, (MCH), gender/women)	- provide input and buy-in for the vaccine introduction and its alignment with the national health plan or strategy and budget; - provide a broader health system perspective and key inputs, such as ways to ensure optimized integrated delivery; - participate in the TWG.
NRA	- ensures alignment with the regulatory pathway for malaria vaccine licensure; - participates in the TWG.
Political, religious, cultural leaders and authorities at national and subnational levels	- foster a supportive environment with stakeholders buy-in for malaria vaccine introduction – if engaged and briefed during the decision-making phase.
Ministry of Finance, funders, and **financing bodies,** as relevant	- allocate resources and/or provide funding opportunities; - issues approval for budget and/or grant levels available.
Other stakeholders (as applicable)	- broad health and non-health sector partners provide technical assistance in both immunization and malaria control, and may participate in the TWG and contribute to decision-making, planning and/or implementation processes.

Examples of these stakeholders' roles in the planning process are described in section 4.2, How to plan for vaccine introduction?.

3.3 Evidence for decision-making

Each country will decide what local data (e.g. malaria disease burden) will inform evidence-based decision-making, and what evidence can be taken from global or regional sources (e.g. cost-effectiveness analyses) if local data are not available. The quality of evidence supporting the decision-making process can enhance confidence in the malaria vaccine. Key information to inform advisory

[7] The NITAG Resource Center. Global NITAG Network/World Health Organization (https://www.nitag-resource.org/, accessed 13 June 2023).

groups as they consider the potential role and fit of the vaccine within the national immunization programme, as well as broader health system, include:

- the malaria burden and epidemiology from local data sources or modelled estimates where necessary;
- coverage rates for other relevant vaccinations in the NIP and for other malaria control tools;
- availability of other malaria prevention tools;
- vaccine characteristics (efficacy, effectiveness, safety);
- immunization programme and health system capacities and the ability to achieve high uptake including: 1) plans for other new antigens, malaria control tools and activities that may overlap with malaria vaccine introduction; 2) availability of physical, human, technical and financial resources; 3) programmatic reviews and lessons learned from recent vaccine introductions and vaccines already provided in the second year of life; 4) relevant subnational vaccination coverage data; and 5) the existence and reliability of information and surveillance systems, including vaccine supply chain and monitoring of adverse events following immunization (AEFI);
- acceptability, values and preferences of the target population;
- economic and financial considerations as part of the overall health strategy;
- gender considerations, including the role of gender in accessing vaccination services[8]
- equity considerations, including the potential to extend the reach of immunization services to "zero dose" and under-immunized children, and of malaria prevention tools to children living in areas of moderate-to-high malaria transmission;
- vaccine supply availability (see section 2.2 Malaria vaccine supply and allocation); and
- potential to fully utilize new immunization visits to increase uptake of other vaccines, catch up on missed vaccines or provide other child health-care interventions, including vitamin A, deworming, growth monitoring and ITNs.

Key resources for malaria vaccine evidence to support decision-making:

- SAGE/MPAG malaria vaccine full evidence report, GRADE, Evidence to recommendation tables etc. (October 2021). See: WHO Guidelines for malaria – Systematic reviews, background papers and other unpublished evidence considered in the development of recommendations (https://www.nitag-resource.org/sites/default/files/2022-05/Full-evidence-report-on-the-rtss-as01-malaria-vaccine-2021.pdf, accessed 13 June 2023).
- NITAG Resource Center (https://www.nitag-resource.org/, accessed 13 June 2023).

[8] Why Gender Matters: Immunization Agenda 2030; https://www.who.int/publications/i/item/9789240033948

Key Resource 7: WHO CAPACITI decision-support tool

WHO's CAPACITI decision-support tool can support countries with prioritization of two or more vaccine introduction options by guiding users through a systematic, step-wise process, including evaluation of evidence and weighing of vaccine options. For further information see: Vaccine prioritization [CAPACITI]. Geneva: World Health Organization (https://www.who.int/teams/immunization-vaccines-and-biologicals/immunization-analysis-and-insights/vaccine-impact-value/economic-assets/vaccine-prioritization/, accessed 13 June 2023).

Key Resource 8: WHO Immunization decision-making resource catalogue

The catalogue can be used as the basis for the collection of high-quality evidence to support vaccine decision-making. Intended users of the collection include country decision-makers at all levels in the health sector, international partner organizations, and other policy-making and coordination bodies. The catalogue is organized by different criteria used in decision-making. Moreover, an overview of decision-support tools is included to help structure a transparent and evidence-based decision-making process (https://www.technet-21.org/en/decision-making, accessed 13 June 2023).

4 Planning

4.1 What plans need to be developed or revised?

Once a decision has been made to introduce, countries should ensure the malaria vaccine is integrated into relevant malaria control and immunization strategies and guidance. NMCPs should review their **national strategic plans for malaria** – aligned with the WHO Global Technical Strategy[9] – to include the vaccine as part of the packages to optimize malaria control in a country.

The NIP should also include the malaria vaccine within its **National Immunization Strategy (NIS**) (see Key Resource 9), aligned with the *Immunization Agenda 2030: A global strategy to leave no one behind*[10] (IA2030)."

Revisions to the national strategic plan for malaria and the NIS do not need to be completed prior to planning or introduction; however, they should be incorporated in the next planned cycle of updates.

A detailed **malaria vaccine introduction plan** should be developed that: 1) outlines all activities and steps required for a successful introduction by programme component (e.g. target population, delivery strategy, vaccination schedule, supply, cold chain and logistics, monitoring and evaluation, and communications and community engagement); 2) identifies key government ministries or programmes, partners and stakeholders that are responsible or can support each activity; and 3) includes a timeline and detailed budget. The budget should be comprehensive and should include all sources of funding from other partners and departments. The plan should consider links to the current vaccination schedule and opportunities for any additional visits to integrate catch-up activities, other health services and key messages. In the situation where more than one delivery strategy is used within a country (e.g. age-based schedule delivery in one area and seasonal schedule delivery in another), the introduction plan should clearly define where activities are cross-cutting and where different schedules require separate activities and approaches.

Pilot lesson learned: Roles of the NIP and NMCP
In the pilot countries, the new vaccine introduction plan and budget were developed by a NIP subcommittee that included the NMCP. The malaria vaccine TWG facilitated preparations and provided guidance, with NIP and NMCP focal points as key members (as detailed in section 3). There was clear delineation of roles between the two programmes; vaccine introduction activities were led by the NIP with active participation from the NMCP. The NMCP provided input towards the development of training and information, education and communication (IEC) materials, as well as key messaging in support of a comprehensive malaria control strategy. Active participation of the NMCP in training, social mobilization, stakeholder engagement, monitoring/evaluation and performance reviews, among other implementation activities, helped to ensure ongoing NIP/NMCP

[9] Global Technical Strategy for Malaria 2016–2030. Adopted in Resolution WHA68.2 by the Sixty-eighth World Health Assembly, May 2015, and endorsed in Resolution 74.9 by the Seventy-fourth World Health Assembly in May 2021. Geneva: World Health Organization, 2021 (https://www.who.int/publications/i/item/9789240031357, accessed 13 June 2023).

[10] Immunization Agenda 2030: A global strategy to leave no one behind. WHO Immunization Vaccines and Biologicals. Geneva: World Health Organization, 1 April 2020. (https://www.who.int/teams/immunization-vaccines-and-biologicals/strategies/ia2030 , accessed 13 June 2023).

integration and reinforced the message that children should continue to sleep under ITNs and seek prompt care for fever after immunization.

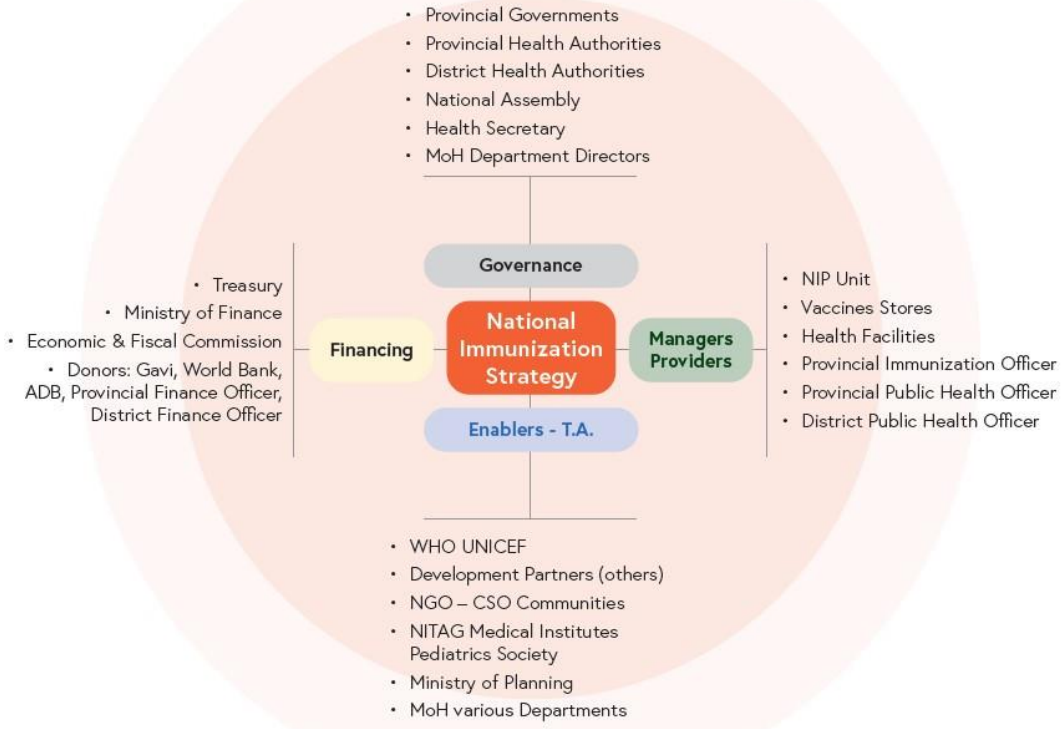
"As other countries get started with the malaria vaccine, here Is what I would like them to know from the start – you need to work with the national malaria control programme and the immunization programme, and they need to work together during this journey. They bring different strengths. The malaria programme brings in the data for where the malaria vaccine is going to be introduced. The immunization programme has the infrastructure to introduce the vaccine. Jointly they can work out their communication and give key messages to the community and health- care workers on malaria vaccine and the other interventions that have been laid down by the malaria control programme."

Dr Rose Jalang'o, National Vaccines and Immunization Program, MoH Kenya

Source: Summarized lessons from presentations by the Ghana, Kenya and Malawi MoHs at inter-country malaria vaccine workshops in late 2022.

Key Resource 9: National Immunization Strategy (NIS) guidelines (August 2021)

The NIS guideline is a streamlined planning document that focuses on a strategic period of 5 years. The NIS builds upon the experience of the comprehensive multi-year plans (cMYP) in use by countries since 2005. The NIS has been designed to prioritize: integration of immunization with other health interventions, Universal Health Coverage (UHC) targets and national planning cycles; focus on long term goals with intermediary objectives and prioritized strategies; country ownership with inclusive design processes; tailored approaches to local and national contexts; and increasing reliance on domestic sources in funding negotiations. A step-by-step guide for developing an NIS and additional tools are available from WHO (https://www.who.int/teams/immunization-vaccines-and-biologicals/vaccine-access/planning-and-financing/nis, accessed 13 June 2023).



4.2 How to plan for vaccine introduction?

Generally, convening an oversight committee (such as the ICC) is an effective mechanism for coordinating and collaborating with the diverse set of stakeholders who need to be engaged for successful malaria vaccine introduction. Well-defined national coordinating mechanisms, like the TWG with subcommittees, provide the basis for planning and coordinating critical aspects of the introduction. During the planning phase, the TWG and subcommittees are led by the NIP, in collaboration with the NMCP and other key stakeholders, and are expected to meet frequently. Post-introduction plans should anticipate continued (less frequent) convening of the TWG as a forum for technical guidance, coordination, issue mitigation and stakeholder alignment as needed.

Planning and implementation of specified activities should begin at least 6–12 months prior to the planned introduction. This includes engagement with leaders at all levels of the political and health systems, from national level to the community, to explain the subnational and/or phased introduction if applicable (see Table 4). Sequencing activities in a detailed chronogram will highlight the milestones necessary for the malaria vaccine introduction to proceed smoothly. Typically, the initiation of planning requires funding confirmation (e.g. budget confirmation, Gavi application approval[11]).

Pilot lessons: Planning considerations

Based on the pilot experience, the following questions are useful for countries to consider during the planning phase and to incorporate into plans or into training and supervisory materials:

- How to ensure collaboration between immunization and malaria programmes at all levels (from planning to service provision)?
- How to ensure uptake of the four-dose schedule and education on fourth dose timing? How to ensure uptake of the five-dose schedule in the case of seasonal delivery of vaccination?
- How to integrate the malaria vaccine with other routine vaccinations, malaria interventions, and health services (deworming, vitamin A, growth monitoring)?
- How to use the additional scheduled visits for the malaria vaccine to screen for missed vaccinations and other child health interventions?
- How to achieve and sustain high and equitable coverage among the most disadvantaged populations?
- How to obtain stakeholder buy-in and community understanding of the subnational and/or phased introduction if applicable?
- How to respond to children who present for vaccination from areas not yet delivering the vaccine?
- How to identify areas that could benefit from vaccine delivery performance improvement through regular subnational monitoring?

Table 4. Examples of roles of key stakeholders involved in planning process

Stakeholder	Description/role in planning process
ICC or equivalent	- coordinates and collaborates with the diverse set of stakeholders engaged in malaria vaccine introduction on financing and activities.

[11] Vaccine support (online). Geneva: Gavi (https://www.gavi.org/types-support/vaccine-support/, accessed 15 June 2023).

Stakeholder	Description/role in planning process
MoH NIP at national and subnational levels	- ensures integration of the malaria vaccine into the NIS; - secures funding for immunization activities and coordinates pool of resources available; - develops malaria vaccine introduction plan and delivery strategy; - develops costing and budget for malaria vaccine introduction; - leads all aspects of malaria vaccine planning, monitoring and evaluation, including the logistics of vaccine supply to health facilities, vaccine administration at the point of service, supervision and quality improvement; - coordinates vaccine introduction activities, including the establishment/ commission of relevant subcommittees and stakeholder participation; - identifies opportunities for integration with the delivery of other vaccinations, catch-up or other health interventions.
MoH NMCP at national and subnational levels	- facilitates integration of the vaccine into the national strategic plan for malaria; - shares updates on disease burden and transmission data analysis; - actively participates in malaria vaccine introduction planning and implementation activities, such as TWG and subcommittee participation, development of materials and messaging, stakeholder engagement, training, supervision, monitoring and evaluation etc.; - incorporates vaccine into activities for recommended malaria preventive measures, including structures for oversight and coordination, social mobilization, communication materials and other existing platforms; explores opportunities to improve delivery of other malaria control interventions being implemented; - continues malaria disease surveillance activities, and establishes links with monitoring of malaria vaccination coverage and surveillance of other vaccine-preventable diseases (VPDs); - ensures appropriate messaging to health workers and community stakeholders about the added value of the vaccine, and the importance of continuing use of other recommended malaria prevention tools (such as ITNs); - coordinates with the NIP to ensure funding for immunization activities and/or malaria activities in support of the vaccine.
NITAG or equivalent	- participates in the TWG (as chair or core members) to ensure adequate information flow between the planning, policy and implementation levels; - advises government on technical matters related to malaria vaccine introduction, on the basis of scientific evidence.

Stakeholder	Description/role in planning process
TWG or equivalent	- establishes a series of subcommittees for activities such as communications, training, vaccine management and logistics, and monitoring and evaluation; - reviews global-level information on the malaria vaccine and incorporates it in planning and preparation, as applicable; - ensures integration across immunization programme and different sectors; - coordinates and/or monitors readiness and progress.
Other malaria advisory bodies	- receive updates on progress and participate in planning as needed.
NRA	- ensures alignment with regulatory authorization for use of the malaria vaccine and ongoing assurance of the quality of medical products in use; - participates in the TWG.
Other MoH departments (i.e. health education/promotion, community health, statistics, surveillance, MCH, gender/women)	- provide input and buy-in for the vaccine introduction and its alignment with the national health plan or strategy and budget; - provide the broader health system perspective and key inputs, such as ways to optimize and integrate; - incorporate malaria vaccine in community engagement and community health worker activities; - participate in the TWG and relevant subcommittees; - participate in supportive supervision and programme monitoring; - incorporate the malaria vaccine into relevant communication and educational materials; - determine possible gender barriers that may affect vaccine uptake and develop approaches to address these.
Civil society organizations (CSOs)	- provide assistance with advocacy, communication and social mobilization to ensure that the value of malaria vaccine is understood, as well as the importance of completing the four-dose (or five-dose) series and continuing with other malaria control interventions; - play potential roles in identifying and reaching “zero dose” or under-immunized children not reached by the immunization programme in various settings; - provides vaccinations via health professionals, if applicable.
Political, religious, cultural leaders and authorities at national and subnational levels	- influence public opinion about the vaccine with a potentially active role in planning and implementation, including advocacy and resource mobilization activities to improve uptake and coverage; - attend training to increase awareness and knowledge about the vaccine;

Stakeholder	Description/role in planning process
	- engage and sensitize communities about the need for the vaccine and the value of the vaccine in reducing the burden of malaria and child deaths; - activate to help respond to vaccination events or issues, including anti-vaccine sentiments (e.g. media spokespersons).
Media at national and subnational levels	- communicate about the vaccine and mobilize communities for vaccination; - counter misinformation if well-informed and engaged.
Ministry of Finance, funders and financing bodies, as relevant	- incorporate malaria vaccine in budget cycles; - confirm and/or release funds for activities to introduce malaria vaccine.
Other stakeholders, as applicable	- education partners, including the Ministry of Education, to update relevant curricula to incorporate the malaria vaccine (medicine, nursing etc.); - immunization, malaria or development partners provide technical assistance.

4.3 How to select the malaria vaccination delivery strategy and schedule?

The following delivery strategies and schedules are recommended for the malaria vaccine:

- An **age-based schedule of four doses** starting from 5 months of age in areas of moderate-to-high malaria transmission with year-round delivery (see section 4.3.1, Age-based four-dose schedule).
- An **optional schedule of five doses with seasonal delivery of vaccination** from 5 months of age in areas with highly seasonal malaria or with perennial malaria transmission with seasonal peaks. This approach maximizes impact by ensuring that the period of highest vaccine efficacy (just after vaccination) coincides with the period of highest malaria transmission. (Schedules and delivery strategy options are described in more detail in section 4.3.2, Options for areas with highly seasonal malaria transmission or with perennial malaria transmission with seasonal peaks).

WHO's recommendation allows for flexibility in the dosing schedule in order to optimize uptake. Countries should consider their local context and the vaccine schedule that is likely to result in highest uptake and high impact. When selecting a vaccine schedule, it will be necessary to weigh the following three considerations:

Consideration #1: Early protection and timing of doses to extend the duration of protection during the period when children are at highest risk of malaria

- Malaria mortality and morbidity are highest among young children and vary by age group. Therefore, it is important to review local malaria epidemiological data to understand the age at which the risk of malaria illness and severe disease begins, and the age at which malaria illness reduces as the result of acquired immunity.
- Substantial protection from the RTS,S/AS01 malaria vaccine does not begin until after the first three doses are received. Subsequently, protection wanes with time; additional doses after the first three prolong the duration of protection.
    - Thus, it is important to reach children with three doses early because the risk of malaria illness and severe disease is high in infants and young children.

Consideration #2: Programmatic ease and likelihood to achieve high coverage
Programmatic implications of additional visits (positive and negative) include:

- opportunities for integration with the delivery of other vaccinations and health services;
- opportunities for catching up on previously missed vaccinations and/or childhood health interventions;
- perceptions and acceptance among parents/caregivers of additional visits and/or multiple injections at a single visit;
- capacity of health workers to provide additional visits;
- ease of communication of the schedule to health workers and caregivers.

Consideration #3: Implementation of the most effective schedule to reduce disease burden

- The fourth dose prolongs protection. Strategies to reach high coverage and minimize dropout for the fourth dose should be developed early and incorporated into initial training and messaging.
- Protection can be maximized in areas of highly seasonal malaria transmission or perennial transmission with seasonal peaks by delivering all doses (or only doses 4 and 5) just before the peak transmission season (see section 4.3.2, Seasonal schedules).

4.3.1 Age-based four-dose schedule

Number of doses: 4

Minimum age for dose 1: 5 months

Minimum interval between doses 1 and 2, and between doses 2 and 3: 4 weeks

Minimum interval between doses 3 and 4: 4 weeks but in order to prolong the duration of protection it is recommended to give the fourth dose 12–18 months after the third dose. However, there can be flexibility to reduce this interval to align the fourth dose with other vaccines in the second year of life (e.g. the second dose of the measles-containing vaccine [MCV2] at 18 or 15 months of age). **All children who begin the vaccination series should complete the fourth dose.**

When determining the age-based schedule, there are several considerations to take into account for scheduling the four doses. Table 5 and Table 6 emphasize the potential benefits and drawbacks for the first and fourth dose timings. There will be trade-offs when scheduling doses, particularly for the fourth dose, between (consideration #1 above) programmatic ease and likelihood of achieving high coverage and (consideration #2 above) the need to extend the period of protection since RTS,S/AS01 efficacy is highest after three doses and wanes with time).

