

Preparedness and resilience for emerging threats

Module 2: planning for arbovirus epidemics and pandemics

DRAFT

DRAFT FOR PUBLIC COMMENT

25 November 2025

© World Health Organization 2025. All rights reserved.

This is a draft. The content of this document is not final, and the text may be subject to revisions before publication. The document may not be reviewed, abstracted, quoted, reproduced, transmitted, distributed, translated or adapted, in part or in whole, in any form or by any means without the permission of the World Health Organization.

Please send any request for permission to: Global Arbovirus Initiative, Department of Epidemic and Pandemic Management, World Health Organization, 1211 Geneva 27, Switzerland, email: GLIA@who.int.

The designations employed and the presentation of the material in this draft do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

The mention of specific companies or of certain manufacturers' products does not imply that they are endorsed or recommended by the World Health Organization in preference to others of a similar nature that are not mentioned. Errors and omissions excepted, the names of proprietary products are distinguished by initial capital letters.

All reasonable precautions have been taken by the World Health Organization to verify the information contained in this draft. However, the printed material is being distributed without warranty of any kind, either expressed or implied. The responsibility for the interpretation and use of the material lies with the reader. In no event shall the World Health Organization be liable for damages arising from its use.

This draft does not necessarily represent the decisions or the stated policy of the World Health Organization.

Contents

Contents	iii
Foreword	vi
Abbreviations.....	vii
Glossary	viii
Executive summary.....	x
Organization of the PRET documents	xi
1 Introduction.....	1
1.1 Preparedness and Resilience for Emerging Threats (PRET) as a global initiative	1
1.2 Arbovirus epidemics	1
1.3 Purpose of the module	2
1.4 Scope of the module.....	2
1.5 What's new in this module?.....	3
1.6 Target audience	3
2 Context for arbovirus epidemic and pandemic preparedness.....	4
2.1 Timeline of arbovirus epidemics from 1970 to 2025.....	4
2.2 Global and regional initiatives for arbovirus epidemic and pandemic planning	6
2.3 National plans for arbovirus epidemics	7
2.4 Guiding principles	9
2.5 Multisectoral interdependencies	9
2.6 Health policy and planning context.....	10
2.7 Challenges posed by arboviruses	11
2.7.1 Arboviruses	11
2.7.2 Modes of transmission and transmission cycles	17
2.8 Epidemiological parameters for arbovirus transmission	20
2.8.1 Vulnerable groups.....	24
2.8.2 Disease severity and impact of arbovirus epidemics and pandemics	24
2.9 Technical implications for arbovirus epidemic and pandemic planning	26
3 Organizing framework for arbovirus epidemic and pandemic planning	30
3.1 Foundation for arbovirus epidemic and pandemic preparedness and response.....	30
3.2 Arbovirus epidemic and pandemic surveillance and risk assessments	30
3.3 Periods and operational stages	31
4 System components for arbovirus epidemic and pandemic preparedness	37

4.1	Emergency coordination	37
4.1.1	Policy, legal and normative instruments	37
4.1.2	Coordination	37
4.1.3	Financing	37
4.1.4	Human resources	37
4.2	Collaborative surveillance.....	38
4.2.1	Surveillance	38
4.2.2	Laboratory.....	39
4.3	Community protection.....	40
4.3.1	Public health and social measures	40
4.3.2	Vector control measures	40
4.3.3	Risk communication and community engagement.....	43
4.3.4	Points of entry and border health.....	44
4.4	Clinical care	44
4.4.1	Health services provision	45
4.4.2	Infection prevention and control in healthcare facilities.....	45
4.5	Access to countermeasures.....	46
4.5.1	Health emergency management.....	46
5	Implementing arbovirus pathogen epidemic and pandemic preparedness	50
5.1	Approaches to strengthen preparedness	50
5.2	What to do when: the focus of actions during different periods	51
6	Monitoring in arbovirus pathogen epidemic and pandemic preparedness.....	55
6.1	Monitoring relevant International Health Regulations (2005) core capacities.....	55
6.2	Monitoring functional arbovirus pathogen epidemic and pandemic preparedness planning.....	55
7	Research in arbovirus epidemic and pandemic preparedness.....	58
7.1	Building a strong research ecosystem for arbovirus preparedness	58
7.2	Strengthening research systems and networks	59
7.3	Leveraging advances in technology	60
8	Suggested outline for a national arbovirus pathogen epidemic and pandemic preparedness plan ⁶¹	
8.1	Essential steps in pandemic planning.....	61
8.2	Suggested outline for a national arbovirus epidemic and pandemic plan	61
9	References	71

Annexes.....	80
Annex 1: Methods for developing this module	80
Annex 2: Methodology for the development of the timeline of arbovirus epidemics from 1970 to 2025	81
Annex 3: Methodology for the Analysis of National Plans for Arbovirus Epidemics	82
Annex 4: Examples of critical interdependencies between health and other sectors for arbovirus epidemic and pandemic preparedness.....	84
Annex 5: Data often collected at local administrative offices that can support arbovirus epidemic and pandemic preparedness	86
Annex 6: Country and regional examples and technical resources to support implementation of arbovirus epidemic and pandemic preparedness planning.....	88
Annex 7: Examples of assumptions in the national planning process	91
Annex 8: Examples of triggers for transitioning between operational stages for pandemic preparedness and response.....	93