Figure 1. Schedule options for four-dose age-based schedule of the malaria vaccine

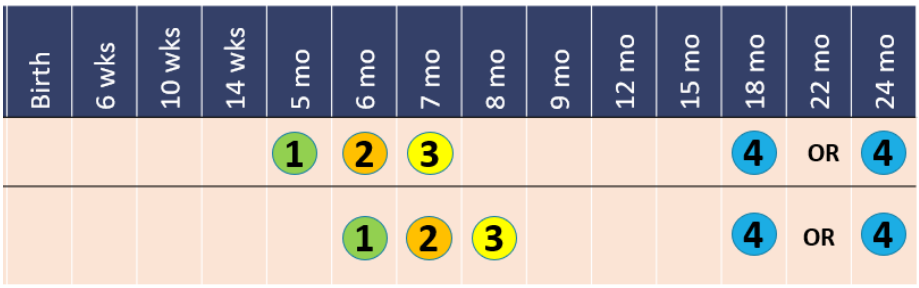
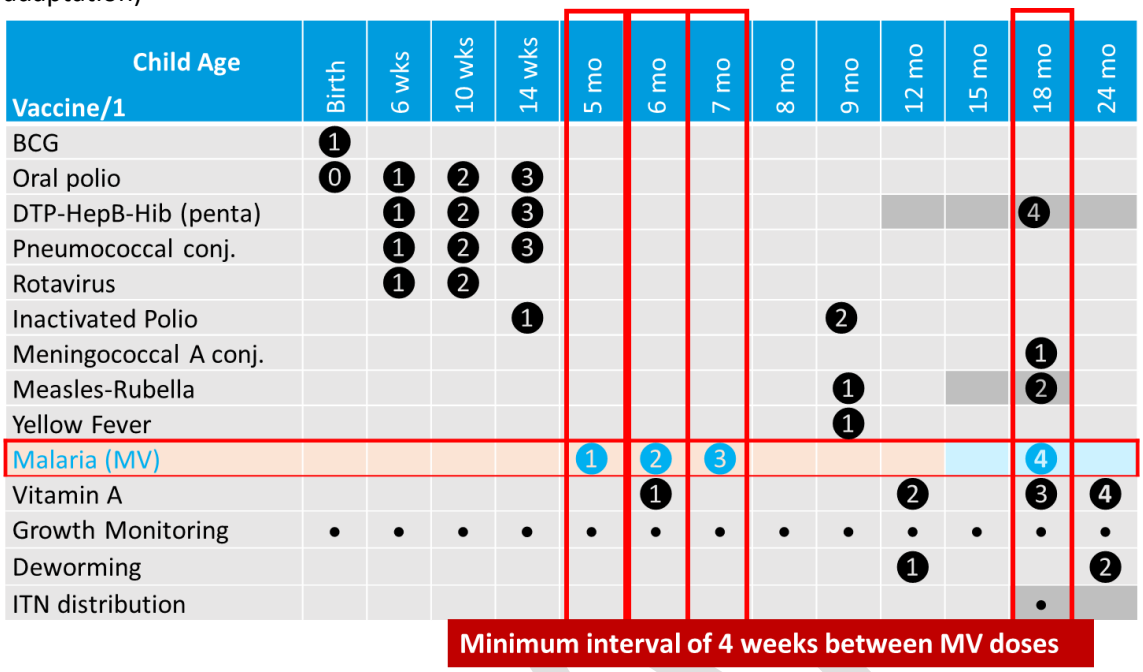


Figure 2. Illustrative example of four-dose age-based schedule of the malaria vaccine (MV) integrated with the childhood vaccination schedule and delivery of child health services (requires country-specific adaptation)



Bacillus Calmette–Guérin vaccination (BCG, to protect against severe forms of tuberculosis); Diphtheria-tetanus-pertussis-hepatitis B-Haemophilus Influenzae pentavalent vaccine (DTP-HepB-Hib, DTP-containing vaccine [DTPCV] or Penta); Pneumococcal conjugate vaccine (PCV); Meningococcal A conjugate vaccine (MenA conjugate); Measles and Rubella (MR) or Measles containing vaccine (MCV); insecticide-treated bed nets (ITN).

MCV2 is recommended between 15 and 18 months of age; DTPCV booster given between 12–23 months; (Source: WHO recommendations for routine immunization - summary tables. Geneva: World Health Organization; Feb 2023 https://www.who.int/teams/immunization-vaccines-and-biologicals/policies/who-recommendations-for-routine-immunization---summary-tables, accessed 23 June 2023).

ITNs can be distributed at birth and as an incentive for the fourth dose visit; these are opportunities to reinforce key messages about sleeping under an ITN throughout every night and seeking prompt diagnosis and treatment for a child with fever.

Table 5. Dose 1 timing considerations for start of the schedule

Consideration	**Dose ❶ at 5 months of age** *Doses 1–3: 5, 6, 7 months of age*	**Dose ❶ at 6 months of age** *Doses 1–3: 6, 7, 8 months of age*
Disease burden	**Benefit:** Provides infants with earliest protection from malaria disease and death during high-risk period. Immune response reaches its highest after the third dose and wanes subsequently until the fourth dose is provided.[12]	**Drawback**: Delays protection past the earliest starting point for vaccination at 5 months.

[12] 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://www.thelancet.com/journals/lancet/article/PIIS0140-6736(15)60721-8/fulltext, accessed 23 June 2023.

Consideration	Dose ❶ at 5 months of age *Doses 1–3: 5, 6, 7 months of age*	Dose ❶ at 6 months of age *Doses 1–3: 6, 7, 8 months of age*
Existing health system alignment	**Benefit**: Infants have monthly visits since birth; therefore the introduction of a 5-month visit may be a natural progression after having received the third DTPCV dose (DTPCV3/Penta3) at around 4 months of age. The second dose may be aligned with other child health services provided at 6 months of age, and may result in increased attendance at the 6-month visit, resulting in increased uptake of the interventions given at 6 months of age (vitamin A supplementation, growth monitoring etc.) . **Caveat**: Requires social mobilization and good health worker communication during initial immunization visits to ensure that parents caregivers are aware they must return at 5 months of age for the first malaria vaccine dose.	**Benefit**: Many countries could align this first visit with other child health services (vitamin A supplementation, growth monitoring etc.). **Caveat:** This depends on whether caregivers bring children for the 6-month vitamin A visit. There may be a false expectation that caregivers will present for this visit without additional social mobilization. In practice, intensified efforts may be needed to alert caregivers to the importance of this visit.

Pilot lesson learned: Three-dose primary series

One pilot country introduced the malaria vaccine with the first three doses administered at 5, 6 and 7 months. The one-month gap between doses facilitated communication and the schedule was readily understood by health workers and community members. Despite the need for new immunization visits, high coverage was achieved.

Two of the three pilot countries introduced the malaria vaccine with the first three doses administered at 6, 7 and 9 months of age, with the aim of aligning the third dose with visits for the first dose of MCV (MCV1) and reducing immunization visits for the caregiver. This schedule caused confusion for health workers and caregivers during pilot implementation because of the two-month gap between the second dose (at 7 months) and the third dose (at 9 months). In many cases, if a child was delayed for the second dose, a two-month gap was unnecessarily maintained between the second and third doses, which resulted in missed opportunities for vaccination and delayed protection, and no reduction in immunization visits.

In addition to service delivery considerations, the vaccine offers **only minimal protection against malaria disease until after a child has received three doses.** For example, giving the third dose at 9 months of age rather than at 7 months of age delays the point at which children receive added protection from vaccination against malaria.

Table 6. Fourth dose timing considerations for the second year of life

Consideration	Dose ❹ at around 18 months of age	Dose ❹ at around 24 months of age
Existing health system alignment	**Benefit:** If aligned with other vaccines given during this visit (for example with MCV2), it may result in increased coverage for malaria vaccine or increased coverage for other vaccinations in the second year of life, as well as an opportunity for catch-up vaccination.	**Drawback**: It may be challenging to achieve high coverage for a new visit at 24 months of age.
Duration of protection	**Drawback:** Due to waning immunity following RTS,S/AS01 vaccination, the duration of protection after the fourth dose will decline if the child is at a younger age when the fourth dose is provided at 18 or 15 months compared to being provided at 24 months. **Benefit:** Vaccine efficacy will continue beyond 3 years of age with any of these schedules and children will benefit from some level of added protection. Children living in areas of moderate-to-high malaria transmission are generally at highest risk of severe malaria and death up to at least 3 years of age.	**Benefit**: The period of protection is expected to extend to nearly 5 years of age.

Pilot lesson learned: Timing of the fourth dose of the malaria vaccine
At the start of vaccination, the pilot countries scheduled the fourth dose as an additional immunization session at 22 months of age (Malawi) and 24 months (Ghana and Kenya). The aim was to use the malaria vaccine fourth dose administration as an opportunity to catch up on vaccinations and/or other health services in the second year of life. However, at the time of publication, the malaria vaccine fourth dose had not yet achieved similar coverage levels as other vaccinations administered earlier, such as the second dose of Measles and Rubella vaccine (MR2) in Kenya. Based on the country's experience and in an effort to increase malaria vaccine fourth-dose uptake, Ghana's MoH and the Ghana Health Service revised their malaria vaccine schedules, changing the timing of the fourth dose from 24 months of age to 18 months of age to coincide with MenA conjugate or MR vaccinations. This change occurred almost 4 years after the start of vaccinations and will be monitored for pilot lessons learned. Source: *Summarized lessons from presentations by the Ghana, Kenya and Malawi MoH cross-country malaria vaccine workshops in late 2022*

Key Resource 10: Immunization in the second year of life

A handbook for planning, implementing, and strengthening vaccination into the second year of life. World Health Organization; 2019 (https://www.who.int/publications/i/item/9789241514194, accessed 14 June 2023).

Establishing and strengthening immunization in the second year of life: practices for vaccination beyond infancy. World Health Organization; 2018 (https://apps.who.int/iris/bitstream/handle/10665/260556/9789241513678-eng.pdf, accessed 14 June 2023).

Vaccinating children who are late or delayed for their vaccination

Malaria prevention is maximized when vaccine doses are received as soon as the child reaches the recommended age. However, if a child presents late for malaria vaccination, the complete four-dose (or five-dose) series should still be offered with a minimum interval of 4 weeks between all doses. See section 8.2.3, Eligibility for more information.

Reminder: Malaria vaccine can be co-administered with other childhood vaccines.

If the child is aged ≥3 years at the time of first presentation for malaria vaccine, and has been living in areas of moderate-to-high malaria transmission throughout, the child is less likely to benefit substantially from vaccination due to acquired immunity against malaria prior to vaccination. Therefore, for children presenting late for vaccination, countries may choose to implement a policy of limiting the initiation of malaria vaccination to a particular age. National guidance and policy on catch-up vaccination should be followed or updated accordingly.

4.3.2 Options for areas with highly seasonal malaria transmission or with perennial malaria transmission with seasonal peaks

There is an **optional schedule** to provide the malaria vaccine seasonally with a five-dose strategy **in areas with highly seasonal malaria transmission or with perennial malaria transmission with seasonal peaks** (See Box 2). A clinical trial in two areas of highly seasonal malaria transmission – where transmission is largely limited to 4 or 5 months per year – has shown that providing the vaccine just prior to the start of the high peak transmission season results in high efficacy and impact. Vaccine efficacy for RTS,S/AS01 wanes, with the highest efficacy during the first 6 months after the primary schedule (first three doses) or in a similar period after subsequent doses. The seasonal malaria vaccination strategy maximizes protection by ensuring that the period of highest vaccine efficacy (just after vaccination) coincides with the period of highest malaria transmission.

Children living in areas with highly seasonal malaria transmission develop acquired immunity more slowly than children living in areas of high perennial transmission, and thus benefit from a fifth vaccine dose to provide protection during the prolonged high-risk period.

Box 2. WHO malaria terminology

Transmission, seasonal	Transmission of clinical malaria cases that occurs only during certain months of the year and is markedly reduced during other months (i.e. when the majority [> 60%] of clinical malaria cases occur within four months. Where health management information system (HMIS) data on malaria are not complete, rainfall can be a proxy for seasonality in incidence using the same threshold of 60% of annual rain in 4 months, considering a 2-week time lag between rainfall and cases).
Transmission, perennial with seasonal peaks	Transmission of clinical malaria cases that occurs throughout the year with peaks of markedly greater intensity in some months.
Just prior to the start of peak transmission	The start or "onset" is the first month of the 4-month window when the peak transmission is identified; therefore, seasonal vaccination should be scheduled to take place prior to this start. Example: a 4-month peak transmission season occurs during July to October; therefore seasonal vaccination takes place by June.

Adapted from:

WHO malaria terminology, 2021 update. Geneva: World Health Organization; 2021 (https://apps.who.int/iris/handle/10665/349442, accessed 14 June 2023).

Seasonal malaria chemoprevention with sulfadoxine–pyrimethamine plus amodiaquine in children: a field guide, second edition. Geneva: World Health Organization; 2023 (https://www.who.int/publications/i/item/9789240073692, accessed 14 June 2023.

Schedule and delivery strategies for areas with highly seasonal malaria transmission and perennial malaria transmission with seasonal peaks

The following are schedules and delivery strategy options (see Figure 1Figure 3, options 1–3) that countries may consider for children living in areas with highly seasonal malaria transmission or with perennial malaria transmission with seasonal peaks:

1. **Age-based strategy** (year-round delivery of all four doses based on the child's age, as described in section 4.3.1, Age-based four-dose schedule).
2. **Seasonal strategy** (seasonally timed delivery of all five doses; first three doses provided monthly just prior to the start of the peak transmission season; subsequent seasonal doses provided annually).
3. **Hybrid strategy** (year-round delivery of first three doses based on child's age (age-based); with subsequent seasonal doses 4 and 5 provided annually just prior to the start of the peak transmission season).[13]

[13] Meeting of the Strategic Advisory Group of Experts on Immunization, March 2023: conclusions and recommendations. Weekly Epidemiological Record, 2 June 2023. 254 –5. (https://www.who.int/publications/i/item/who-wer9822-239-256, accessed 23 June 2023).

Countries adopting a seasonal transmission schedule strategy should monitor and document their experience. When adopting the hybrid schedule (Option 3) with a minimum interval of six months between the third and fourth doses, safety should be monitored through routine pharmacovigilance.

For the seasonal and hybrid schedules (Options 2 and 3), countries must plan how to reach children with all doses and achieve high and equitable coverage. Delivery strategies might include activities prior to the peak transmission season – such as campaign implementation or periodic intensification of routine immunization (PIRI) – depending on the resources available. Strategies to ensure outreach, education and social mobilization will be essential to enable caregivers to bring children to vaccination centres or sites during the necessary time periods and to leverage existing opportunities and health services to increase vaccination coverage. This might include, for instance, launching local media campaigns prior to the peak season to encourage caregivers to bring children to the immunization clinics. Further Table 7. Considerations for different malaria vaccine schedules and delivery strategies in areas with highly seasonal malaria transmission or perennial malaria transmission with seasonal peaks are found in Table 7.

Figure 3. Malaria vaccine schedule and delivery strategy options 1–3

Option 1: Age-based strategy

Number of doses: 4.

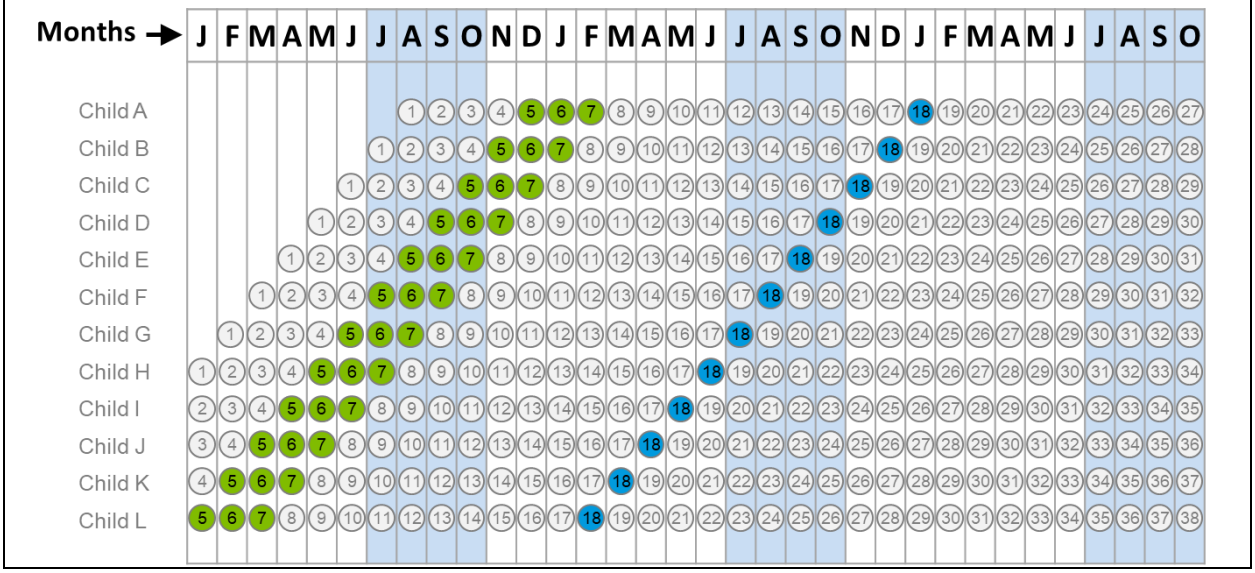
Delivery: year-round, based on child's age; described in section 4.4.1**.**

Minimum age for dose 1: 5 months of age.

Minimum interval: 4 weeks between each dose.*

Recommended interval between doses 3 and 4: 12–18 months to prolong protection. There can be flexibility to reduce the interval to align the fourth dose with other vaccinations and health services in the second year of life (e.g. with MCV2 at 18 or 15 months of age).

For example (see figure): 5, 6, 7, 18 months of age through the routine immunization services.



Option 2: Seasonal strategy

Number of doses: 5.

Delivery: all doses provided seasonally; first three doses provided monthly just prior to the start of the peak transmission season; subsequent seasonal doses provided annually.

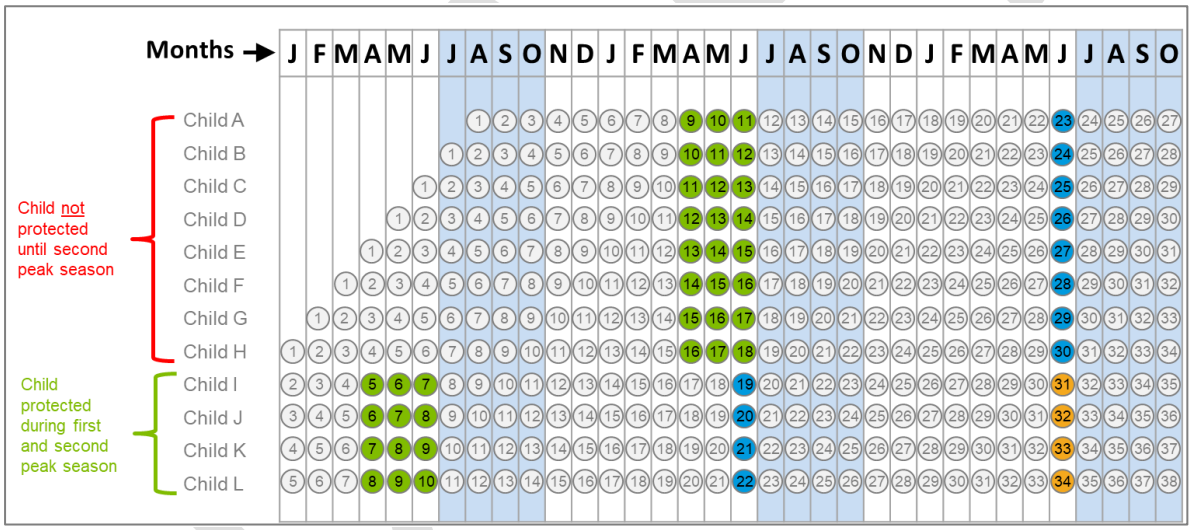
Minimum age for dose 1: 5 months of age.

Recommended interval between doses 1 and 2 and 3: 4 weeks between each.

Recommended interval between doses 3 and 4 and 5: approximately 12 months; doses 4 and 5 are annual doses provided just prior to the start of each subsequent peak transmission season.

For example (see figure): "campaign" starting in April from 5 months of age.

Based on evidence available, the seasonal strategy results in the greatest benefit for individual children who receive the vaccine doses just prior to the start of the peak transmission season. However, children who are below 5 months of age just prior to the start of the peak transmission season will not benefit until they are age-eligible for vaccination a full year later, when they may be as old as 18 months before receiving the primary series (children A–H in the figure).



Option 3: Hybrid strategy

Number of doses: 5.

Delivery (doses 1–3): age-based via year-round routine immunization services.

Delivery (doses 4–5): seasonally timed each year, just prior to start of the peak transmission season.

Minimum age for dose 1: 5 months.

Minimum interval between doses 1 and 2 and 3: 4 weeks between each.

Recommended interval between doses 3 and 4: approximately 12–18 months later prior to a subsequent peak transmission season. However, there can be flexibility to **reduce the interval to as short as 6 months** to allow for more children to receive the fourth dose prior to the next peak transmission season after the third dose.

Recommended interval between doses 4 and 5: approximately 12 months, provided just prior to the start of the subsequent peak transmission season after the fourth dose.

For example (see figure): 5, 6, 7 months of age and then annual seasonal doses through "campaigns".

For operational reasons, countries may consider the hybrid strategy to be a more feasible way to reach children through the routine immunization programme services by providing the first three doses year-round on the basis of the child's age, followed by the fourth and fifth doses just prior to the start of the peak transmission season.

Immune response reaches its highest level after the third dose and starts to wane until the fourth dose is provided. Therefore, children who receive the third dose (based on their age) 6 months or more before the peak transmission season can receive the seasonally-timed fourth dose to increase their protection before the next peak transmission season (children D – I in the figure).

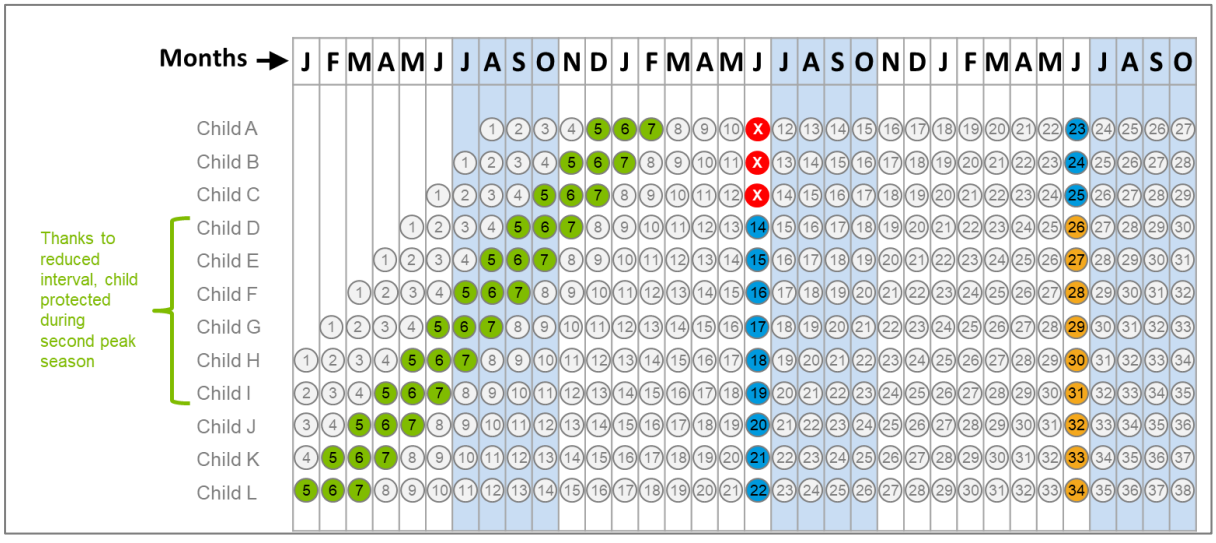


Table 7. Considerations for different malaria vaccine schedules and delivery strategies in areas with highly seasonal malaria transmission or perennial malaria transmission with seasonal peaks

Considerations	**Option 1: Age-based four-dose strategy** via year-round routine immunization services	**Option 2: Five-dose seasonal strategy**	**Option 3: Five-dose hybrid strategy** (age-based three-dose strategy, with doses 4 and 5 seasonal)
Access	Vaccinations through a well-known and established system using existing routine strategies.	Vaccinations through health centre and/or outreach site by PIRI, or campaign delivery (for difficult-to-reach populations).	Doses 1, 2 and 3 year-round through well-known and established services using existing routine strategies, with subsequent annual doses given through PIRI, or campaign delivery.
Disease reduction	Protection provided, but not fully optimized to maximize protection by ensuring that the period of highest vaccine efficacy (just after vaccination) coincides with the period of highest malaria transmission (peak season).	Protection optimized by aligning the period of highest vaccine efficacy with the period of highest malaria transmission (peak season); however, some children will have delayed vaccination due to age if they are younger than 5 months just prior to the first peak transmission season.	Protection improved compared to Option 1 (age-based) by increasing the proportion of children vaccinated in the period of highest vaccine efficacy prior to the period of highest malaria transmission (peak season). The interval between the third and fourth doses may be as short as 6 months in order to maximize the number of children receiving the fourth dose just prior to the peak transmission season.
Service delivery: for all options, planning should include strategies to reach each child with the complete vaccination series. Each malaria vaccine dose should be properly recorded in facility-based and/or retained home-based records.	Relies on well-functioning NIP and health delivery system to achieve good coverage.	Requires strong health system capacity or considerable advanced planning for areas with poor health-system capacity. Campaign delivery for all five doses may disrupt provision of other routine vaccination immunization and essential health services if not properly integrated and planned. Countries should determine the number of months prior to the peak transmission season to implement primary series and a maximum age for a child to receive their first dose.	Relies on well-functioning immunization and health delivery system to achieve good coverage of primary doses; advanced planning and resources to provide the fourth and fifth doses in the months just prior to the start of the peak transmission season. Effective delivery of doses 4 and 5 through campaigns or PIRIs could result in high coverage before the period of highest malaria transmission. Alternate vaccination strategies may be considered for children missed during the seasonal delivery of doses 4 and 5.

Considerations	Option 1: Age-based four-dose strategy via year-round routine immunization services	Option 2: Five-dose seasonal strategy	Option 3: Five-dose hybrid strategy (age-based three-dose strategy, with doses 4 and 5 seasonal)
		Alternate vaccination strategies may be considered for children missed during the seasonal delivery.	
Community mobilization	More familiar strategy for caregivers and health workers; however communication strategies are required to alert the community to new vaccine contact points, beginning at 5 months of age, and to reinforce from the outset the importance of receiving the fourth dose during the second year of life.	Intense mobilization effort to vaccinate all eligible children in a short timeframe and to communicate the target age group for vaccination.	Similar requirements to those of the age-based delivery strategy for primary series. Strong communication is required to ensure understanding of and good uptake of both the year-round primary series and seasonally-timed fourth and fifth doses. Communication that not all children will receive the fourth dose before the next transmission season if the interval since the third dose was administered is less than 6 months. Particular effort to communicate that caregivers need to bring home-based records to campaigns for the fourth and fifth doses to be recorded.
Frequency of vaccinations	Continuous vaccine availability all year.	Vaccine availability during the months just prior to the start of the peak transmission season.	Continuous vaccine availability all year, with doses 4 and 5 in the months prior to the peak transmission seasons
Vaccine supply	Continuous vaccine supply available.	Large volume of vaccine over short duration may present challenges to distribute/resupply quickly.	Continuous vaccine supply available with other routine vaccines. Larger volumes required during the months just prior to the start of the peak transmission season.
Cold chain management	Adequate cold chain available at all health centres.	Increased cold chain capacity needed over short duration; potential need to deploy rapid cold chain options, including using long-term passive	Stable and adequate cold chain capacity needs within routine immunization system. Increased cold chain capacity may be required prior to peak transmission season.

Considerations	Option 1: Age-based four-dose strategy via year-round routine immunization services	Option 2: Five-dose seasonal strategy	Option 3: Five-dose hybrid strategy (age-based three-dose strategy, with doses 4 and 5 seasonal)
		storage devices; frequent distribution of limited stocks when needed.	Potential need to adjust resupply schedule (monthly is currently recommended) with consideration of the monthly utilization rate and available storage capacity.
Integration with other interventions	Opportunity to strengthen routine immunization services, to screen for missed vaccinations and to deliver other health services.	Opportunity to integrate with other time-limited activities, child health days or campaigns (i.e. other vaccines, ITN distribution, SMC).	Opportunity to strengthen routine immunization services, screen for missed vaccinations and deliver other health services. Annual PIRIs, campaigns, child health days and other time-limited activities are opportunities to integrate with other vaccines, ITN distribution, SMC etc.
Operational costs	Comparable to other new vaccine introductions.	Resource-intensive (estimates of cost of delivery not yet available).	Need for additional resources to support PIRIs and/or campaigns.

Note: strategies may vary throughout a country on the basis of different subnational settings and assessment of the optimal resource use to achieve highest coverage and protection.

4.4 How can the malaria vaccine be integrated with other vaccinations, malaria interventions or health services?

Many of the activities for planning, implementing and monitoring malaria vaccine introduction present opportunities for integration with other vaccinations, malaria interventions or other health services. This could promote the sharing of resources and knowledge across programmes, optimize health worker training and service delivery costs and logistics, and serve to integrate a variety of activities and services in a more efficient, effective and sustainable way. In a phased introduction approach, such integration will be helpful groundwork for further expansion into new areas.

The malaria vaccine is provided as part of the national immunization and malaria control programmes. Each immunization visit for the malaria vaccine is an opportunity to provide other preventive health services, such as catch-up of previously missed doses of other vaccines, reminding caregivers of the importance of continuing to use an ITN every night, and of seeking prompt diagnosis and treatment for a child with fever.

Specific examples of integrated delivery are listed in Table 8 and Appendix 3: Example planning checklist of activities to introduce, deliver and integrate the malaria vaccine in national immunization programmes.

Table 8. Examples of interventions that can be integrated with the delivery of malaria vaccine

Category	Intervention
Vaccinations	• provide all childhood vaccines along with malaria vaccine as scheduled (e.g. MCV2, meningococcal, typhoid conjugate vaccines, DTPCV booster) at malaria visits or during seasonal campaign or PIRI); • catch-up any missed doses for other antigens during visits for malaria vaccination, or during campaign or PIRI seasonal malaria vaccination.
Preventive care and treatment	• anti-helminthic treatment (de-worming); • vitamin A supplementation; • growth and development monitoring; • iron and folic acid supplementation.
Other malaria interventions	• ITN (reminders/campaigns/distribution with vaccination); • PMC for infants and young children; • SMC for children less than age 5 years (check vaccination status and refer for vaccination; provide reminders during SMC campaigns); *Note: SMC is provided during the peak transmission season, whereas seasonal vaccine doses are provided just prior to the start of the peak transmission season* (See section 4.3.2, Options for areas with highly seasonal malaria transmission or with perennial malaria transmission with seasonal peaks).

Category	Intervention
Information and education	• delivery of key health messages; • education on the prevention and treatment of malaria; • counselling for the caregiver on identifying and treating infant and child illness at home; • education for the caregiver on other aspects of health and well-being.

Pilot lesson: How to promote integration of malaria vaccine?

- **National strategic plans and budgets:** incorporate the malaria vaccine into the national strategic plans and budgets of both immunization and malaria programmes.
- **Key messages, training and job aids for health workers:** explain how the malaria vaccine visits align with other antigens or health services, and provide additional opportunities for catch up.
- **Key messages, sensitization and materials for caregivers:** inform and/or remind caregivers about the malaria vaccine in the context of the broader immunization schedule, health services in the second year of life and malaria prevention messages.
- **Cascading trainings:** involve other MoH departments (NMCP, MCH etc.) and the NRA in material development and conduct of training; combine training with other NIP activities (such as another vaccine introduction); provide training opportunities for community health workers and other personnel not directly involved in immunization sessions who will engage the community, identify and track defaulters, or refer for vaccination.
- **Community health workers**: engage in trainings and incentivize the important link between health facilities and communities to include the malaria vaccine in spreading awareness and messaging, and defaulter-tracing for all vaccines and other health interventions such as vitamin A and deworming.
- **Recording and reporting**: incorporate the malaria vaccine into existing permanent tools and HMIS reporting (rather than stand-alone tools or stickers); ensure that updated tools are made available in health facilities prior to introduction; confirm that the tools are not restricted by age group (i.e. the register of children under 2 years may not have a place to record children presenting for the fourth dose after 2 years of age) and can track defaulters beyond the second year of life for all health services due; involve other MoH departments (e.g. MCH) in subcommittee tasked with tool updates.
- **Supportive supervision:** consider how to best streamline across multiple antigens through a consolidated checklist or coordinated visits.
- **TWG:** membership includes a broad range of stakeholders for key input and buy-in, including NIP, NMCP, other relevant MoH departments (e.g. MCH), the NRA, and other partners/organizations (e.g. CSOs, academia, technical assistance partners etc.).
- **Uptake activities:** support high uptake of multiple antigens and malaria preventive measures (e.g. community engagement sessions, child health days, social mobilization, media engagement, mop-up campaigns, PIRI, defaulter tracing, ITN distribution as an incentive for fourth dose visit); utilize

community health workers and outreach facilities; plan fourth dose uptake activities well in advance as part of the second year of life platform.

- **Monitoring and evaluation:** combine evaluation activities across multiple antigens (e.g. post-introduction evaluations, coverage surveys).
- **Linking World Malaria Day and World Immunization Week:** these annual events coincide in April and provide an excellent opportunity to promote malaria control interventions, including the malaria vaccine, and to draw attention to the vaccine schedule and deliver key messages.

4.5 Calculating the target population

In order to plan, forecast vaccine supply and calculate coverage, an accurate estimate of the number of children in the target age group in the targeted areas is required. Ideally, the national immunization programme will determine the target population using up-to-date national or local census data by working together with the national statistics office.

Estimates of the target population are frequently derived from previous census data or similar surveys at national level to determine surviving infants. Surviving infants are estimated on the basis of the birth cohort, taking into account the infant mortality rate (i.e. surviving infants = live births x (1 – infant mortality rate). If estimates for the number of surviving infants are not available, the number of live births may be appropriate as an estimate of the target population. It is appropriate to use the same target population as that used for other vaccines given to infants and children of similar age.

4.6 How much will it cost to introduce and sustain the malaria vaccine programme?

Adding the malaria vaccine to the national immunization programme will have cost implications for delivery of the vaccine and procurement of both the vaccine and injection supplies, as well as the costs of introduction (see Box 3. Cost of delivery). Costing tools are available to assist with this process (Key Resource 11: National Immunization Strategy (NIS) costing application (NIS.COST). Price and procurement data for vaccine and supplies are necessary inputs for forecasting, budgeting and planning. The malaria vaccine price is published when procured by UNICEF.[14] Countries may consider a budget impact analysis to help understand the funding needs, funding gaps and implications to ensure sustainability of the programme. The immunization programme budget and financing plan will need to be updated on the basis of the budget for malaria vaccine introduction.

The budget, which aligns with the malaria vaccine introduction plan, describes the resource needs for relevant phase(s) of malaria vaccine roll-out. Based on pilot country experience, possible cost categories are provided in the Appendix. Note, however, that not all may be relevant for new vaccination introduction and will vary by country, context and delivery strategy.

[14] Malaria vaccine price data. Copenhagen: UNICEF Supply Division (https://www.unicef.org/supply/documents/malaria-vaccine-price-data, accessed 14 June 2023).

Key Resource 11: National Immunization Strategy (NIS) costing application (NIS.COST)

Developed by UNICEF, this Google sheet application supports the estimation of NIS resource requirements. NIS.COST should be completed alongside the development of the NIS to: 1) facilitate adjustment of the strategy according to predicted available resources; and 2) help budget negotiations and funding proposals.

National Immunization Strategy costing application (NIS.COST). Immunization Economics (https://immunizationeconomics.org/unicef-niscost, accessed 14 June 2023).

Box 3. Cost of delivery

Cost analysis from the three pilot countries, after approximately one year of fourth dose administration, suggests that the financial cost (**excluding commodity costs, i.e. vaccine dose and injection supplies**) will be:

- US$ 1.04–2.46 to introduce and deliver a malaria vaccine dose (start-up and recurrent operational costs), of which:
  - ~US$0.75–2.11 per dose for one-time introduction (start-up) costs,
  - ~US$0.29–0.86 per dose for operational (recurring) costs to deliver and sustain the malaria vaccination; and
- US$ 8.91–10.65 to fully immunize a child with four doses of malaria vaccine.

⚠ *Comparisons of these costing study results with findings from the literature should be made cautiously because: 1) methods and delivery strategies differ; and 2) these estimates were drawn from ongoing pilot introductions rather than national or subnational programme introductions. Costs will vary according to the specific country context.*[15]

Baral R, Levin A, Odero C, Pecenka C, Bawa JT, Antwi-Agyei KO et al. Cost of introducing and delivering RTS,S/AS01 malaria vaccine within the malaria vaccine implementation program. Vaccine. 2023;41(8):1496–502. https://doi.org/10.1016/j.vaccine.2023.01.043.

The Excel-based Malaria Vaccine Introduction Costing Tool (MVICT) developed for this study is available on request from PATH (https://www.path.org/about/contact-us/).

[15] The reported estimates were based on target populations and coverage levels from administrative data in the three pilot countries for dose 1 (72, 75, 93%), dose 2 (66, 73, 84%), dose 3 (58, 75, 80%), and dose 4 (46, 57, 54%) after approximately one year of dose 4 administration.

5 Vaccine management

5.1 How to forecast and calculate the vaccine supply needed for malaria vaccine?

In general, malaria vaccine introduction follows the standard procedures for calculating vaccine supply and can be integrated into existing mechanisms for forecasting and ordering vaccines. Malaria vaccine should also be integrated into the stock management systems, and the vaccine orders and delivery schedule must be timed to prevent supply stock-outs.

Doses required for the annual supply are based on the size of the target population, estimates of vaccination coverage of the first dose and wastage rate. Wastage rates can be estimated by using national data or the WHO Vaccine Wastage Rates Calculator.[16] For the RTS,S/AS01 malaria vaccine, it is usually suggested to use a vaccine wastage rate of < 7%.

The simple formula below can be used to calculate the malaria vaccine supply needs for a four-dose or five-dose schedule over a period of one calendar year:

> *[Estimated size of the target population in introduction areas only] x [estimated vaccine coverage] x [doses delivered per child in a four- or five-dose regimen*] x [wastage factor] = malaria vaccine doses required for annual supply.*

In the forecasting of vaccine needs for a country receiving vaccine for the first time, buffer stock must be included to cover unexpected delays in shipments during resupply and fluctuations in demand. This rolling buffer stock should be available prior to the launch of the vaccine.

Table 9. Example of malaria vaccine requirements for forecasting over first three years of introduction

	Malaria vaccine	Parameter to use	Year 1	Year 2	Year 3	Total
1	Estimated target population (implementing areas only)	100% surviving infants				
2	Target immunization coverage (doses 1 to 3)	Average DTPCV1/Penta1 coverage				
3	# of doses in schedule (4-dose)*	See note below	3	4	4	
4	# of doses in schedule (5-dose)**	See note below	3	4	5	
5	Estimated wastage factor^	Wastage rate 7% (RTS,S)	1.08	1.08	1.08	
6	Buffer for first year	25%	1.25	0	0	
7	Total # of doses required	Multiplication of lines 1*2*(3 or 4)*5*6 for each year				
8	# of auto-disable syringes required (0.5mL)	10%				
9	# of reconstitution syringes required (2mL)	1 vial = 2 doses				
10	# of safety boxes required	1 safety box holds 100 used syringes				

[16] Vaccine wastage rates calculator. Geneva: World Health Organization (https://www.who.int/publications/m/item/vaccine-wastage-rates-calculator, accessed 14 June 2023).

Note: # = number.
^Wastage factor is 1 / (1 – wastage rate). Wastage rate = (total doses used – total doses administered)/total doses used.

*For the four-dose regimen: use three-dose schedule for the first year forecast and four-dose schedule for the second year forecast.
*For the alternate five-dose regimen (i.e. seasonal vaccination): use three-dose schedule for first year forecast and four-dose schedule for the second year forecast due to annual dose; and five-dose schedule for the third year due to second annual dose.

5.2 What cold chain capacity will be required for the malaria vaccine?

Adequate cold storage space should be available to store the malaria vaccine and other vaccines at recommended temperatures in the cold chain. The RTS,S/AS01 vaccine has relative higher cold storage volume per target compared to other vaccines. The reasons for this include the high packed volume per dose and the number of doses per target (Table 2. RTS,S/AS01 malaria vaccine characteristics). The WHO Logistics Forecasting Tool[17] provides multi-year forecasts for vaccine supplies, storage and transport equipment at national and subnational levels of the vaccine supply chain. Adequate dry storage will also need to be available for the additional supplies such as injection materials (syringes and safety boxes), recording and monitoring tools and other required items.

The introduction of any new vaccine offers a good opportunity to review the cold chain and logistics system and to improve its performance. The timing and outcomes of the most recent Effective Vaccine Management (EVM, see Key Resource 12) review of an up-to-date cold chain inventory and management system and other cold chain assessments should be documented in the introduction plan. If none are available for the past 3–5 years, either a full national assessment or a targeted assessment should be conducted and a Cold Chain Logistics (CCL) improvement plan developed as needed. When circumstances or timing do not allow for conducting an EVM, a rapid assessment of the malaria vaccine cold chain needs should be completed.

Key Resource 12: Effective Vaccine Management
EVM is a tool and process that assesses each component of the immunization supply chain – such as vaccine arrival, storage or management, looking for strengths and weaknesses. This allows countries to develop plans and allocate resources to implement improvements where they are needed most.

EVM resources and guidance are available at: https://evm2.who.int/Public/Resources (accessed 15 June 2023).

The CCL improvement plan incorporating the malaria vaccine and/or final rapid assessment report should be developed at least one year before the introduction of a new vaccine to allow for expansion of the cold chain as required, including ordering and installing of cold chain equipment (CCE). Storage and additional needs should be assessed at each level of the health system to ensure there is sufficient capacity to store the malaria vaccine. The purchased CCE must be distributed and installed at least 3 months before introduction to avoid delays in the vaccine introduction and potential malaria vaccine stock-outs.

[17] EPI Logistics forecasting tool. Geneva: World Health Organization 20 June 2021. (https://www.who.int/publications/m/item/epi-logistics-forecasting-tool, accessed 23 June 2023).

Table 10. Adequacy of cold chain capacity to accommodate malaria vaccine – given monthly collections from regional store (example table)

Region level	District/sub-county or equivalent unit			Health facilities		
Name of region / county	Total #: implementing districts	# with sufficient capacity	% with sufficient capacity	Total #: implementing facilities	# of facilities with/sufficient capacity	% of facilities with/sufficient capacity

Table 11. Summary of CCE to be procured and estimated budget (example table)

CCE	Make	Type	Region	District	HF	Total	Unit cost of CCE

5.2.1 RTS,S/AS01 product characteristics and packaging

The presentations and packaging available for the injectable malaria vaccine are listed in Table 12.

Table 12. Packaging dimensions and contents

RTS,S/AS01 packaging	
Secondary packaging	**Carton**
Inner dimensions (centimetres)	18.0 cm length, 14.9 cm width, 3.7 cm height
Vials per carton	Contains 50 pairs of vials clipped together -50 vials (red ring) antigen RTS,S containing lyophilized powder -50 vials (green ring) diluent AS01 containing diluent used for reconstitution
Doses per carton	50 pairs of clipped vials x 2-dose vial = 100 doses after reconstitution
Cold chain volume per dose	9.92 cm^3 per dose in carton
Tertiary packaging	**Insulated shipping box**
Inner dimensions (cm)	120 cm length, 100 cm width, 160 cm height
Cartons per box	576
Doses per box	57600
Shelf-life	36 months
Manufacturer	GlaxoSmithKline (GSK) Biologicals

Product overview of WHO list of prequalified malaria vaccines: Mosquirix. Geneva: World Health Organization (**https://extranet.who.int/pqweb/content/mosquirix**, accessed 15 June 2023).

Product information for vaccines and cold chain equipment. Geneva: Gavi (**https://www.gavi.org/our-alliance/market-shaping/product-information-vaccines-cold-chain-equipment**, accessed 15 June 2023).

5.3 How should the malaria vaccine be distributed, stored and handled?

5.3.1 Malaria vaccine distribution

All malaria vaccines will be procured and bundled with adequate supply of auto-disable syringes, reconstitution syringes and safety boxes. These will be distributed to all immunizing facilities ideally 2 weeks before the introduction using existing routine distribution systems.

Coolant ice packs should be used to maintain cold chain at 2–8°C during transport. To reduce the risk of vaccine freezing, follow proper procedures for conditioning frozen water packs for use in cold boxes and vaccine carriers.[18]

5.3.2 Malaria vaccine storage

The shelf-life of the RTS,S/AS01 vaccine is 36 months (3 years).

Malaria vaccine management should be aligned with existing vaccine management standards (following the same procedures as for other vaccines in the cold chain).

Vaccines must be placed in designated refrigerators at between +2° and +8°C. The vials should be kept in their original box until ready to use. The vials are clipped together and should be stored clipped together and not separated.

Regular temperature monitoring procedures should be maintained in all cold storage equipment and should be checked twice daily every day of the year, including weekends and holidays.[19] Contingency plans should be established in case of power or cold chain failure.

Malaria vaccines must never be frozen as they are sensitive to temperatures lower than +2°C and lose their efficacy if frozen. Vaccines subjected to sub-zero temperature exposure, as demonstrated by the freeze indicators, should not be used.

Malaria vaccines **cannot** be stored:

- directly in or near the freezer portion of a refrigerator;
- near cold air vents blowing air;
- directly on the liners or walls of cold boxes of vaccine carriers that are not freeze-preventive and/or ice-packs.;
- with inside-opening doors, solid plastic trays, drawers or floor of refrigerators.

WHO guidance on these procedures is available in: *Immunization in practice: a practical guide for health staff, Module 2 – The vaccine cold chain* and the *WHO Vaccine management handbook* modules.[20]

If a freeze-sensitive vaccine is found frozen solid, take the vaccine out of the cold chain and label "for discard". Immediately report the evidence of freezing to the supervisor for corrective actions.[21]

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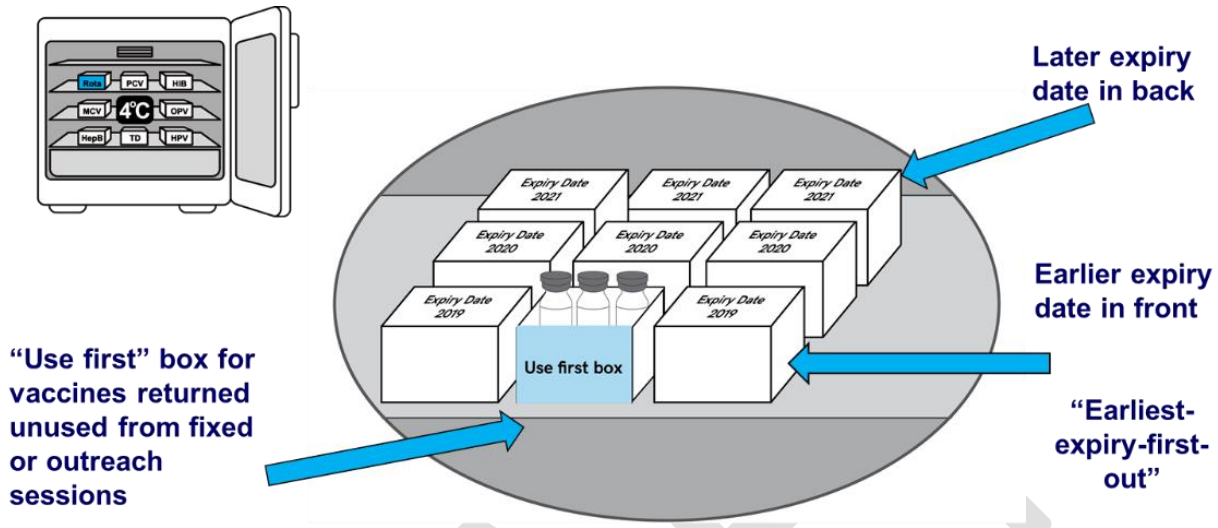
[18] Guidance on selecting, commissioning and using freeze-preventative vaccine carriers (who.int). Geneva: World Health Organization; 2021 (https://www.who.int/publications/i/item/WHO-IVB-2021.02Rev.1, accessed 15 June 2023).
[19] Vaccine management handbook: how to monitor temperatures in the vaccine supply chain. Geneva: World Health Organization; 2015 (https://www.who.int/publications-detail-redirect/WHO-IVB-15.04, accessed 15 June 2023).
[20] Vaccine management handbook: how to calculate vaccine volumes and cold chain capacity requirements. Geneva: World Health Organization; 2017 (https://www.who.int/publications/i/item/WHO-IVB-17.06, accessed 15 June 2023).
[21] Aide mémoire for prevention of freeze damage to vaccines. Geneva: World Health Organization; 2007 (https://apps.who.int/iris/handle/10665/69673, accessed 23 June 2023).

Vials with early expiry dates and/or vaccine vial monitors (VVMs) nearing discard point (started to change colour) should be kept at the front of the refrigerator to be used first. A "use first" box can be placed in front for vaccines that have returned unopened from fixed or outreach sessions (Figure 4).

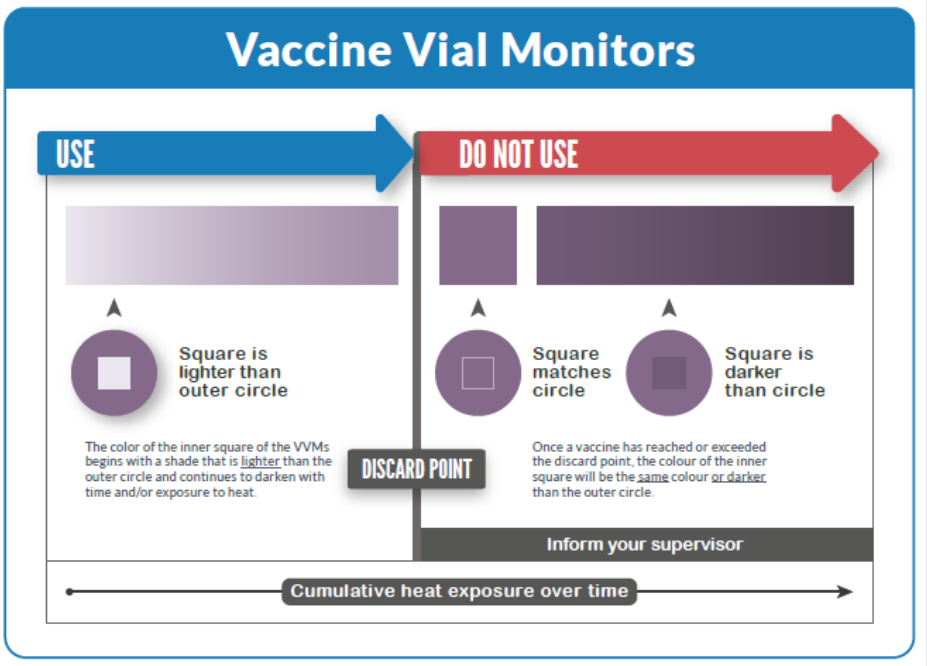
Figure 4. "Use first" box in refrigerator for vaccines



Vaccine vial monitor (VVM)

Malaria vaccines are sensitive to light and heat, and exposure can reduce the potency of the vaccine. The malaria vaccine has been certified for VVM type 14 and the VVM is located on the diluent label (green ring). The VVM indicates cumulative exposure to heat and provides a warning when it should be discarded (see Figure 5). Only use the vials where the inner square is lighter than the outer circle. It is important to highlight that the VVM does NOT alert about vaccine freezing nor the potency of the vaccine.

Figure 5. Using the Vaccine Vial Monitor (VVM)



Key Resource 13: Vaccine Vial Monitor (VVM) – The App

As part of the Effective Vaccine Management (EVM) app, there is a VVM checker application to guide health workers in determining for how much longer the vaccine will remain useful on the basis of VVM status and expiry date.

The EVM app can be downloaded from: https://evm2.who.int/Public/App

5.3.3 Malaria vaccine handling

Countries should ensure that health workers are trained in appropriate handling of unpreserved multi-dose vials in accordance with the guidelines set out in the WHO multi-dose vial policy.[22]

Opened vials of malaria vaccine must be discarded 6 hours after opening (if stored at 2–8°C) or at the end of the immunization session, whichever comes first.

During the session, put open vials in the foam of the vaccine carrier (do not return them to the refrigerator).

The diluent for the malaria vaccine contains the adjuvant and therefore cannot be used to reconstitute other lyophilized vaccines; similarly, the diluents from other vaccines cannot be used to reconstitute the malaria vaccine.[23]

Before reconstituting the vaccine, it is important always to check the expiry date on the labels.

5.3.4 Monitoring vaccine stocks

As with other vaccines, health facilities should report malaria vaccine availability, utilization and wastage data and should request vaccines from the subnational level monthly. Reporting malaria vaccine availability and utilization should be compulsory in order to receive additional vaccine supply. It is important that facilities are trained in timely reporting to avoid stock-outs. The malaria vaccine should be incorporated into the routine use of a digital information system such as the stock management tool (SMT) to monitor vaccine stock and other aspects of vaccine management.

5.3.5 Disposal of medical waste

As with any new vaccine introduction, the malaria vaccine will generate additional waste in various forms that must be adequately disposed of. The immunization programme should estimate the approximate increase in injection waste upon introduction of the malaria vaccine and depending on the delivery strategy (see Table 7. Considerations for different malaria vaccine schedules and delivery strategies in areas with highly seasonal malaria transmission or perennial malaria transmission with seasonal peaks). The waste disposal management plan should be updated at the national, subnational and facility levels. All existing waste management facilities and practices must be reviewed to ensure that they can accommodate the additional waste generated by malaria vaccine activities.

[22] WHO policy statement: multi-dose vial policy (MDVP): handling of multi-dose vaccine vials after opening, Revision 2014. Geneva: World Health Organization; 2014 (https://apps.who.int/iris/handle/10665/135972, accessed 15 June 2023).
[23] WHO guidance note: Vaccine diluents. Geneva: World Health Organization; 2015 (https://apps.who.int/iris/bitstream/handle/10665/192741/WHO_IVB_15.08_eng.pdf, accessed 15 June 2023).

The national policy on medical waste disposal should be followed for disposable syringes and needles (including those used for reconstitution). Health worker training should include safe injection practices to prevent reuse and needle-stick injuries. NIP clinics and health facilities should have safety boxes, as these are also used for other injections.

For more information, see: Overview of technologies for the treatment of infectious and sharps waste from health care facilities. Geneva: World Health Organization; 2019 https://apps.who.int/iris/handle/10665/328146, accessed 15 June 2023).

6 Microplanning

Microplanning is one of the most important activities for ensuring successful vaccine introduction and to ensure everyone is protected by full immunization, regardless of location, age, socioeconomic status, or gender-related barriers. It can help identify human, financial and logistical resources as well as the geographical, demographic and sociocultural attributes of the resident population and target community groups. This section highlights general considerations and resources for successful microplanning for the malaria vaccine.

The usual microplanning tools and approaches such as "reaching every district" (RED)[24] should be used to identify eligible children (Figure 6). Microplanning should be coordinated at an established administrative level such as the district but should be conducted at the level of the health facility and in collaboration with key community members. Health facility microplanning tools should be updated to include the malaria vaccine, and annual plans and targets identified to ensure that every eligible child is reached. For more information, refer to Key Resource 14 and Key Resource 15.

Key Resource 14: Reaching Every District (RED) – A guide to increasing coverage and equity in all communities in the WHO African Region (2017)
The 2017 RED guide, and the guide's planning and monitoring tools, are intended for adaptation and use by national immunization programmes. The RED guide is primarily designed as a resource for district, health facility and community teams to improve their immunization services. Reaching every district (RED). Brazzaville: WHO Regional Office for Africa; 2017 (https://www.afro.who.int/publications/reaching-every-district-red-guide-increasing-coverage-and-equity-all-communities, accessed 15 June 2023).

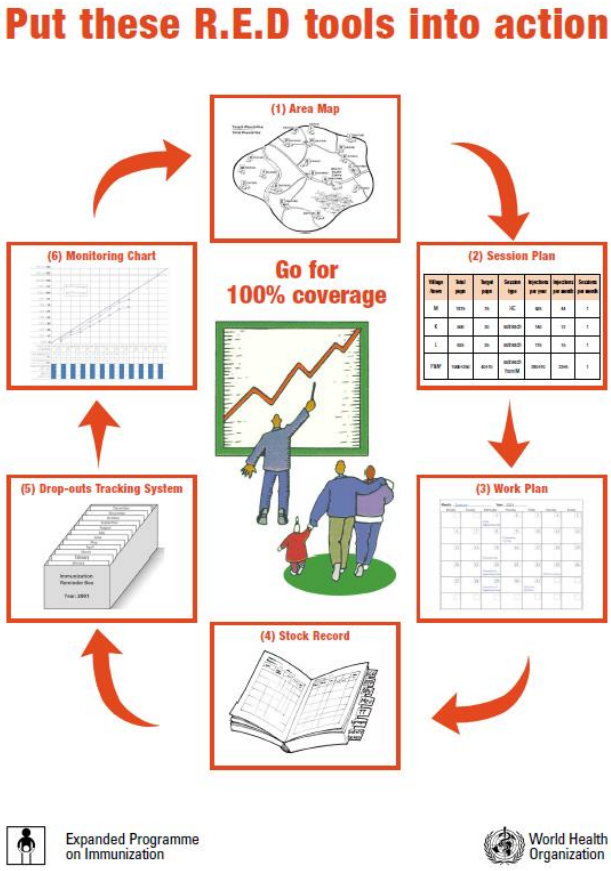


Figure 6. Put these R.E.D tools into action

[24] Reaching every community approach for vaccination microplanning
https://www.who.int/immunization/documents/IIP2015_Module4.pdf?ua=1

Key Resource 15: Microplanning for reaching every community – Module 4: Microplanning for reaching every community (2015)

Part of WHO's **Immunization in Practice: a practical guide for health staff**, this module discusses the process of microplanning to ensure that immunization services reach every community. It starts with maps at district and health-centre level, which should be updated to include all population centres and groups in the catchment area and to flag high-risk areas. It next describes how to identify priority and high-risk health centres and communities on the basis of numbers of unimmunized children. It describes how to clarify barriers to service access and utilization in priority communities and how to make a workplan for solutions. It concludes with making a session plan and following up on defaulters. Critical to the microplan development process is the participation of key community members to ensure that the microplan is rooted in the community context and culture.

Immunization in Practice: a practical guide for health staff. Module 4: Microplanning for reaching every community. Geneva: World Health Organization: 2015 (https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff, accessed 15 June 2023).

6.1 Verifying the estimated target population

Estimates of the target population through census data or other national surveys may vary from actual target population numbers aggregated through "head count"-like approaches for microplanning at health-facility level. It is therefore important to conduct a thorough microplanning exercise at different levels to estimate and target the accurate number of children to be vaccinated and plan for them accordingly. Every health facility should verify its catchment population – sometimes assisted by community health workers, volunteers or local leaders who have access to updated data on households and targeted children. The use of the District Health Information System version 2 (DHIS2) population/community mapping tool could be explored to enhance quality microplanning. Microplans should also be updated to reflect the data from other immunization activities and campaigns – e.g. with newly-identified remote or hard-to-reach communities.

7 Demand promotion and communications

Without exception, effective demand promotion and communications are critical for the success of any new vaccine introduction. For the malaria vaccine, this includes implementing a range of ongoing stakeholder- and community-centered interventions to generate demand and uptake.

Interventions to generate demand include community engagement, service quality improvements, behaviour-informed interventions, communications and other interventions that may contribute to building confidence and positive social norms, and improving the overall experience of vaccination.

This section therefore provides an overview of the following activities:

- Planning, coordination and stakeholder engagement
- Review and use of behavioural and social data
- Partnering with the community
- Service experience
- Behavioural interventions
- Communications.

7.1 Planning and coordination

The advocacy, communication and social mobilization (ACSM) subcommittee within the MoH should coordinate communication and social mobilization activities, and meet regularly to plan activities, review documents and communication messages, and approve related tasks. It is best practice for the ACSM subcommittee to coordinate the development, implementation and monitoring of an evidence-based demand promotion and communications plan that includes stakeholder engagement and risk management plans.

Preparatory activities for the malaria vaccine have included the establishment of ACSM subcommittees that are coordinated by the NIP and NMCP managers as well as malaria, immunization, health education/health promotion programmes and other stakeholders (see the highlight on “Pilot lesson, ACSM and communications strategy”) in order to manage demand promotion and communications planning at all levels and define roles among partners. Successful malaria vaccine introductions had frequent initial ACSM meetings, as often as bi-weekly during the initial planning through vaccine introduction, and continued to meet regularly through post-introduction monitoring.

Development of a plan for demand promotion and communications activities should be informed by local data and should include sections on each area of intervention, target audiences, key messages, budget, timelines and responsible entity. Ideally, output and outcome measures are included to assess progress and guide adjustments at key stages.

The plan contains these basic elements:

1. Technical programme objective(s).
2. Situation analysis, including behavioural and social insights from communities where the vaccine is to be provided.
3. Identification of target audiences and key stakeholders, including channels for engagement.
4. Communication objectives that are specific, measurable, attainable, realistic and time-bound (SMART).
5. Adapted and tailored messages for different audiences at all levels.
6. Media and spokesperson orientation.
7. Media and digital engagement (press briefings, media workshops, social listening that includes the monitoring of traditional media, online social conversations and other public discourse, rumour tracking, use of social media).
8. Development, pre-testing, translation and printing of IEC materials.
9. Engagement with community leaders and identified vaccine champions.
10. Improvements to service quality, including through a focus on service quality during health worker training.
11. Use of health behavioural interventions such as prompts and reminders.
12. Risk communication plan (handling of rumours or detractors; preparation for and response to AEFI; or other issues).
13. Monitoring and evaluation plan (which may include ongoing social media and media monitoring if resources allow).
14. Workplan with budget, timelines and assigned responsibilities – revised and updated as required.

New or existing plans should take into account the following key considerations for malaria vaccine introduction:

- integration of malaria prevention with childhood vaccination messages;
- emphasis on the importance of completing the four-dose (or five-dose) schedule for optimal prevention;
- need to create awareness of visits beginning at 5 months of age; need for caregivers to bring their children to vaccination clinics for extra visits, with the fourth visit in the second year of life, at around 18 months or 2 years of age, depending on the national schedule;
- importance of continuing other proven malaria prevention measures because, although the vaccine will reduce cases of clinical and severe malaria, it will not prevent all cases;
- need to promptly seek care for a child with fever; and
- need for appropriate messaging for subnational and/or phased malaria vaccine introduction, if applicable.

Implementation of the plan should begin early to ensure that activities can be designed in a timely manner, and that IEC materials on the malaria vaccine reach target audiences (particularly at community level) well ahead of vaccine introduction.

Pilot lesson: ACSM and communications strategy

In the pilot countries, the ACSM subcommittee included a diversity of stakeholders who facilitated collaboration and alignment on roles and objectives between the programmes for malaria, immunization and child health. In Ghana, ACSM membership includes representatives from the MoH's Ghana Health Service (Health Promotion Division, Office of Director-General, NMCP, and the NIP), CSOs, local media, health nonprofit and nongovernmental organizations (Red Cross Society, PATH, WHO, UNICEF), media outlets, the Ministry of Women's and Children's Affairs, and the Food and Drug Authority (FDA).

Conducting a communications strategy workshop can facilitate the ACSM planning process. In Malawi, stakeholders were convened for a malaria vaccine communications strategy workshop early to develop a communications plan. Public and private national stakeholders at the workshop included national MoH Health Education Services, the NIP and NMCP, Pharmacy Medicines and Poisons Board (PMPB), nonprofit partners, Malawi Broadcasting Corporation (radio and television), and others involved directly with the pilot introduction, including WHO and PATH. The strategy was subsequently presented to the ACSM subcommittee, the NIP and NMCP for approval prior to starting vaccination.

7.2 Demand promotion

7.2.1 Review and use of behavioural and social data

In addition to engaging with the necessary partners, and before developing a demand promotion and communications plan, existing pertinent data should be compiled and reviewed from multiple sources to understand the behavioural and social drivers of malaria vaccine uptake, and any other insights from communities (see Key Resource 16). Tools are available to support data collection, analysis tracking and interpretation of such data.[25] Methods can include surveys, qualitative research or information gathered via social listening. Behavioural and social data can also be analysed together with other NIP and NMCP data sources, such as vaccine coverage or supply data.

The available data and situation analysis can inform key elements of the plan (as described above).

Key Resource 16: WHO Behavioural and social drivers of vaccination: tools and practical guidance for achieving high uptake

This guidebook supports the use of the behavioural and social drivers of vaccination tools to understand what drives uptake of vaccines. It is intended for immunization programme managers, research advisors and others who are collecting, analysing and using data for immunization programme planning and evaluation. Routine tracking of data on behavioural and social drivers will offer insights into how to continually improve programme implementation.

Using the tools presented here will equip programmes and partners to better understand the reasons for low vaccine uptake, track trends over time and reduce coverage inequities by gathering and using data systematically to design, implement and evaluate tailored interventions.

Behavioural and social drivers of vaccination: tools and practical guidance for achieving high uptake. Geneva: World Health Organization; 2022 (https://apps.who.int/iris/handle/10665/354459, accessed 15 June 2023).

[25] Understanding the behavioural and social drivers of vaccine uptake. WHO position paper – May 2022. Weekly Epidemiological Record. 2022;20(97):209–24.

7.2.2 Community engagement

Community leaders and community health workers and, in many countries, community health workers, can play an important role in tracking eligible infants and children, sharing accurate information, helping to make connections to vaccination and malaria services, and strengthening social norms[26] to vaccinate (see section 9.2.2, Improving uptake).

For more general information, see: Immunization in practice: a practical guide for health staff. Module 7: Partnering with communities. Geneva: World Health Organization; 2015 https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff, accessed 15 June 2023).

7.2.3 Service quality improvements

The immunization service experience for both the health worker and the receiving client (caregiver and child) is an important element in establishing and maintaining confidence, acceptance, trust and demand for vaccination. It will be important to ensure that health workers have a supportive work environment, and the interpersonal communication and interaction skills and technical confidence to communicate with caregivers about the vaccine (see Appendix 2: Key messages for health workers to deliver to caregivers about malaria vaccination (for country adaptation)).

It may not be possible to address every component of immunization service experience, but people-centred approaches – such as community participation and ownership, supportive supervision, group problem-solving, and technical skill development – will help to ensure the success of the malaria vaccination programme.

For more information, refer to the Immunization Service Experience Toolkit (JSI) at the Vaccination Demand Hub (https://demandhub.org/service-experience/, accessed 15 June 2023), and UNICEF's Interpersonal Communication for Immunization toolkit (https://ipc.unicef.org/, accessed 15 June 2023).

7.2.4 Behaviourally informed interventions

After reviewing and/or measuring behavioural and social drivers of vaccination, tailored behavioural interventions can be developed and implemented to increase vaccine uptake. Potential interventions include health-care worker training on interpersonal communication – i.e. the skill of communicating and sharing information in a way that is accurate, engaging and respectful – or motivational interviewing, a strategy used to share information in a way that encourages a person to think about a topic from a new perspective (such as addressing vaccine hesitancy). Other behavioural interventions and messaging used to strengthen social norms to vaccinate include intensifying community engagement, messaging using positive social norms (a common practice to encourage; for example, "Vaccinate your child to reduce the number of times they get malaria"), use of vaccine champions and advocates, and collecting and implementing recommendations from health workers. To address practical issues that could hinder vaccine uptake, scheduling appointments in advance (or default appointments), incentives and SMS-based reminder-recall systems have been shown to increase vaccine uptake (See section 7.3.3, Using multiple channels and opportunities for communication; and section 9.2.2, Improving uptake). These interventions could be particularly useful in efforts to achieve high coverage for the fourth dose of vaccine.

[26] Social norms are perceived rules that define acceptable and appropriate actions within a given group or community. They guide our behaviour by telling us what others are doing or what they expect us to do. By using positive social norms in messaging, motivations to vaccinate may increase.

7.3 Communications

7.3.1 Identifying and understanding key stakeholders

Many persons are involved, directly or indirectly, with the vaccination of a young child. All these stakeholders need to understand the benefits of malaria vaccination. Engagement and sensitization of audiences can begin with the mapping and prioritization of stakeholder groups. Each target audience will require specific messages, with some requiring more information than others. Some stakeholders – particularly those that speak for the vaccination programme – should be updated with current information as the introduction progresses or expands. Below are some examples, based on prior implementation experience, of target audiences for demand promotion and communication activities for malaria vaccine introduction. A more comprehensive stakeholder mapping and engagement based on the pilot experience can be found in Appendix 5: malaria vaccine stakeholder engagement plan example (not exhaustive).

- **Health workers** require detailed information on how to communicate key messages effectively and accurately with caregivers (see sections 7.2.3 and 8.2.2 on Service quality improvements and experience). In many cases, health workers are particularly effective at delivering health messages because they are trusted by caregivers. See appendix for key messages for key messages.
- **Caregivers** decide whether a child will be vaccinated and therefore require basic, easy-to-understand information in local languages. Caregivers may include extended family members (e.g. grandmothers) who often care for older children after new babies are born. Country experience as well as evidence from research in communities has shown that caregivers' decisions related to childhood vaccination are heavily influenced by information received from sources they trust, such as health workers and community leaders. See Appendix 2.
- **Community leaders** may require more targeted messaging to foster their understanding of the vaccine introduction (particularly if the introduction is subnational and/or phased), to promote integration with the childhood vaccination schedule and malaria prevention package, and to mobilize communities for uptake of the vaccine.
- **Government officials/politicians and subnational health authorities** (local, district, regional/provincial/county) may be spokespersons for the vaccine. They may require additional and tailored advocacy to communicate the reason for a subnational and/or phased vaccine introduction (e.g. why some areas are receiving the vaccine and others are not), if applicable. The NMCP can ensure that the vaccine is included as part of the comprehensive malaria control strategy.
- **Medical professionals and scientists** are credible spokespersons for the vaccine in the health community and they can deliver messages to caregivers, endorse vaccine benefits and safety from the medical and scientific perspectives, and report or speak publicly should any issues arise. This audience requires complete and detailed scientific information about vaccine performance, including safety.
- **Professional, cultural and religious leaders and organizations** should understand the benefits and safety of the vaccine, the reasons for subnational and/or phased introduction (if applicable), why it is important to community health, and the continued use of malaria prevention

measures. They often motivate caregivers to vaccinate their children and can be consulted should issues arise.

- **Media and journalists** (local, national, international) are important for engagement during planning for vaccination through journalist briefings, visits to vaccinating areas, and information packages etc. Journalists who are not well informed about the vaccine or the subnational and/or phased introduction (if applicable) can amplify rumours at community level or inaccuracies in social media postings that, if spread more widely, could undermine trust in the vaccine or the immunization programme. It is important to monitor traditional media coverage and track social media conversations (a form of social listening), if possible, and correct any misinformation that is reported in the early stages of the introduction. Refer to section 7.3.4, Misinformation and risk management.

Pilot lesson: Stakeholder and community engagement

All pilot countries spent considerable time and resources engaging with leaders at all levels of the political and health systems – from national-level politicians through to community and religious leaders – to explain the subnational and/or phased introduction to communities, the reason for the approach, the vaccine's benefits and the intention to expand access to neighbouring areas. This helped ensure adequate buy-in and averted negative reactions from those areas not initially participating in the vaccine roll-out.

Based on pilot experience, a key planning activity prior to the start of vaccination is to identify (or map) key stakeholders at all levels of the political and health systems to target for community engagement activities.

Source: Summarized lessons from presentations by the Ghana, Kenya and Malawi MoHs at cross-country malaria vaccine workshops in late 2022.

7.3.2 Developing key messages and materials for malaria vaccine

Evidence-based materials and messages should be developed collaboratively by child health experts with experience in immunization, malaria, communications and other areas. Increasing health worker knowledge and community awareness through timely, complete and appropriate communication is the key to successfully and sustainably introducing vaccines.

Key messages

Health messages should be tailored to the audience and the delivery channel. The messenger is equally important as is the message. Messages should be clear, simple and accurate, with an appropriate level of detail for each audience – using the "right" message for the "right" audience. For instance, information presented to medical groups at a scientific or professional conference will differ from messages conveyed to members of parliament or community leaders in individual interactions. The actual wording of messages should consider culture, language and literacy, and should ensure a call to action.

It is important for health workers interacting with caregivers to communicate in a respectful manner and to convey correct messages on the vaccine using a "Triple A" communication approach (Advise, Alert and Arrange). See Box 4. "Triple A" communication to help health workers deliver key messages to

caregivers and stakeholders of the malaria vaccine (for country-specific adaptation [X])Box 4 for more details on messaging.

Pilot lesson: Development of key messages

Available malaria vaccine evidence and data from previous community perceptions and publications was used to inform messaging at the start of the pilot introductions. Key messages were developed and subsequently adapted to each country's context. Key messages included the subnational, phased introduction of the malaria vaccine; the benefits of the malaria vaccine; the importance of completing the four-dose schedule; that the vaccine should be used with other malaria prevention measures such as ITNs; and the importance of promptly seeking care for a child with fever.

Community and household surveys were conducted to provide insights into perceptions of the vaccine, household health behaviours, and the effectiveness of messaging and communication channels targeting caregivers, health workers, community groups, programme managers and policy-makers.

These insights, as well as supportive supervision interactions and other pilot experience, showed that vaccine introduction resulted in no reduction in ITN use or care-seeking behaviour for fever. However, insights also revealed challenges that called for the revision of messages to further highlight and emphasize the benefits of completing the four-dose schedule and catching up on any missed vaccines and child health interventions.

Reflections from Dr Rose Jalang'o, National Vaccine and Immunisation Programm**e,** MoH, Kenya:

"The other concern that we faced was that the community might see the malaria vaccine as a magic bullet and stop using other malaria control interventions. But – something exciting – we witnessed the community using both the malaria vaccine and also continuing to use the other malaria control interventions that have been given by the national malaria control programme."

Pilot lesson: Key messages on the phased introduction approach for the malaria vaccine

In the context of a phased and/or subnational malaria vaccine introduction, the following key messages are recommended for countries to use and/or adapt in their communications:

- The MoH has recommended vaccine introduction in some areas where children are at greatest risk of severe malaria; and
- As global vaccine supply increases, the MoH plans to expand access to the vaccine to children living in other malaria endemic areas.

Reflections from Dr Rose Jalang'o, National Vaccine and Immunization Program**,** MoH, Kenya:

"One challenge we had at the beginning was how we were going to communicate to the communities on the phased approach to introduction – how would the community perceive this, would they take up the vaccine? Three years later the community has accepted that you can do a subnational introduction where some areas can introduce the vaccine and some areas can introduce later based on the burden of disease in a community."

Pilot lesson: Key messages to emphasize the importance of children receiving all four doses

Qualitative study findings from select communities in the pilot introductions showed that, as children received more doses of the malaria vaccine, caregivers came to believe that their child had reduced frequency and severity of malaria cases. By the time of fourth dose administration (given some months later), some caregivers were not motivated to bring the child for additional doses or felt that a child over one year of age was strong enough to survive malaria.

It is important for health workers to explain to caregivers that vaccinated children remain vulnerable to malaria and that children under 5 years of age in particular, can become very sick or even die from malaria. Therefore it is important that the child receives the fourth dose to prolong protection from malaria through the most vulnerable years.

Key messages on the importance of the fourth dose should be developed and delivered to caregivers from the start of vaccination (do not wait until the third dose has been given or until fourth dose administration is underway). Health worker training should emphasize that these additional visits for vaccination, particularly in the second year of life, are opportunities for:

- children to catch up on any vaccines and child health interventions that are due
- caregivers to receive reminders and health information, including reinforcing the importance of children sleeping under ITNs every night.

Box 4. "Triple A" communication to help health workers deliver key messages to caregivers and stakeholders of the malaria vaccine (for country-specific adaptation [X])

"Triple A" communication: Advise – Alert – Arrange

ADVISE	**Advise on the malaria vaccine and schedule*** The malaria vaccine is safe and effective. For the best protection a child should receive all four vaccine doses: • A child receives the first dose from **[X]** months of age. • The recommended schedule is **[X]** months, **[X]** months, **[X]** months and **[X]** months. • Remind caregivers that the child will need a fourth dose at around **[X]** months to prolong the protection. Children who come late for doses should still receive their vaccination. The minimum period between doses is 4 weeks. The malaria vaccine is initially being introduced here as part of a phased introduction because children in this area are at high risk of getting malaria. Vaccine delivery will be expanded to other areas as supply increases. [IF APPLICABLE]
	Advise on other vaccinations and health services that are due Check the child's home-based record; inform caregivers of other health services that are due such as: • other vaccinations, including late vaccinations; • growth monitoring; • vitamin A; • deworming.
ALERT	**Alert on side effects** Common side effects are fever, irritability, and injection site pain and swelling. An uncommon side effect was febrile seizures, which can occur within 7 days after vaccination. Remind caregivers to return to the nearest health facility if they notice any side effects (even those not listed here).
	Alert on malaria prevention The malaria vaccine reduces the number of times a child gets malaria and saves lives. The vaccine is part of a recommended malaria prevention package that includes other preventive measures such as [insecticide treated nets, perennial or seasonal malaria chemoprevention, and indoor residual spraying [for country adaptation]. A child who receives the vaccine may still become sick with malaria, so it is important to seek prompt diagnosis and treatment for a child with fever.

ARRANGE	**Arrange for the next visit to ensure completion of four-dose schedule** Write on the home-based record the date of the next visit to receive the malaria vaccine along with other vaccines (and child health services) according to the immunization schedule. • The next visit should correspond to the schedule or, if the child is late for vaccination, wait at least 4 weeks before administering the next malaria vaccine dose. • Ensure that there is a vaccination session on the date of the next dose (i.e. no public holiday, weekend etc.). • Inform caregivers when to return with their child and the child's home-based record. Reminders to caregivers: • Visit the health facility monthly to have their child weighed and examined, and to receive all needed vaccines and child health services. • To get the best protection children should receive all four vaccine doses. Specifically remind caregivers that the fourth dose will be given at **[X]** months.

* For countries with seasonal delivery of doses, refer to the *WHO malaria vaccines* webpage for adapted materials and messaging (https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/malaria, accessed 17 June 2023).

Materials

Tailored IEC materials can be used to build demand for, and acceptance of, the malaria vaccine among health workers, caregivers, community leaders and policy-makers. The following materials may be developed to disseminate information, reinforce key messages or improve uptake:

For general use:

- brochures (or leaflets);
- flyers (or one-page handouts);
- booklets with vaccine key facts and messages;
- frequently asked questions (FAQ);
- clothing items (t-shirts, hats etc.) or other materials with messaging to raise awareness.

For health workers:

- health worker training materials, job aids, interactive quizzes on key messages and eligibility (in print or for use on digital platforms) and other learning tools;
- videos for health workers, including refresher training on key immunization or malaria topics;
- SMS messages sent to health workers to disseminate short-form refresher training information.

For caregivers:

- SMS messages with health information or vaccination reminders sent to caregivers;
- flipcharts;
- invitation cards;
- posters.

Pilot lesson: Use of remote digital tools in support of uptake and in the context of COVID-19

Across the three pilot countries, one of the key early implementation challenges was health workers' understanding of the malaria vaccine schedule, particularly regarding when the vaccine doses should be given. Health worker training materials and key messages were revised to clarify the age for first vaccine dose and when subsequent doses should be given. In addition to revised job aids, innovative health worker training tools were developed to share on digital platforms, including through text messages, e-mail and phone applications. The digital messages and tools were rolled out in Ghana and Malawi in English and local languages. Short messages to health workers and their supervisors on digital platforms focused on the age when children were eligible for vaccination, the vaccine schedule, catch-up for missed vaccination visits, and the importance of children completing the full four-dose malaria vaccine schedule. The messages served as reminders about malaria vaccination essentials in the absence of physical supportive supervision due to COVID-19 restrictions.

Short training videos for individual or group use were created to improve understanding of the four-dose schedule and of how to avoid missing opportunities for vaccination. The training videos, which could be watched on mobile telephones, were rolled out in Ghana (see Figure 7) and Malawi. The tool was also used during training and supportive supervision sessions. An interactive quiz was developed that allows health workers to probe various scenarios on age eligibility for vaccination (see Figure 7) and to minimize missed opportunities for all vaccines and for other child health interventions such as growth monitoring, deworming and vitamin A. The quiz enabled health workers to understand when to give the malaria vaccine, including when children present late for vaccinations. The quiz could be answered remotely online or by telephone, or it could be printed for use as a handout during group training.

Figure 7. Training video and interactive quiz from Ghana's malaria vaccine implementation

Fig. 8: Short health worker training video for Ghana malaria vaccine implementation

7 From September 2020 you can expect the first children to come back to receive their fourth dose of the malaria vaccine.

What else should you do when a 2-year-old child comes to the clinic for the malaria vaccine?

A a. Check the Maternal and Child Health Record Book to see if any other vaccine has been missed and should be given.

B Monitor growth

C Provide vitamin A

D All of the above

Perfect! You have identified all relevant opportunities to make sure the child is optimally protected. The visit for the 4th dose of the malaria vaccine provides an opportunity to check if other vaccines have been missed, monitor growth, and provide vitamin A.

Remember that the malaria vaccine can be given at the same time as other vaccines. A mild illness should not prevent you from vaccinating the child."

Submit

Pilot lesson: Information, education and communication (IEC) materials

The pilot countries adapted generic malaria vaccine materials to their contexts. The drafts were pre-tested among audiences in selected communities and health facilities in the implementation areas in order to assess clarity, understanding and acceptability of the messages. IEC materials adapted for use in the pilot countries took account of local languages, the portability for community education, and comprehension by populations with low levels of literacy. Examples of the pilot countries' communication materials are shown in Figure 8. Among the pilot lessons, posters were generally found to be less useful and more costly than other materials.

Figure 8 Extracts from countries' communication materials, developed under the leadership of the MoH, highlighting the complementarity of malaria vaccine with other malaria control interventions.
From top to bottom: Ghana flipchart; Kenya flyer; Malawi flyer and Key Facts booklet

7.3.3 Using multiple channels and opportunities for communication

It's important to use multiple channels or approaches to provide and reinforce messages on the introduction of a malaria vaccine – striking a balance between mainstream national-level media announcements and targeted communications to reach key audiences in vaccinating areas.[27] Factors that will influence the optimal mix of approaches to reach particular audiences include educational and literacy levels, access to media (including social media), understanding which sources for health information can be trusted, and budget considerations. The range of communication channels may include:

- **Interpersonal communication** between health workers and caregivers during routine clinic visits (see Box 4 and Appendix 2 for the "Triple A" communication on the malaria vaccine for health workers and caregivers) or during events involving community members (e.g. during community gatherings). Health workers are one of the most effective channels for communicating about vaccines, including their benefits and safety, since health workers are trusted sources of health information.
- **Existing community structures** – including community and religious leaders, village health committees, community health workers, caregivers' groups – are important channels to promote uptake, dispel rumours, share information, and distribute information about the vaccine.
- **Public service media** include materials such as the NIP and NMCP websites, newspaper advertisements, brochures, posters, billboards, announcements in the community, at churches and mosques, or on the radio.
- **Electronic media** in areas with access, television spots and radio jingles, SMS text messages, and other messaging platforms are potentially effective communication channels. Messaging and group chat platforms can also be used to share training, refresher materials or quizzes with health workers to increase their knowledge.
- **Social media** can be a powerful tool for delivering and amplifying health messages to caregivers and communities. This can motivate vaccine uptake and deliver accurate health information to broader audiences (and can monitor and counter rumours or misinformation).
- **Identified and trained spokespersons** at all levels of the health care system can serve as a resource to address public concerns or questions should they arise.
- **Communication workshops** with stakeholders at all levels of the health system can be useful to ensure alignment on strategies and key messages while developing and/or finalizing elements of malaria vaccine communications.
- **Media workshops or briefings** also provide interactive forums to engage the media – both before a big announcement and also to share facts and progressive updates with the public.

The timing of demand-related and communications activities is important to ensure that all stakeholders have the information they need prior to the start of malaria vaccination. Experience shows that it is best to begin activities prior to vaccine availability in the community. Decisions on whether to hold launch events should be carefully considered in the context of a phased and/or subnational introduction.

[27] Communicating for health: WHO strategic framework for effective communications. Geneva: World Health Organization. (source: https://www.who.int/about/communications, accessed 23 June 2023).

Launch events may help to increase demand and coverage in the first months of roll-out (see Pilot lesson: Start of vaccination and subnational launch events).

Pilot lesson: Start of vaccination and subnational launch events

Regardless of the approach for the launch, successful introductions in the pilot countries were based on comprehensive stakeholder and media engagement plans and were aligned with key messages and overall readiness assessments. The days and weeks leading up to the start of vaccination included events such as media breakfasts, stakeholder forums and press releases. The type and scope of launch events were observed to have an impact on initial uptake:

Malawi did not have a formal pilot launch event; instead a small group of key stakeholders and media gathered to witness the first vaccination. Following this "quiet" launch, malaria vaccine coverage levels were lower than in the other two pilot countries. The MoH had to intensify community engagement in the months that followed, including by using local media and community radio to raise awareness of the malaria vaccinations. Gradually over the next year, malaria vaccine first-dose coverage increased to levels similar to those of Penta3.

In Ghana and Kenya, there were formal national and community pilot launch events. In both countries, vaccine uptake was high following the launch. In Kenya, malaria vaccine first-dose coverage rapidly achieved similar coverage levels to those of Penta3, while in Ghana vaccine coverage was below that of Penta3 but remained consistently high from the launch through the years of pilot introduction. Hundreds of observers attended the launch events, including community members, health workers, national and subnational stakeholders, traditional leaders and media crews.

7.3.4 Misinformation and risk management

Real or perceived vaccine safety or other concerns can pose risks for a new vaccine or immunization programme if they are not identified and addressed promptly and appropriately. Potential risks to the programme can include rumours, AEFIs that raise community concerns, inaccurate press reports, and real or perceived procedural errors or mishaps. Preparation of strategic communication plans, including monitoring and social listening tools to identify and track issues, and draft responses to address potential risk scenarios, can be helpful to improve the response to any potential risks that arise. Communication responses from trusted sources of information can prevent escalation and can result in maintained or increased public trust and confidence in a vaccine or immunization programme.

Information voids, misinformation and disinformation about a new vaccine can lead to vaccine refusal, rumours and skepticism. Health workers and community members should be familiar with communication messages and tools to address questions and gaps in information, and should be able to give needed reassurances to caregivers and other community members throughout vaccine introduction and scale-up. Such planning is intended to lessen public anxiety regarding new vaccines, including the malaria vaccine, and to promote confidence in the value of immunization.

The good safety profile of the malaria vaccine – and other vaccines delivered through the NIP – should be emphasized by the MoH and trusted leaders. Information on common adverse events (or side effects, e.g., mild fever, redness, and swelling at the injection site) should be included in messages and

materials for health workers to prepare them to be able to communicate effectively with caregivers on what to potentially expect. Communications on a strong pharmacovigilance system can help provide confidence in vaccines and safety surveillance processes and can help ensure the prompt detection and response to clusters of events.

It is good practice to develop a risk communication plan prior to the introduction of any new vaccine. Some basic elements of a risk communication plan are:

- an outline of actions to take in case of a vaccine-related event (AEFI action plan) with specific roles for partners and stakeholders, including identification and role of the AEFI committee to investigate any potential AEFIs and determine their real cause(See section 8.6, Safety and adverse events following immunization (AEFI)]);
- a risk communication management team (with representatives at all levels of the health system) with defined roles and responsibilities, and a plan for communicating to key audiences;
- a few respected, well-prepared spokespersons;
- clear channels of communication with the media;
- a social listening system for tracking rumours and misinformation with prompt analysis of issues to determine the response;
- training of health workers on how to communicate with caregivers and the community on concerns or rumours;
- use of clear and understandable messages that are respectful, demonstrate empathy and provide sources for more information;
- prepared templates for communication tools such as holding statements or FAQ on key topics to facilitate a prompt response.

For more, see the Key Resource 17, Vaccine safety events; and Pilot lesson: Responding to social media anti-vaccination activity.

Key Resource 17: Vaccine safety events: managing the communications response: a guide for MoH EPI managers and health promotion units

Beyond the initial vaccine introduction phase, traditional, online and social media monitoring should take place periodically as the vaccination programme continues. The monitoring can track misinformation and rumours that arise over time and need to be corrected. The monitoring can also help to assess communications effectiveness – i.e. are health messages being reported accurately? Are there communities that are not being reached with information that should be targeted with intensified engagement? Are there leaders, journalists or community members who should be better sensitized or made aware of vaccination progress or impact? This monitoring provides insights to inform what is working and any course correction activities.

The guide provides informative strategies and tools to support effective communication planning and management in response to vaccine safety events. It is accompanied by a “Quick Guide” and is designed to be used by immunization programme managers and partners.

Source: Vaccine safety events: managing the communications response. Copenhagen: WHO Regional Office for Europe; 2013 (https://www.who.int/europe/publications/i/item/9789289054935, accessed 15 June 2023).

Pilot lesson: Responding to social media anti-vaccination activity

The problem: Very soon after the malaria vaccine was launched in Ghana, some inaccurate articles about the vaccine were published, and negative social media videos were posted online that encouraged caregivers not to vaccinate their children against malaria or other vaccine-preventable diseases. Monitoring showed that negative social media activity was circulating on social media and messaging platforms.

The response: The Ghana Health Service responded promptly, issuing a press release to provide additional information about the malaria vaccine pilot implementation and state the benefits of the malaria vaccine. The press release and accompanying statements by the Deputy Health Minister – strongly emphasizing that vaccines save lives – were picked up widely by national media. The Ghana ACSM subcommittee had also developed infographics and other materials with positive, accurate information and messages and distributed them on the same social media platforms where negative postings were seen. Spokespeople participated in radio and television talk shows to convey key messages about the life-saving potential of vaccines, including the malaria vaccine.

The result: Within a month, social media monitoring showed a significant decline in negative chatter and online postings. The Ghana immunization programme reported that malaria vaccine uptake was on track. The programme continued to monitor acceptance of other routine childhood vaccines, to sure that negative social media engagement did not affect uptake of other vaccines.

8 Implementation – training, service delivery and supervision

8.1 Training

Even though many aspects of malaria vaccine delivery are the same as for other established childhood vaccinations, health staff need to receive specific training before introducing any new vaccine, including the malaria vaccine. If prepared well, a two-day training course (at the minimum) should be sufficient to cover the necessary background information, operational issues and hands-on practice. Training should be undertaken just before malaria vaccine introduction (within a month of the start of vaccinations) or a refresher should be conducted if the training took place earlier.

Training should be conducted in a similar manner to that of other vaccine introductions – i.e. development of a comprehensive training plan and materials, with initial national training that is cascaded down to subnational levels and to health facilities. To enable close collaboration between sectors and partners, the training should include immunization focal points, malaria focal points, health workers, health records officers, health promotion officers and community health focal points. At least one or two health workers should be trained at each facility and will, in turn, be expected to train other health workers. The cascading training plan should consider sensitization of community health workers to support their community education efforts and to enable integration of the malaria vaccine into their household visits (screening of children with fever and referral of vaccine defaulters to health facilities).

For health workers, WHO has developed a training package of slide sets on key topics that can be downloaded and customized to meet specific country needs.[28] The topics to cover include:

0. Brief introduction
1. Introduction to malaria infection and disease in children
2. Malaria vaccine characteristics and storage conditions
3. Malaria vaccine schedule, eligibility, and contraindications
4. Malaria vaccine administration
5. Recording and monitoring of the malaria vaccine
6. AEFI monitoring
7. Communicating about the malaria vaccine with caregivers
8. Missed opportunities for vaccination (MOV).

Training materials should be adapted to the local context and, where necessary, should be translated into local languages to be well understood by targeted audiences, including health workers and community health workers. Summarized information on key topics should be given to training participants as reference materials that can be kept and used when needed (and shared with

[28] Vaccine specific training materials. Geneva: World Health Organization (https://www.who.int/teams/immunization-vaccines-and-biologicals/essential-programme-on-immunization/training/vaccine-specific-training-materials, accessed 16 June 2023).

colleagues). See section 7.3.2, Developing key messages and materials for malaria vaccine, for more examples of printed and electronic resources.

Interactive, hands-on training (e.g. field visits, scenarios, videos of correct practices, small group discussions, demonstrations, skills practices etc.) are generally more effective learning approaches for adults than lecture-style training.

During planning and budgeting, a country should consider the need for refresher training due to staff turnover after the initial training has been completed.

Pilot lesson: Training of health workers and community health workers

In all three pilot countries, training of health workers was carried out at the national level and was subsequently cascaded to other levels of the health-care system through to frontline workers who deliver the vaccine in facilities, clinics and health posts. The training sessions helped to ensure that vaccinators and health workers at every level understood why the vaccine was being introduced in a phased manner, that the vaccine will reach other areas at a later time, and that they were able to communicate these messages effectively with audiences, including caregivers, and answer any questions to minimize any misunderstanding or listen for rumours or concerns.

On the basis of experience during the pilot, **health worker training and the start of vaccination should occur as close together as possible** (less than a month apart), so information is fresh in health workers' minds when vaccination starts.

While training and sensitization of **community health workers** may be expensive given their large numbers, it is a worthwhile investment to ensure that accurate information and health behaviour messaging reaches caregivers, to mobilize children to present for vaccination from 5 months of age, and to support defaulter tracking to assure uptake of all four doses of vaccine. A key finding of Kenya's post-introduction evaluation was that not including community health workers in the health worker trainings conducted prior to vaccine introduction impacted both demand and defaulter tracing activities. As a result, an unanticipated training of the community health workers was required following the launch.

Given the workload and staff turnover of health workers, it is important to share reference materials for health facilities and identify opportunities to provide refresher training and information-sharing with health workers after the initial training occurs. This may also include the use of virtual platforms, such as quiz links or SMS messages.

Source: Summarized lessons from presentations by the Ghana, Kenya and Malawi MoHs at cross-country malaria vaccine workshops in late 2022.

8.2 Service delivery

8.2.1 How to organize a malaria vaccination session

All vaccination sessions should be well organized with all supplies and materials to ensure effective vaccine delivery and documentation. In addition to following all the basic requirements for any injectable vaccine, a few additional steps are required before, during and after children attend the vaccination sessions. These steps will ensure that the malaria vaccine is properly administered. (See Table 13. Activities for an immunization session that includes malaria vaccination).

Key supplies and materials include vaccine and diluent (clipped together), a box of reconstitution syringes, a box of auto-disable syringes, a chair and table, water and soap or hand sanitizer for cleaning hands, trays, safety boxes with closed lids, containers for used vials, drugs to manage adverse events (an AEFI kit)[29], pen and pencil, and IEC materials (e.g. flyers, brochures etc.). All forms and monitoring tools should be brought to every vaccination session and should include the vaccination register, tally sheets, home-based records, a calendar and AEFI forms.

Table 13. Activities for an immunization session that includes malaria vaccination

Before children come for vaccination	**1. Take clipped vials out of refrigerator.** 2. Remove the plastic clip. 3. Check the expiry date and VVM status on the vial with the green band. 4. Check that the liquid diluent is clear colourless to pale brownish and does not have matter or discolouration (discard both vials if observed). 5. Collect and arrange supplies and monitoring tools for the immunization session. 6. Ensure that a first-aid kit is available.
During the vaccination session	1. Greet the caregivers and record the child in the register. **2. Check the facility and home-based records for any vaccines, vitamin A, growth monitoring, deworming or other preventive interventions previously missed or due.** 3. Inform caregivers, ensure there are no contraindications and answer any questions. 4. Prepare to deliver the malaria vaccine along with all vaccine(s) and services the child is due during the session (as appropriate). **5. Reconstitute the malaria vaccine** (see video on *WHO malaria vaccines* webpage[30]): a) Remove the plastic caps on both malaria vaccine vials. a) Use the 2mL reconstitution syringe to puncture the rubber seal and withdraw the entire contents of the green ring vial containing the diluent. b) Slowly transfer the entire contents of the syringe into the red ring vial containing white powder. c) Discard the reconstitution syringe and needle into the safety box. d) Gently swirl red ring vial until powder completely dissolved in diluent (do not shake) e) Check that the reconstituted vaccine is a colourless to pale brownish liquid. f) Withdraw 1 vaccine dose of 0.5mL using a new auto-disable syringe. g) Take precautions to avoid contamination of the needle. **6. Vaccinate the child intramuscularly (IM) with 0.5mL dose at a 90-degree injection angle either in the anterolateral (outer) thigh if 5–12 months of age OR in the muscle of the upper arm (deltoid) if over 1 year of age – according to national policy.** 7. Immediately discard the used auto-disable syringe and needle into the safety box. 8. If applicable, return the vial with the remaining second vaccine dose in the red ring vial into foam of the cold box or vaccine carrier (Do not return to the refrigerator; see 5.5.3 on vaccine handling). 9. Document the dose received and the date in the vaccine register and tally sheet. 10. Complete the child's home-based record. **11. Communicate with caregiver(s) on which vaccine(s) and services are provided. For the malaria vaccine, give the following key messages:**

[29] Brief overview of anaphylaxis as an adverse event following immunization (AEFI) and practical guidance on its identification, case management and response in a primary care setting. World Health Organization: Geneva. (https://apps.who.int/iris/handle/10665/342195, last accessed: 23 June 2023).

[30] *WHO malaria vaccines webpage* (https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/malaria, accessed 17 June 2023).

	a) Potential side effects include fever (seek treatment) and pain or mild swelling at injection site. An uncommon side effect is fever with convulsions. b) Note the date of return and the importance of receiving all four doses, reminding caregivers that the fourth dose is given at **[X]** months of age and is important to prolong protection against malaria. c) Continue to use an insecticide-treated net every night and seek prompt diagnosis and treatment for fever.
After the entire session is over	1. Complete the immunization tally sheet by counting the number of doses given. 2. Return unopened vaccine vials to the refrigerator. 3. Discard any open vial with unused doses that remain in the carrier. 4. Put the safety box in a safe and dry location.

For more information, see: Immunization in practice: a practical guide for health staff. Module 4: Managing a vaccination session. Geneva: World Health Organization; 2015 (https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff , accessed 16 June 2023).

8.2.2 Service experience

Creating a positive, high-quality and person-centred immunization service experience requires consideration of various elements at the individual, community, facility and system levels which affect either the client (caregiver or child) or the health worker. Key factors to consider include: the health facility environment; ease of access to services (e.g. location of the health facility and hours of operation or timing of outreach sessions); the ability of communities to engage in the design, delivery and monitoring of immunization services and provide feedback; workplace community and job satisfaction; and the basic availability of, and access to, a reliable supply of vaccines, commodities and operational resources. All these factors affect the vaccination experience for health workers, clients and caregivers.

Given the importance of continued engagement in the health system in order to adhere to the four-dose (or five-dose) malaria vaccine regimen, countries may consider how to cultivate a people-centred approach to service experience. A caregiver who has a negative experience early in the process may not bring the child back for subsequent visits. While it may not be possible to address every component of immunization service experience, research has shown that the most successful interventions include encouraging community participation and ownership, supportive supervision, group problem-solving and development of technical skills for health workers.

For more information on toolkits available for immunization service experience and interpersonal communication, refer to section 7.2.3, Service quality improvements.

8.2.3 Eligibility

Use every health contact to "screen and vaccinate".

It is better to vaccinate late than never!

On the basis of the malaria vaccination schedule, health workers must assess if a child is eligible to receive the malaria vaccine during their visit to a health centre. The generic training materials include several scenarios to equip health workers with the tools and knowledge if a child comes for late or delayed vaccinations. Job aids and IEC materials also can be provided to support decision-making and reinforce key messages (see section 7.3.2, Developing key messages and materials for malaria vaccine).

The following key messages and principles relate to eligibility to incorporate (as appropriate) in planning, training and supervision of malaria vaccine implementation:

- **The minimum age for the first dose is 5 months of age. There is no maximum age** recommended by WHO for the first dose. However, health workers should be aware of any national policies which limit the initiation of malaria vaccination to a particular age.
- **There is no maximum age for the fourth dose** (a child may receive it at any age). In practice, immunization programmes may choose to offer late vaccination until 5 years of age.
- **The malaria vaccine is being rolled out in a phased manner**. In the initial phase, some children living in areas at greatest risk of severe malaria will receive the vaccine first, with phased expansion of introduction to children in other areas as the malaria vaccine supply increases.
- **For all children who begin malaria vaccination, the four-dose or five-dose schedule should be completed**. In the case of a subnational and/or phased introduction, children may come to a vaccinating health centre from neighbouring areas that are not yet implementing the malaria vaccine. As with other vaccines, countries should advise health workers through training and information materials how to respond and what qualifies as a child's "residence". No child should be turned away from vaccination and clear guidance is needed on how to record such situations in the immunization registers. Children who are from outside the vaccinating area should be vaccinated and advised to return to complete the four-dose or five-dose schedule for optimal protection. See section 9.1.1 for more information on recording vaccinations in these circumstances.
- **A child who presents late should be given the dose that is due.** The minimum interval between doses is four weeks.
- **The vaccine should be provided to children when they relocate to an area where the vaccine is implemented, including during emergency situations.**
- **For late vaccination, the intervals between malaria vaccine doses in the immunization schedule (e.g. 12 months between doses 3 and 4) need not be maintained** (seeBox 5. Scheduling the next dose if a child receives a late vaccination (age-based strategy)).

For more information, refer to the Pilot lesson: Health worker understanding of eligibility and to the WHO Recommendations for interrupted and delayed vaccination. See on the WHO website: https://www.who.int/publications/m/item/table-3-who-recommendations-for-routine-immunization (accessed 16 June 2023).

Box 5. Scheduling the next dose if a child receives a late vaccination (age-based strategy)

Following a late vaccination, health workers will write in the home-based record when the caregiver and child should return for the next malaria vaccine dose (if the four-dose or five-dose schedule has not yet been completed). The health worker should check when the next dose is due according to the schedule.

Specify when the caregiver should return, with the date and age of the child, and update the home-based record. Check other vaccines and health interventions the child may be due to have and issue reminders of when to return.

- Check for other vaccinations and health services the child is due to have – including vitamin A, deworming and growth monitoring – before the next scheduled malaria vaccination visit.
- Ensure there is a vaccination session on the date of the next malaria vaccine dose (i.e. no public holiday, weekend etc.).
- Encourage caregivers to visit the health facility monthly to have their child weighed and examined, and to receive all needed vaccines and child health services.
- Remind the caregiver: for the best protection, children should receive all four vaccine doses. Specifically mention the fourth dose at **[X]** months *(for country-specific adaptation)*.

Pilot lesson: Health worker understanding of eligibility

Challenges: In the first few months of vaccine introduction, health workers across the pilot countries were often unsure what to do about children who did not show up for vaccination. In Malawi, supportive supervision uncovered this misunderstanding as a key driver behind poor uptake in some facilities.

Solutions: Shortly after becoming aware of some misunderstanding on the schedule, countries went back to the drawing board to ensure that information products, job aids and health messages for caregivers (to be delivered by health workers) were as clear as possible.

- Ghana and Malawi developed short educational videos for health workers that outlined the dosing schedule and how to handle scenarios that might arise when children present late.
- In Ghana, this included a virtual, interactive quiz distributed on messaging platforms that presented multiple situations and real-time feedback on the correct way to respond.
- Remote tools were particularly useful in the COVID-19 context when training and visits to communities were limited or put on hold.
- In Kenya, a one-page document was developed to guide health workers – with precise information about what to do if a child presented late.
- In Kenya's child health books, the documentation for the receipt of doses was initially labelled 6, 7, 9 and 24 months. The team changed this to read dose 1, 2, 3 or 4, so there was no confusion if a child presented late for vaccination.

For more information, see: Learning lessons from the pilots: overcoming knowledge gaps around the malaria vaccine schedule in support of vaccine uptake. Feature story, 5 October 2022. Geneva: World Health Organization (https://www.who.int/news-room/feature-stories/detail/learning-lessons-from-the-pilots--overcoming-knowledge-gaps-around-the-malaria-vaccine-schedule-in-support-of-vaccine-uptake, accessed 16 June 2023).

8.3 Safe injection practices

WHO defines a safe injection as one that does not harm the recipient, does not expose the health worker to any avoidable risks, and does not result in waste that is dangerous to the community. The correct technique for preparing and administering a vaccine must be followed to ensure that it is effective and does not result in an AEFI caused by vaccine administration errors (see section 8.5, Contraindications and precautions).

As with all other immunizations, the malaria vaccine should be delivered with good technique and following the best practices for safe injections, namely:

- **Always follow manufacturer recommendations for use, storage and handling** (see section 5.3).
- **To minimize risk of injury, prepare the work area** such that:
    - the vaccinator is placed between the child (and caregiver) and needles and sharps;
    - monitoring tools and safety boxes are easily accessible; and
    - each vaccinator can see the safety box and its entrance hole when discarding the needle.
- **Wash hands with soap and water and drip dry.**
- **Prepare each dose just before administering. Do not pre-fill syringes in advance.**
- **Check the vial for condition, VVM status and expiry date.**
    - *Do not use if the colour of the VVM's inner square is the same colour as, or darker than, the outer circle, or if the packaging is punctured, torn, or damaged, or if the vial contains particles, or if there is discoloration.*
- **Use a new auto-disable (AD) syringe for each child.**
- **Do not touch any part of the needle.**
- **Discard the syringe and needle directly into a safety box – i.e. no recapping.**
    - *Discard any opened two-dose vial with unused doses at (whichever comes first): 1) six hours after opening; or 2) the end of the immunization session.*
- **Use safety boxes that are in good condition – waterproof, securely closed with only a hole through which syringe and needle can pass:**
    - Do not overfill the safety box – close and seal the box when three-quarters full.
    - Ensure safe transportation and disposal of filled safety boxes.

For more information on safe injection practices, see: Injection safety. Geneva: World Health Organization (https://www.who.int/teams/integrated-health-services/infection-prevention-control/injection-safety, accessed 16 June 2023).

8.4 Co-administration

The malaria vaccine can be given concomitantly with any other monovalent or combination vaccines that the child is due to have. Separate syringes and different injection sites should be used. When two injectable vaccines are administered during the same visit, they should be injected in different limbs. In

the case of three vaccines given during a single visit, two can be injected in the same limb, at least 2.5 cm apart to enable differentiation of local reactions, and the third injection in a different limb.[31]

The vaccine can be safely given with vitamin A or antihelminth (deworming) medications.

8.5 Contraindications and precautions

The RTS,S/AS01 vaccine is not recommended for a child who has known severe hypersensitivity to a previous dose of RTS,S/AS01, to a previous dose of Hepatitis B (HepB) vaccine[32] or to any of these vaccine components (see Key Resource 18: Mosquirix™ package insert, EMA (2015)).

Key Resource 18: Mosquirix™ package insert, EMA (2015)

Powder: Sucrose, polysorbate 80, disodium phosphate dihydrate, sodium dihydrogen phosphate dihydrate.

Suspension: Dioleoyl phosphatidylcholine (DOPC), cholesterol, sodium chloride, disodium phosphate anhydrous, potassium dihydrogen phosphate, water for injections

Source: Amsterdam: European Medicines Agency (https://www.ema.europa.eu/en/documents/outside-eu-product-information/mosquirix-product-information_en.pdf, accessed 16 June 2023).

A minor illness – including respiratory tract infections, mild diarrhoea, and fever below 38.5°C – is not a contraindication for malaria vaccination. If a caregiver objects to immunization for a sick infant or child (after explanation that mild illness is not a contraindication), the health worker should ask the caregiver to return when the infant is well.[33]

The vaccine is well tolerated and immunogenic in children born prematurely (<37 weeks' gestation) or with low birthweight, and also in children with HIV infection or malnourishment.

8.6 Safety and adverse events following immunization (AEFI)

An AEFI is any untoward medical occurrence which follows immunization and which does not necessarily have a causal relationship with the usage of the vaccine.[34] For instance, a fever may have occurred at the time of the vaccination (temporal association) but is in fact caused by another childhood illness or malaria. These coincidental events reflect the natural occurrence of health problems in the community. However, if not properly managed, even AEFI which are not causally related to vaccines can undermine confidence in a vaccine and potentially affect new vaccine introductions.[35]

The adverse event may be any unfavourable or unintended symptom (reported by the patient) or abnormal laboratory finding or sign (found by a doctor) or disease. AEFIs can range from minor events such as a mild reaction at the injection site to life-threatening events such as anaphylaxis and possibly

[31] Meeting of the Strategic Advisory Group of Experts on immunization, April 2015: conclusions and recommendations. Weekly Epidemiological Record. 29 May 2015;90(22):267–8).

[32] See malaria vaccine position paper (see section 2.1 WHO position and summary of product characteristics (see section 8.6.1) for more details on the use of HepB surface antigen in the circumsporozoite protein of the RTS,S vaccine component.

[33] Immunization in practice. Module 5: Managing an immunization session. Geneva: World Health Organization; 2015:(5)1–35 (https://apps.who.int/iris/handle/10665/193412, accessed 16 June 2023).

[34] Adverse events following immunization (AEFI). Geneva: World Health Organization (https://www.who.int/teams/regulation-prequalification/regulation-and-safety/pharmacovigilance/guidance/aefi, accessed 23 June 2023).

[35] Vaccinations and trust: how concerns arise and the role of communication in mitigating crisis". Copenhagen: WHO Regional Office for Europe; 30 September 2017 (https://www.who.int/europe/publications/i/item/WHO-EURO-2017-2908-42666-59448).

death. Although minor AEFI can be caused by vaccines, serious AEFIs such as death, hospitalization, disability or life-threatening events, when investigated are found to be more commonly coincidental and unrelated to vaccination. In rare cases, they may be due to programmatic or human errors caused by inappropriate vaccine-handling, prescribing or administration.

Box 6. AEFI classification

Vaccine product-related	caused or arising from one or more of the inherent properties of the vaccine product.
Vaccine quality defect-related	caused or arising from one or more quality defects of the vaccine product, including its administration device as provided by the manufacturer.
Immunization error-related	caused or arising from inappropriate vaccine-handling, prescribing, or administration and thus by nature is preventable.
Immunization stress-related	caused or arising from stress or anxiety about the immunization.
Coincidental event	caused or arising from something other than the vaccine product, immunization error or immunization anxiety.

8.6.1 Malaria vaccine safety profile

The malaria vaccine is safe and well tolerated. Commonly reported AEFI include fever, irritability, and pain and swelling at the injection site. An uncommon AEFI is febrile convulsions during the 7 days following vaccination (mainly within 3 days).[36]

Countries that elect to introduce the vaccine in a five-dose seasonal strategy should document their experience, including monitoring for adverse events following immunization.

For further information on malaria vaccine safety refer to the WHO position paper on malaria vaccine.[3]

8.6.2 Reporting and investigation of AEFI

Prior to national introduction, countries should ensure the malaria vaccine is fully incorporated into adverse event monitoring within the national AEFI monitoring system including their guidelines. Clear procedures for what to report and how to report are necessary elements of any AEFI reporting system. All AEFIs should be reported (even if not included in section 8.6.1, Malaria vaccine safety profile) and brought to the notice of the health-care system through existing AEFI reporting systems.

According to these procedures, health workers should be trained in the recognition of adverse events, completion of the standardized AEFI reporting form[37] (see Key Resource: AEFI monitoring), and

[36] Product information – Mosquirix. GSK, Inc. 21 July 2021 (https://www.ema.europa.eu/documents/outside-eu-product-information/mosquirix-product-information_en.pdf, accessed 16 June 2023).

[37] Reporting form for AEFI. Geneva: World Health Organization; 2021 (https://www.who.int/publications/m/item/reporting-form-aefi, accessed 16 June 2023).

appropriate notification of supervisors and the district health officer immediately for information and decision-making.

A system should be in place to facilitate prompt reporting and investigation of AEFIs with oversight by a national vaccine safety and advisory committee – using standardized AEFI case reporting and investigation forms, respectively (see **Key Resource 19: AEFI monitoring**). The use of electronic tools for AEFI reporting will enhance the speed and response of surveillance systems. The NRA and the NITAG can play proactive roles in investigating reports of serious adverse events to determine if there is any link to malaria vaccine and also to develop communication messages to address rumours.

Key Resource 19: AEFI monitoring

1. Global Vaccine Safety AEFI tools: Adverse Event Following Immunization (AEFI) (http://gvsi-aefi-tools.org/, accessed 16 June 2023).
2. Aide Memoire on AEFI investigation. Geneva: World Health Organization (https://cdn.who.int/media/docs/default-source/pvg/global-vaccine-safety/new-aide-memoire-aefi.pdf?sfvrsn=66340a11_4, accessed 16 June 2023).
3. Global Vaccine Safety serious AEFI investigation form, 12 August 2019. Geneva: World Health Organization (https://cdn.who.int/media/docs/default-source/pvg/global-vaccine-safety/aefi-investigation-form-final-version12augt2019.pdf?sfvrsn=314e55c7_4&download=true, accessed 16 June 2023).
4. Causality assessment of an AEFI: user manual for the revised WHO classification, second edition, 2019 update. Geneva: World Health Organization; 2021 (https://www.who.int/publications/i/item/9789241516990, accessed 16 June 2023).

Pilot lesson: Routine pharmacovigilance

Pilot countries used the malaria vaccine introduction as an opportunity to strengthen their routine national pharmacovigilance systems. The following activities leveraged malaria vaccine implementation and are recommended for countries to include in their introduction plans, as applicable:

- NRA membership in the malaria vaccine TWG and relevant subcommittees;
- inclusion of an AEFI module in the malaria vaccine training for health workers to strengthen the overall NIP and AEFI surveillance/pharmacovigilance systems;
- NRA participation in malaria vaccine training sessions;
- establishment of an AEFI committee and/or training workshops on AEFI investigation and causality assessment (jointly with the NIP and NRA).

9 Monitoring and evaluation

Monitoring and evaluation of malaria vaccine introduction should be primarily performed by the NIP, and should include supportive supervision, malaria vaccination coverage monitoring, AEFI monitoring, post-introduction evaluation, and economic analyses as needed. The NMCP should continue to support malaria disease surveillance through established malaria disease reporting and surveillance systems. If

the malaria vaccine introduction is subnational, the NIP will consider how adjustments to the monitoring system to include the malaria vaccine and monitor impact overall on routine delivery.

New (or adaptation of existing) maternal and child health home-based records, recording and reporting tools, tally sheets, ledgers and registers will need to be developed and disseminated to targeted areas; as well as any updates to electronic recording and reporting systems, such as DHIS2.

For more information, see: Immunization in practice: a practical guide for health staff. Module 6: Monitoring and surveillance. Geneva: World Health Organization; 2015 (https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff, accessed 16 June 2023).

9.1 Recording and reporting tools

The main recording and reporting tools that are used for immunization should be adapted to include the malaria vaccine. These are:

- the child health or immunization register (static and outreach);
- the child's home-based record;
- monthly report;
- stock management forms;
- monitoring chart.

If there is a subnational and/or phased introduction, countries should decide how to incorporate the malaria vaccine into existing monitoring tools and distribute it to the implementing areas. Countries may have prior experience or they can review cases of other subnational introductions of new vaccines.

If the tool in use has not yet been updated, health workers may: 1) replace it with the new version by transferring all the data and discarding the old version; or 2) find an appropriate space to write the dose that is being given and the next doses that are due where this will be easily seen.

For more general information, see: Immunization in practice: a practical guide for health staff. Module 6 – Monitoring and surveillance. Geneva: World Health Organization; 2015 update (https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff, accessed 16 June 2023) and the forthcoming: Handbook on the use, collection, and improvement of immunization data. Geneva: World Health Organization.

Pilot lesson: How to integrate

Stickers and stand-alone tools were originally designed for the malaria vaccine introduction. However, pilot countries found this led to missing reports and data loss through the routine reporting systems. Furthermore, a qualitative study conducted among health workers found that their chief concern about the malaria vaccine was increased workload, primarily due to additional documentation and reporting. **It is therefore recommended that the malaria vaccine should be integrated into existing recording and reporting tools.**

Bundling the vaccine, supplies and updated data collection tools was found to be an effective means of distribution.

9.1.1 Child health or immunization registers

Immunization registers are used to record doses given to an individual. The registers help health workers to keep track of each dose that has been administered and to record the completion of the vaccination series. The immunization register is the basis for tracking individual immunization status (for instance, if the home-based record is lost) and for tracking defaulters.

Immunization registers typically contain the following data:

- a unique identification number, if possible;
- registration date (usually the date of the first visit);
- name of the child;
- date of birth;
- residence/location;
- sex of the vaccine recipient;
- name and mobile telephone number of parent/caregiver, if feasible, to facilitate reminders;
- date and dose administered (e.g. dose 1 or dose 2 or dose 3 or dose 4);
- other data of relevance to the immunization programme (including adverse events).

If a child re-locates to, or visits, another health facility for vaccination (other than the facility registered upon birth or first vaccination), transcribe the previous vaccinations from the home-based record, if available, into the register and record prospective vaccinations, as appropriate – following standard operating procedures for (sub)national policy. Consider notifying the child's previous health facility of the visit and vaccinations.

Caution: If an "Under 2 years Child Register" is used to record vaccinations, health workers are likely to face challenges in monitoring and tracking children who miss the fourth dose in their second year of life. Children who are scheduled to receive the fourth dose at 18 months of age may present late, even after 24 months of age, and those scheduled to receive the fourth dose at 24 months of age will present in their third year of life.

Registers should include space for additional doses (and possibly other interventions) to be provided in the second year of life, and beyond, without restricting the recording of doses to the intended age group. It is crucial that registers are organized in a manner that facilitates the tracking of defaulters.

If it is not possible prior to vaccine introduction to re-design the register, the NIP should develop a strategy to address the defaulter tracking challenge that health workers are likely to face for the fourth dose.

Source: Establishing and strengthening immunization in the second year of life: practices for vaccination beyond infancy. Geneva: World Health Organization; 2018:57 (https://apps.who.int/iris/bitstream/handle/10665/260556/9789241513678-eng.pdf, accessed 16 June 2023).

9.1.2 Child health home-based records

Child health home-based records are essential tools for tracking immunization status and include information that is similar to that in the immunization or child health register. The main uses of the home-based record are:

- to provide health workers with the child's age and date of birth;
- to inform health workers and caregivers of the vaccines and child health services already received and those needed in the future;
- to inform health workers and caregivers of the child's next appointment for vaccination or child health services;
- to help identify children who do not return on time or have missed vaccinations or child health services (i.e. vitamin A supplementation, growth monitoring, deworming) in order to administer those for which they are eligible, respecting the necessary spacing (Key Resource 20: Reducing missed opportunities for vaccination (MOV)); and
- to facilitate coverage surveys.

Home-based records should be updated to include space to record (at least) four doses of the malaria vaccine, the date, vaccine batch number and vaccine expiry date (according to the NIP policy).

For more information, see: Strengthening implementation of home-based records for maternal, newborn and child health: a guide for country programme managers. Geneva: World Health Organization; 2023 (https://www.who.int/publications/i/item/9789240060586, accessed 16 June 2023).

Key Resource 20: Reducing missed opportunities for vaccination (MOV)

A missed opportunity for vaccination is any visit to a health facility by a child (or adult) who is eligible for vaccination but which does not result in the person receiving all the vaccine doses for which he or she is eligible.

Possible contacts or missed opportunities could occur when receiving a different vaccine OR being treated for an illness OR receiving other preventive services OR accompanying a family member to an appointment OR if a health facility does not have vaccines or related supplies.

See: Reducing missed opportunities for vaccination. Geneva: World Health Organization (www.who.int/teams/immunization-vaccines-and-biologicals/essential-programme-on-immunization/implementation/reducing-missed-opportunities-for-vaccination-(mov), accessed 16 June 2023).

9.1.3 Tally sheets

Tally sheets are the forms that health workers use to document an immunization session by making a record for every dose of vaccine given. Tally sheets should be used at all vaccination sessions whether at the health centre, fixed outreach, or conducted by mobile teams. Tally sheets are also useful in tracking doses delivered and any vaccine doses wasted. The summarized data will be compiled at the end of each month in an overall summary sheet for onward submission.

9.1.4 Monthly report

To monitor coverage, malaria vaccine immunization data should be aggregated from the tally sheets and registers and submitted on a monthly basis to the next level of the health system, as for all other vaccines. The monthly report should record all doses of the malaria vaccine (Malaria1, Malaria2, Malaria3, Malaria4 etc.). The integrated monthly report contains data on most of the components of the immunization system in summary format for both easy recording and easy tracking. It is a valuable tool for management of the programme's achievements and for monitoring progress throughout the year. The integrated monthly report should be adapted when malaria vaccine is added to the national immunization schedule.

If the malaria vaccine delivery strategy provides vaccination only seasonally (i.e. in the months prior to the peak malaria transmission season) then "zero" reporting will be necessary for the months when the malaria vaccine was not given.

9.2 Monitoring and reporting coverage

Calculating malaria vaccine coverage is necessary for monitoring the uptake of the vaccine in the target population, as well as for evaluating performance in relation to programme objectives. As with other NIP vaccines, administrative coverage can be supplemented by coverage surveys, as described below.

A coverage monitoring wall chart for malaria vaccination should be maintained and displayed in the health facility. This chart should include the target population of children at the health facility or catchment area and should record the number of children vaccinated per month, per dose, over time. If seasonal delivery is used, charts showing the time points prior to peak malaria transmission season can be used to provide a visual record of the administrative coverage. Implementation progress should be monitored at national, subnational and facility levels on the basis of monthly summary results and should be presented regularly to the two programmes (NIP and NMCP) along with relevant subcommittees or TWGs for information and guidance. It is recommended that malaria vaccine coverage and programme performance be reviewed in comparison with DTPCV3/Penta3 given at 14 weeks, MCV1 at 9 months, MCV2 at 15 or 18 months for the same target population in the same areas where the malaria vaccine is being implemented. Regular monitoring and joint NIP-NCMP meetings should be established to review data on malaria vaccine coverage and malaria surveillance in order to guide improvements to the malaria vaccine programme.

A standard formula can be used to estimate the coverage and dropout rates:

$$\textbf{Coverage} = \frac{(Number\ of\ children\ who\ have\ received\ vaccine\ dose)}{Number\ of\ children\ in\ target\ population}\ x\ 100$$

It is important to document when fourth dose administration began and/or the number of months of fourth dose administration.

9.2.1 Dropout

The dropout rate compares the number of children who completed the vaccination schedule for a given vaccine to the total number who failed to finish the course. To calculate dropout rates, the number of doses administered can be compared to the number of children eligible to receive them.[38]

The following formula may be used to calculate **dropout between malaria vaccine doses provided the time periods used for the number of doses administered for the initial and later dose(s) are the same:**

$$\frac{(Number\ of\ doses\ administered\ for\ an\ initial\ dose - Number\ of\ doses\ administered\ for\ a\ later\ dose)}{Number\ of\ doses\ administered\ for\ an\ initial\ dose}\ x\ 100$$

A dropout rate formula helps to evaluate whether:

- children who begin vaccination complete the four-dose schedule (dropout between dose 1 and dose 4);

[38] Immunization in practice: a practical guide for health staff. Module 6: Monitoring and surveillance (section 4.1). Geneva: World Health Organization; 2015 (https://www.who.int/publications/i/item/immunization-in-practice-a-practical-guide-for-health-staff, accessed 16 June 2023).

- children who begin vaccination complete the primary series (dropout between dose 1 and dose 3);
- children who complete the primary series return for dose 4 in their second year of life (dropout between dose 3 and dose 4).

Important notes on fourth-dose dropout:

Because of the longer interval between the third and fourth doses, monitoring of fourth-dose dropout should start only from the first month of fourth-dose administration (and should not include the time period before the fourth dose was given).

When interpreting the dropout rate using the above formula, it should be recognized that the children who are included in the "number of doses administered for an initial dose" in the primary series (i.e. dose 1, dose 2 or dose 3) are not the same children as included in the "number of doses administered for a later dose" (i.e. dose 4). Fourth-dose performance is always conditioned by the performance of the primary series about a year earlier – after these children become "age-eligible" to receive the fourth dose according to the vaccination schedule.

The example in Figure 9 illustrates a vaccination schedule of dose 1 at 5 months, dose 2 at 6 months, dose 3 at 7 months and dose 4 at 18 months of age. Vaccination started in January (Year 1) when the first children (represented by child L) received dose 1. Dose 4 administration started in February of the subsequent year (Year 2) after children (child L) who received three doses became "age-eligible". The example is carried forward in Table 14 on reporting of doses administered and dropout rate calculations that follow.

Figure 9. Illustrative vaccination schedule and the start of dose 4 monitoring

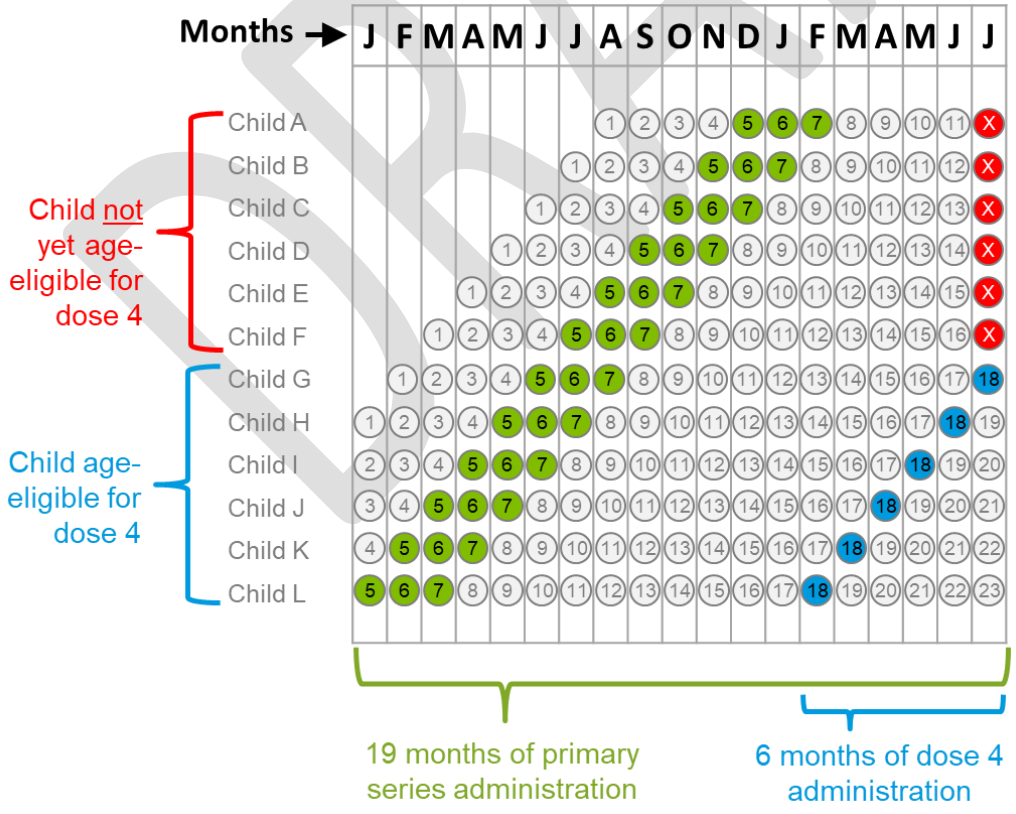


Table 14. Example reporting of malaria vaccine doses administered by month and by dose (and target population)

	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J
Dose 1	4000	5000	5000	5000	5000	5000	5000	5500	5500	5500	5500	5500	5500	5750	5750	5750	5750	5750	5750
Dose 2		3500	4500	4500	4500	4500	4500	4750	4750	4750	4750	4750	4750	5000	5000	5000	5000	5000	5000
Dose 3			3250	3250	3250	3250	3250	4000	4000	4000	4000	4000	4000	4500	4500	4500	4500	4500	4500
Dose 4														3000	3000	3000	3000	3000	3000
Target population	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000	6000

Dropout between malaria vaccine doses 1 and 4 (February to July, 6 months)

$$\frac{((5750\ x\ 6) - (3000\ x\ 6))}{(5750\ x\ 6)}\ x\ 100\ = 48\%\ \text{dropout between dose 1 and dose 4}$$

In the first 6 months of dose 4 administration, approximately 50% of age-eligible children have completed the four-dose schedule

Dropout between malaria vaccine doses 3 and 4 (February to July, 6 months)

$$\frac{((4500\ x\ 6) - (3000\ x\ 6))}{(4500\ x\ 6)}\ x\ 100\ = 33\%\ \text{dropout betwen dose 3 and dose 4}$$

In the first 6 months of dose 4 administration, approximately two-thirds of age-eligible children who received dose 3 have returned for dose 4

9.2.2 Improving uptake

For early protection, it is important children receive the first dose of the malaria vaccine as soon as they are eligible (according to NIP policy). Box 7 includes examples based on pilot experience of how to identify children eligible for vaccination and how to inform caregivers about the vaccination schedule, with particular attention to increasing awareness and coverage of the fourth dose.

The coverage with vaccinations currently delivered during the second year of life as part of the immunization schedule (for example MCV2 at 15 or 18 months of age) may be an indication of the expected coverage for the fourth dose of the malaria vaccine. Innovative strategies may be used to incentivize caregivers to bring their children for the fourth dose, such as ITN distribution in the same visit. If high and equitable coverage is not achieved with other vaccinations or health interventions in the second year of life, additional efforts should be planned and implemented to achieve and sustain high coverage with the fourth dose of the malaria vaccine. These may include communication or PIRI activities, ideally timed for added impact just prior to the start of the peak transmission season.

As with other vaccinations, it is important to follow up with children who have not returned for vaccination on time to complete the full recommended schedule. Community health workers can identify defaulters and arrange for them to receive the missing doses. High levels of defaulting could be an indication of more systemic problems in the community, such as lack of confidence or trust in the vaccine, or in service delivery such as stock-outs. A system to track dropouts is an integral part of the RED strategy (see section 6, Microplanning)Key Resource 14: Reaching Every District (RED) – A guide to increasing coverage and equity in all communities in the WHO African Region (2017). The RED/REC approach for monitoring and follow-up of defaults utilizes the following tools and platforms:

- **Immunization register** – When using the register, regularly review it to identify children who may have failed to receive their follow-up doses when they were due.
- **Electronic immunization registries (EIRs)** – These are computerized registries that include records for each child, with personal information as well as vaccination data. EIRs allow automatic generation of listings of children who are due for a vaccine or who have missed a dose, as well as sending recall/reminders by telephone, email or letters directly from the EIR to consenting users.
- **Reminder cards** – or "tickler" box with copies of home-based records with dividers by month. The reminder card is put into the month when the next vaccine dose is due. Health workers can use community messaging, mobile telephone texts to caregivers, or other mechanisms to send reminders of the need to receive the next vaccine dose. Tracking every month will provide consistency and make the exercise a regular part of the work of the health centre staff.

As part of overall strategies for achieving high and equitable coverage and implementing catch-up vaccination, ministries of health may consider additional immunization activities in communities that report low vaccination coverage with the primary series or specifically with the fourth dose. Some countries may experience external factors, to address barriers to vaccination (due to age, location, social and cultural and gender-related factors) or that reduce coverage, or they may wish to close "immunization gaps" following a significant disruption in immunization services. Catch-up should include strategies for "zero-dose" or under-vaccinated children and hard-to-reach populations:

- **Periodic intensified routine immunization (PIRI)** describes a spectrum of time-limited, intermittent activities to administer routine vaccinations – including catch-up doses – to under-vaccinated populations and/or raise awareness of the benefits of vaccination. This may include integrated delivery of malaria vaccine with other vaccinations or health interventions. Examples include child health days, national vaccination weeks, intensified social mobilization efforts etc.

  Best practice for applicable settings**:** Conduct the PIRI just prior to the start of peak transmission season to increase uptake and leverage the period of highest efficacy (after the third dose and subsequent doses) against the period of highest risk.
- **Targeted mop-up campaigns** in specific areas deemed priority.

Pilot lesson: Mop-up after vaccine stock-out

After a delayed international malaria vaccine shipment led to stock-outs in some facilities in Ghana, a significant drop in vaccination was observed and only 45% of the monthly target population was reached. Stocks were replenished in the same month and missed children were identified for catch-up immunization activities. Mop-up activities enabled a strong recovery, exceeding pre-stock-out coverage levels within three months.

- **Monthly outreach to under-performing districts and/or hard-to-reach populations or under-immunized populations** (including "zero-dose" children).

  It is best practice to monitor coverage levels at district/county level and set indicators driven by equity to monitor performance (e.g. the number of districts reporting less than 50% coverage with dose 1 and the number of districts reporting more than 90% coverage with dose 1).

- **Innovative, locally tailored, evidence-based local strategies** to reach poorly served populations and can ensure that individuals have the opportunity for all children to receive routine immunizations vaccinations for which they are overdue and eligible.

Box 7. Platforms and methods to facilitate malaria vaccine uptake

Identifying children for vaccination	• birth registries/records; • education of caregivers at 14-week visits on the childhood vaccination schedule; • community health workers, volunteers and/or community/religious leaders to issue reminders or follow-up; • reminder cards or immunization registers to identify defaulters.
Informing caregivers about the childhood vaccination schedule	• health visits and vaccinations at 6, 10 and 14 weeks of age; • community health sessions and community leaders; • well-child visits under 5 years of age; • Digital information-sharing platform (e.g. SMS texts); • radio spots and jingles; • national launch.
Increasing awareness and coverage of the fourth dose	• reminders to caregivers at each vaccine visit about the four-dose schedule and timing of the fourth dose; • community volunteers, mobilizers, announcements; • SMS or messaging platform or telephone calls to caregivers (if contact information is available); • periodic intensified routine immunization (PIRI); • links with other child health services (ITNs, second year of life strategies);[39] • home-based record checks at well-child visits under 5 years of age.

Key Resource 21: Improving immunization coverage and equity technical resources

A database of resources relevant to improving the coverage and equity of immunization services. The intended users of the collection include managers of national immunization programmes and NIP and primary health care technical advisers and partners. This database has been designed to guide browsing in three different ways: by topic, by question or by the IRMMA framework (Identify – Reach – Monitor – Measure – Advocate) for zero dose (https://www.technet-21.org/en/cov-eq, accessed 17 June 2023).

It includes this specific example: Leave no one behind: guidance for planning and implementing catch-up vaccination. Geneva: World Health Organization; 2021 (https://www.who.int/publications/i/item/9789240016514, accessed 17 June 2023).

[39] Vaccination in the second year of life (2YL). Guidance and resources from WHO (online). Geneva: World Health Organization (www.who.int/teams/immunization-vaccines-and-biologicals/essential-programme-on-immunization/integration/vaccination-in-the-second-year-of-life-(2yl), accessed 17 June 2023).

9.2.3 Health and immunization management information systems

Data flow from the health facility will follow the current system for consolidation, summary and transmission on a regular basis. Indicators should be developed in alignment with the tools for data capture in the immunization and malaria programmes. The standard practices for monitoring indicators should be used in accordance with other health and immunization management procedures (i.e. District Health Information Management System [DHIMS], DHIS2). Where available, the use of electronic vaccination registries (as demonstrated by COVID-19) can support data quality improvements and tracking. In the case of subnational and/or phased introduction, the DHIMS modifications can be manipulated to be available only for entry by implementing districts. All data in DHIS2 will be available for viewing by all with access to the platform. Any proposed alterations should be aligned with the health management information systems reviews, unless special conditions are granted.

Periodical data audits guided by data quality improvement plans should be incorporated in malaria vaccine introduction plans.

Pilot lesson: How to integrate malaria vaccine data?
• HMIS such as DHIS2 – alongside malaria and immunization indicators. • NMCP quarterly and annual data reviews and reports, including malaria vaccine coverage data. • Regular performance reviews and feedback to districts to make improvements and use data for action.

9.2.4 WHO/UNICEF joint reporting form on immunization (JRF)

National immunization programmes administer malaria vaccination to different age groups. For international comparison of the four- or five-dose coverage data and for calculating regional and global coverage by a certain age (e.g. by 2 years or by 5 years), all countries will be requested (from 2024, if agreed to by the regional offices of WHO and UNICEF) to report administrative coverage by age groups using the WHO/UNICEF Joint Reporting Form on Immunization.

9.3 Supportive supervision

Supportive supervision is key to ensuring that proper procedures are followed and for troubleshooting problems that can arise, particularly during the initial introduction of a vaccine. Supervision should be coordinated between partners and integrated with supervision efforts across the immunization programme. It is recommended to conduct readiness assessments in selected areas prior to starting vaccinations and to plan supportive supervision,

Supportive supervision is helping to make things work, rather than checking what is wrong.

Supportive supervision:

- encourages open, two-way communication;
- builds team approaches to facilitate problem- solving;
- focuses on monitoring performance towards goals;
- uses data for decision-making;
- depends on regular follow-up with staff to ensure that new tasks are being implemented correctly.

including on-the-job-training, for health workers within a short time frame afterwards.

Visits can strengthen health-worker capacity by providing feedback and motivation, raising awareness of missed opportunities for vaccination or missed opportunities for other health interventions, and identifying training needs. Adequate planning is required for supportive supervision in order to prepare the necessary tools, provide a plan to address identified gaps, and conduct meaningful capacity-building visits. Supervisors should allow enough time to interact with health workers to discuss new vaccine uptake, best practices, challenges and overall NIP factors that influence vaccine uptake (related to age, location, socioeconomic status or gender-related barriers). Supervisor schedules and integrated checklist tools should be adapted to include the malaria vaccine. Staff should be specifically asked about malaria vaccine uptake and any problems (supply or demand) that they face with this vaccine.

Sample supervisory questions on issues particularly relevant for malaria vaccine implementation are included in Appendix 4: Sample supportive supervision questions.

For further information, see: Training for mid-level managers (MLM). Module 4 – Supportive supervision. Geneva: World Health Organizatiion; 2020 (https://apps.who.int/iris/handle/10665/337056, accessed 17 June 2023).

Pilot lesson: Supportive supervision

- Prior to the start of vaccination, technical teams conducted pre-introduction visits to assess levels of preparedness and readiness for the introduction and to make recommendations for improvement.
- A rapid assessment soon after vaccine introduction was key in identifying gaps quickly and informed early remedial actions.
- Findings from supervisory visits were discussed during review meetings and were used to inform changes at each level of the health system.
- Supportive supervision by the NIP during pilot implementation often included the NMCP and covered multiple antigens.
- Combining supportive supervision with immunization and/or surveillance data review meetings enabled key issues and timely solutions to be identified, and also provided opportunities for on-the-job training of health workers to strengthen immunization and malaria programme data.
- Where available, electronic supervisory tools (e.g. using Open Data Kit [ODK] technology) have been updated to include malaria vaccine indicators. It is recommended that district health teams be provided with access to these results and data to facilitate learning plans and the use of data for action.

9.4 Evaluation tools

Current immunization programme evaluation tools can be adapted for malaria vaccination. These include post-introduction evaluations (PIE), NIP reviews and coverage surveys.

9.4.1 Post-introduction evaluation

This post-introduction evaluation (PIE) tool is designed for immunization managers and provides a systematic method for evaluating the impact of the introduction of a vaccine on a country's existing immunization system. The PIE also identifies problems and lessons learned.

Global experience with the introduction of new vaccines is now very extensive, and most countries have introduced at least one or more new vaccines in the last 10 years. For these reasons, WHO no longer recommends that all countries conduct a PIE following the introduction of every vaccine. Instead, WHO recommends combining the assessment of any new vaccine introduction with the next scheduled NIP review or other evaluation opportunity. However, a PIE is likely to be very informative following malaria vaccine introduction given the vaccination schedule of four doses (with one in the second year of life) and potential subnational, phased and/or seasonal implementation strategies. PIEs are typically recommended 6–12 months following introduction and can be integrated with PIEs for other vaccines when feasible.

In addition to the standard PIE, countries may consider a more rapid programme assessment earlier within 2–6 months of starting vaccination. During the COVID-19 pandemic, the vaccination intra-action review (IAR) methodology was developed and recommended.[40] IARs were conducted by many countries, and this method could be adapted to assess the malaria vaccine roll-out rapidly for early identification of issues that need to be corrected. IARs consist of a desk review and facilitated discussion involving key stakeholders that typically take place over two to three days. The discussion includes a standardized set of questions and reporting format. The process is flexible and can be repeated to focus on certain areas where a country is experiencing challenges.

Refer to the *WHO malaria vaccines* webpage for an example of a PIE questionnaire for the malaria vaccine (https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/malaria, accessed 17 June 2023).

For further guidance, see: New vaccine post-introduction evaluation (PIE) tool. Geneva: World Health Organization; 2010 (https://apps.who.int/iris/handle/10665/70436, accessed 17 June 2023).

9.4.2 National immunization programme reviews

NIP reviews are undertaken every 3–5 years and should be adapted to include malaria vaccine once it has been introduced. WHO methodology for conducting NIP reviews recommends integrating immunization-related programme assessments, where feasible, in order to promote efficiency. If a malaria vaccine component is to be included in the NIP review, the main objectives and knowledge gaps regarding malaria vaccine introduction should be considered at the desk review stage so that these issues can be addressed through specific lines of questioning that are included in the review tools.

Additional modifications may be required – such as interviews with NMCP and other key stakeholders or partners.

For further guidance, see: A guide for conducting an Expanded Programme on Immunization (EPI). Geneva: World Health Organization; 2017 (https://fctc.who.int/publications/i/item/a-guide-for-conducting-an-expanded-programme-on-immunization-(epi)-review, accessed 17 June 2023).

[40] Guidance for conducting a country COVID-19 intra-action review (IAR). Geneva: World Health Organization; 2020 (https://www.who.int/publications/i/item/WHO-2019-nCoV-Country_IAR-2020.1, accessed 17 June 2023).
Mini-cPIE (COVID-19 vaccination IAR): What is it and how to conduct one? Geneva: World Health Organization; 2021 (https://www.who.int/publications/m/item/mini-cpie-(covid-19-vaccination-iar)-what-is-it-and-how-to-conduct-one , accessed 17 June 2023).

9.4.3 Vaccination coverage surveys

Coverage surveys are useful for validating administrative data reported throughout the year. For the malaria vaccine, there will need to be consideration of phased and/or subnational introduction, as well as the timing of the survey compared to the start of routine age-based or seasonal vaccination.

For further guidance, see: WHO's Vaccination coverage cluster surveys: reference manual. Geneva: World Health Organization; 2018 (https://apps.who.int/iris/handle/10665/272820, accessed 17 June 2023).

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Finally, the lessons documented would not have been possible without the leadership and continuous uptake monitoring of the malaria vaccine pilot introduction by the Ministries of Health in Ghana, Kenya, and Malawi.

Appendix 1: Information on the malaria vaccine for health workers (for vaccine introduction and ongoing implementation activities)

For country adaptation (including **[X]**)

Take the time to interact with caregivers before vaccination

- Tell caregivers that their child is due for malaria vaccine and provide information about why it is important for their health.
- As with other vaccines, treat fathers, mothers and other caregivers with respect.
- Ask if there are questions or concerns and take the time to respond.

The malaria vaccine reduces the number of times a child gets malaria and therefore saves lives

- Malaria is a serious disease that can kill young children.
- The malaria vaccine is safe and effective.
- The malaria vaccine reduces the number of times children get malaria, including severe malaria, and it reduces child deaths.
- The malaria vaccine is a recommended form of protection against malaria and is used as part of a malaria prevention package, which includes measures such as the use of insecticide-treated nets, perennial or seasonal malaria chemoprevention, and indoor residual spraying.
- Even after vaccination, children may still become sick with malaria. Caregivers should seek prompt malaria testing and treatment for a child with fever.

Four (4) doses of the malaria vaccine = the best protection

- Children benefit most when they receive all four doses of the malaria vaccine.
- Children get the first dose from **[X]** months of age.
- The schedule is **[X]**months, **[X]**months, **[X]** months and **[X]** months. As with other vaccines, children who come late for doses should still receive the dose they are due.
- The minimum period between vaccine doses is 4 weeks.
- Remember to screen the child at every contact for other vaccines that are due and check whether the child is due for vitamin A or deworming.

The Ministry of Health has introduced the malaria vaccine into routine immunization

- [IF APPLICABLE] The vaccine is given in the following **[districts/regions/counties]: _____]**
- [IF APPLICABLE] The malaria vaccine is initially being introduced here as part of a phased introduction because children in this area are at very high risk of getting malaria. Vaccine delivery will be expanded to other areas.
- The malaria vaccine is free of charge and is given to children to provide them with added protection against malaria.

As with other vaccines, side effects are possible

- Common side effects include pain, redness and swelling at the injection site, and fever.
- Sometimes there is an uncommon side effect; some children who get fever after vaccination can have convulsions.
- Children with any concerning side effects in the days after immunization should be brought to the health facility.
- As with other vaccines, new clinical signs following immunization should be properly documented and reported through the existing reporting systems for adverse events following immunization (AEFIs).

Take time after the vaccination to remind caregivers when to return to the health facility

Appendix 2: Key messages for health workers to deliver to caregivers about malaria vaccination (for country adaptation)

"Triple A" communication: Advise – Alert – Arrange

ADVISE	**Advise on the malaria vaccine and schedule*** The malaria vaccine is safe and effective. For the best protection a child should receive all four vaccine doses: • A child receives the first dose from **[X]** months of age. • The recommended schedule is **[X]** months, **[X]** months, **[X]** months and **[X]** months. • Remind caregivers that the child will need a fourth dose at around **[X]** months to prolong the protection. Children who come late for doses should still receive their vaccination. The minimum period between doses is 4 weeks. The malaria vaccine is initially being introduced here as part of a phased introduction because children in this area are at high risk of getting malaria. Vaccine delivery will be expanded to other areas as supply increases. [IF APPLICABLE]
	Advise on other vaccinations and health services that are due Check the child's home-based record; inform caregivers of other health services that are due such as: • other vaccinations, including late vaccinations; • growth monitoring; • vitamin A; • deworming.
ALERT	**Alert on side effects** Common side effects are fever, irritability, and injection site pain and swelling. An uncommon side effect was febrile seizures, which can occur within 7 days after vaccination. Remind caregivers to return to the nearest health facility if they notice any side effects (even those not listed here).
	Alert on malaria prevention The malaria vaccine reduces the number of times a child gets malaria and saves lives. The vaccine is part of a recommended malaria prevention package that includes other preventive measures such as [insecticide treated nets, perennial or seasonal malaria chemoprevention, and indoor residual spraying [for country adaptation]. A child who receives the vaccine may still become sick with malaria, so it is important to seek prompt diagnosis and treatment for a child with fever.

ARRANGE	**<u>Arrange</u> for the next visit to ensure completion of four-dose schedule** Write on the home-based record the date of the next visit to receive the malaria vaccine along with other vaccines (and child health services) according to the immunization schedule. • The next visit should correspond to the schedule or, if the child is late for vaccination, wait at least 4 weeks before administering the next malaria vaccine dose. • Ensure that there is a vaccination session on the date of the next dose (i.e. no public holiday, weekend etc.). • Inform caregivers when to return with their child <u>and the child's home-based record.</u> Reminders to caregivers: • Visit the health facility monthly to have their child weighed and examined, and to receive all needed vaccines and child health services. • To get the best protection children should receive all four vaccine doses. Specifically remind caregivers that the fourth dose will be given at **[X]** months.

* For countries with seasonal delivery of doses, refer to the *WHO malaria vaccines webpage* for adapted materials and messaging (https://www.who.int/teams/immunization-vaccines-and-biologicals/diseases/malaria, accessed 17 June 2023).

Appendix 3: Example planning checklist of activities to introduce, deliver and integrate the malaria vaccine in national immunization programmes

Category	Potential activity	Opportunities for integration
Planning and coordination	• TWG/National coordination committee/task force meetings • Subcommittee meetings • Joint meetings with EPI-ICC and NMCP-ICC • Orientation to district task force committees • District-level microplanning • Planning and budgeting meetings • Stakeholder meetings.	**National strategic plans and budgets** of both immunization and malaria programmes include the malaria vaccine. **TWG** membership includes a broad range of stakeholders for key input and buy-in, including NIP, NMCP, other relevant MoH departments (e.g. MCH), NRA and other partners/ organizations (civil society organizations, academia, technical assistance partners etc.).
Training	• Training materials development workshops • Printing of training kit books (slideshow) • Readiness assessment for national-level facilitators (orientation) • Training of national-level trainers, regional or subcounty-level trainers, health workers • Community health worker training/ meeting • Follow-up training for health workers and supportive supervision • Training of health workers for periodic intensification of routine immunization.	**Cascading trainings:** involve other MoH departments (NMCP, MCH etc.) and the NRA in development of materials and conduct of training; combine training with other NIP activities (such as another vaccine introduction); provide training opportunities for community health workers and other personnel not directly involved in immunization sessions who will engage the community, identify and track defaulters, or refer for vaccination. **Key messages, training and job aids for health workers:** explain how visits align with other antigens or health services, and provide additional opportunities for catch-up.
Community engagement and sensitization	• Regional-level stakeholder engagement • District level: district health management team, assemblies, stakeholder engagement, executive committees • Sensitization of community leaders and religious leaders • Local leader orientation • Community health workers sensitization meeting • Peer education training of trainers • Orientation sessions for local leaders and peer education volunteers • Interactive quizzes to share over messaging platforms • Social announcements (regional and district levels)	**Key messages, sensitization, and materials for caregivers:** inform and/or remind caregivers about the malaria vaccine in the context of the broader immunization schedule, health services in second year of life, and malaria prevention messages. **Engage community health workers** in training sessions and incentivize volunteers as important link between health facilities and communities to include the malaria vaccine in awareness-spreading and messaging, and defaulter tracing for all vaccines and other health interventions, such as vitamin A and deworming.

Category	Potential activity	Opportunities for integration
	• District-level house-to-house sensitization • Communication with stakeholders (to support vaccination) • Press release in newspapers, public address system, airing of messages at radio stations, community centres and mobile vans • Launch event, including VIP luncheon, pre-launch media/stakeholder workshop, visibility items such as banners, branded t-shirts etc. • Public education at community information centres	**Support high uptake** of all recommended vaccines and malaria preventive measures (e.g. through the establishment of community sessions, social mobilization, media engagement, mop-up campaigns, PIRI, defaulter tracing); utilize community health workers and outreach facilities; plan dose 4 uptake activities in advance as part of the second year of life platform.
Transport	• Distribution of vaccine between cold stores (national to regional to district/county level/health facility).	**Bundle distribution** of vaccine and/or supplies with recording and reporting tools, IEC materials etc.
Supplies	• Two-dose vials • 2 mL reconstitution syringes • 0.5 mL auto-disable injection syringes • Safety boxes (100-syringe capacity) • Printing of training kit books (decks).	
Cold chain and waste management	• Vaccine fridge • Cold boxes • Incinerators • Spare parts.	**Conduct EVM and identify overall needs** for health-system strengthening.
Monitoring and evaluation (M&E)	• Development of recording and reporting materials • Printing of monitoring charts, tally books, reporting forms, under-2 registers, defaulter tracing registers and other tools • Distribution of monitoring tools • Pre-introduction assessments at national, regional and district/county levels • Post-introduction supportive supervision by national, regional and district/county levels • Review meetings at health facility and district levels to validate and reconcile EPI data • Mapping of unvaccinated and under-immunized children • Home visits and defaulter tracing • Periodic intensified routine immunization • Mop-up vaccination campaigns • Monthly outreach to hard-to-reach areas • DHIS2 coordination and data analysis • Post-introduction coverage surveys Post-introduction evaluation.	**Incorporate the malaria vaccine in existing permanent recording and reporting tools** and HMIS reporting (rather than stand-alone tools or stickers); ensure that updated tools are made available in health facilities prior to introduction; confirm tools are not restricted by age group (i.e. the under-2 register may not have a place to record children presenting after 2 years of age for dose 4) and will track defaulters beyond the second year of life for all health services due; involve other MoH departments (e.g. MCH) in M&E sub-committee. **Consider how best to streamline supportive supervision across all recommended vaccines** through consolidated checklist or coordinated visits. **Combine evaluation activities** across all recommended vaccines (e.g. post-introduction evaluations, coverage surveys).

Category	Potential activity	Opportunities for integration
Communication	• Finalization of plan and planning meetings • Message and IEC material development, validation, pre-testing, and translation • Printing of communications materials and field guides • Spokesperson training • Stakeholder engagements at national, regional, and district/county levels.	**World Malaria Day and World Immunization Week** coincide every April and provide an excellent opportunity to promote malaria control interventions – including the malaria vaccine – and to draw attention to the vaccine schedule and key messages.
AEFI surveillance	• Identify areas for AEFI surveillance system strengthening.	**Incorporate AEFI module** into health-worker training and supervisory sessions.

Adapted from: Cost of introducing and delivering RTS,S/AS01 malaria vaccine within the malaria vaccine implementation program. Baral R, Levin A, Odero C, Pecenka C, Bawa JT, Antwi-Agyei KO et al. Vaccine. 2023;41(8):1496–1502. (https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9946791/, accessed 17 June 2023). Note: Line items for activities conducted in the first 2 years of vaccine implementation to introduce and deliver the RTS,S/AS01 malaria vaccine within routine immunization programmes in subnational areas of the malaria vaccine pilot countries: Ghana, Kenya and Malawi.

Appendix 4: Sample supportive supervision questions
*To be adapted by country

Topic area	Supervisory questions on issues particularly relevant to malaria vaccine
Service delivery	1. Are reporting and recording tools available at the facility with spaces for all four doses of the malaria vaccine? 2. What is the schedule of the malaria vaccine? 3. Who is eligible for the malaria vaccine? 4. Does this health worker know the guidance on late malaria vaccination when doses are delayed? *Example scenarios: What would the health worker do? What advice will the health worker provide to complete the remaining doses?* a. A 7-month-old * comes for the first dose of malaria vaccine today. b. A 17-month-old * who has received two doses of the malaria vaccine comes for the third dose today. 5. Did the health worker screen for all vaccinations or health services due at today's session? 6. Did the health worker include the date for the next dose in the child's home-based record?
Key messages/ interactions between health worker and caregiver	1. Did the health worker have the knowledge and skills to share clear messages about malaria vaccines with caregivers and respond to any related questions or concerns? *Topics include :* *a. To get the best protection, children should receive all four doses.* b. *A child may still become sick from malaria after vaccination; it is therefore important to continue other preventive measures for malaria, including sleeping under an ITN and seeking care for a child with fever.*
Community engagement	1. Are tools and materials for malaria vaccine communication and community engagement available? *(If yes, ask to see to confirm and indicate which materials are available).* 2. In the past 3 months, have community engagement activities been carried out (e.g. social announcements, facility health talks, community meetings)? *(If yes, please provide details; If no, please explain why).* 3. Have any rumours or misinformation been detected about the malaria vaccine? *(If yes, please describe along with any response).* 4. Have there been any refusals of the malaria vaccine? *(If so, why?)* 5. What demand promotion and communication activities are taking place to: a. follow up with children who are behind on their malaria vaccinations? b. raise awareness about the fourth dose?

Appendix 5: malaria vaccine stakeholder engagement plan example (not exhaustive)

Audience	Messages	Examples of activities or channels	Examples of materials	Example activities from pilot introductions
Health workers	Malaria vaccine schedule, including the importance of the fourth dose; age eligibility; screen for all child health interventions at each visit (minimize missed opportunities); benefits and risks of vaccination; continued use of other malaria prevention tools; AEFI reporting	Cascade training Supportive supervision Group training sessions and refreshers Text messages; email; telephone applications	Training plan Training modules to reference afterwards Job aids Posters Short videos Interactive quizzes	Health worker training was close to start of vaccinations and included updated job aids and information tools. In addition to health workers, training included health assistants and community health workers involved in community engagement activities, defaulter tracking. Short SMS/texts to health workers and their supervisors with key messages and reminders about malaria vaccination. Short training videos for the telephone, training and supervisory sessions, to improve understanding of the four-dose schedule and key topics. Interactive quizzes to take online, on the telephone, or in group training sessions to probe various scenarios on age-eligibility or missed opportunities for vaccination.
Caregivers	Benefits of vaccine and what to expect; importance of malaria vaccine and schedule; use of vaccine with other available prevention tools; seek care for fever; visit health facility monthly to have child weighed and examined	Peer education – interactive health education session Educational entertainment (or edutainment) and key messages via radio, television, social media Community meetings Reminders via community health workers, messaging platforms or telephone calls	Leaflets, posters with graphics Radio jingles and drama	Wide circulation of IEC materials in local languages. Community health information programmes with local radio. Community meetings.
Community leaders	Encourage caregivers; benefits of vaccine; generate support and champions; integrate with childhood vaccination schedule and malaria prevention package	Advocacy meetings for traditional leaders	Brochures Leaflets	Prior to start, invitation sent to local chiefs and opinion leaders to hear about the vaccine and ask questions. Early engagement to explain the phased and/or subnational introduction to communities – the reason for the approach, the vaccine's benefits and the intention to expand access to

Audience	Messages	Examples of activities or channels	Examples of materials	Example activities from pilot introductions
	May require more targeted messaging (e.g. if phased or subnational)			neighbouring areas. This helped ensure adequate buy-in and averted negative reactions from those areas not initially participating in vaccine roll-out.
Government/ politicians/ subnational health authorities (local, district, regional/provincial/ county)	Benefits of vaccine toward achieving public health objectives; generate support and build champions; reminder of vaccine schedule; integration with the national immunization schedule, malaria prevention, and other childhood interventions Advocate for resources to effectively deliver vaccine; generate support for vaccine *May require more targeted messaging (e.g. if subnational or phased)*	Technical discussions Briefings Spokesperson orientations	Brochures Leaflets FAQ	Prior to start, technical discussion on the malaria vaccine with malaria and immunization partners Briefings of subnational health authorities such as regional coordination committees and health management teams at regional/district levels, and community orientations of district health management teams. Briefings of Parliament and/or relevant committees.
Medical professionals /scientists	Generate support for vaccine; clarify questions; build champions; endorse vaccine benefits and safety from medical and scientific perspective; refute misinformation	Briefings Conferences	FAQ	Prior to start, briefings at annual conferences or regular meetings of these organizations, academies, or associations; written responses provided to questions.
Professional, cultural, and religious leaders and organizations	Generate support for vaccine; clarify questions; build champions; understand benefits and safety of vaccine; rationale for vaccine introduction (including if subnational and/or phased); continued use of malaria prevention measures; refute misinformation	Briefings Conferences	FAQ Leaflets Brochures	Prior to start, briefings by programme experts on the malaria vaccine to present information and answer questions at annual conferences and/or in response to queries.
Media (local, national, international) and journalists	Generate support for vaccine; promote accurate information sharing of key messages and information	Brochures; media breakfasts; press briefings and media releases; newspaper announcements; visits to vaccinating areas	Brochures Information packages	Media sensitization events (e.g. journalist briefing, media breakfast). Media engagement at key milestones (i.e. one year since start of vaccinations) or on major health recognition days/week (World Malaria Day, African Immunization Week). Tours of vaccinating health centres accompanied by MoH and key partners.