Foreword

DRAFT

Abbreviations

EYE	Eliminate Yellow Fever Epidemics
GLAI	Global Arbovirus Initiative
GVCR	Global Vector Control Response
HEPR	Health Emergency Preparedness, Response and Resilience
IHR	International Health Regulations
MCM	Medical countermeasures
PHEIC	Public Health Emergency of International Concern
PRET	Preparedness and resilience for emerging threats
RELDA	Red de Laboratorios de Diagnóstico de Arbovirus (The Arbovirus Diagnosis Laboratory Network of the Americas)
TAG	Technical Advisory Group
WHO	World Health Organization

Glossary

Access to countermeasures: ensuring equitable access to countermeasures through fast-tracked and prioritized research and development with pre-negotiated benefit-sharing agreements, scalable manufacturing platforms and agreements for technology transfer, and coordinated procurement and emergency supply chains (1).

Arbovirus (arthropod-borne virus): virus transmitted by an arthropod vector, including mosquitoes, ticks and sandflies.

Autochthonous arthropod-borne transmission: transmission of an arbovirus that occurs within a given geographic area (i.e., locally) rather than imported from elsewhere. This contrasts with disease importation whereby an individual contracts the disease outside the given area and introduces it locally, with potential for onward autochthonous arthropod-borne transmission if competent vectors are present.

Capacity: combination of all the strengths, attributes and resources available within an organization, community or society to manage (2).

Clinical care: providing lifesaving and scalable clinical care, protection of health and care workers and patients, and health systems that can maintain essential health services (1).

Collaborative surveillance: the systematic strengthening of capacity and collaboration among diverse stakeholders, both within and beyond the health sector, with the ultimate goal of enhancing public health intelligence and improving evidence for decision-making (1).

Community protection: community-centred actions that protect the health and wellbeing of those affected, such as vaccination to protect from an infectious disease (1).

Emergency: a type of event or imminent threat that produces or has the potential to produce a range of consequences, and which requires coordinated action, usually urgent and often non-routine (2).

Emergency coordination: developing coherent national action plans for preparedness, prevention, risk reduction and operational readiness and scalable health emergency response coordination through a standardized and commonly applied emergency response framework (1).

Endemic: the constant presence or usual occurrence of cases of a particular illness, specific health-related behaviour, or other health-related events within a community or region, typically at a predictable and stable level.

Epidemic: the occurrence, in a community or region, of cases of an illness, specific health-related behaviour, or other health-related events clearly in excess of normal expectancy (2).

Local transmission: continuous spread of cases within a defined community or region. The transmission cycle is self-sustaining and does not rely on imported cases to persist.

One Health: having an integrated, unifying approach that aims to sustainably balance and optimize the health of people, animals and ecosystems. It recognizes that the health of humans, domestic and wild animals, plants and the wider environment including ecosystems are linked (3).

Pandemic emergency: a public health emergency of international concern caused by a communicable disease which (i) has, or is at high risk of having, wide geographical spread to and within multiple States, and (ii) is exceeding or is at high risk of exceeding, the capacity of health systems to respond in those States; and (iii) is causing, or is at high risk of causing, substantial social and/or economic disruption, including disruption to international traffic and trade; and (iv) requires rapid, equitable and enhanced coordinated international action, with whole-of-government and whole-of-society approaches (4).

Pandemic plan: A living document that describes the actions needed during a pandemic (i.e., response) and the actions needed during the interpandemic period to ensure a quality response (i.e., preparedness)

Preparedness: having the knowledge, capacities, and systems that work to reduce vulnerability and enhance resilience (5).

Public health emergency of international concern: an extraordinary event which is determined, to constitute a public health risk to other States through the international spread of disease and to potentially require a coordinated international response (6).

Resilience: the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (7).

Response: any public health action triggered by the detection of a public health risk.

Widespread community transmission: spread of cases across multiple communities or geographic areas, transitioning from localized clusters to widespread transmission within and between regions.

Whole-of-government: having a collaborative effort by different government ministries and agencies to public service delivery.

Whole-of-society: having a collaborative effort by different government ministries and agencies, businesses and civil society.

Executive summary

There are more than 500 recognized arthropod-borne viruses (arboviruses), with at least 150 known to cause human disease (8). In recent decades, arboviruses have posed growing global public health challenges due to their increasing incidence and expanding geographic reach. For instance, global dengue cases rose by 123% between 1990 and 2021 (from 26.5 million to 59 million) and in 2024 alone, over 14 million cases, including 52,199 severe cases and 10,554 deaths, were reported to WHO (9).

Multiple factors are driving this trend, including environmental changes (e.g. deforestation, habitat disruption, climate change), vector-related dynamics (e.g. insecticide resistance, changing distribution), viral evolution, human mobility, and socioeconomic vulnerabilities such as poor-quality housing and inadequate sanitation. As a result, arboviruses are expected to continue causing large-scale regional epidemics that may potentially expand into a pandemic.

While many countries have implemented control programmes for certain arboviruses, fewer than 20% have adopted integrated, multisectoral approaches capable of addressing the full range of arboviral threats. This gap is particularly concerning in areas with co-circulating arboviruses, where fragmented systems weaken surveillance, vector control, and response. Strengthening preparedness through harmonized, cross-cutting strategies can enhance efficiency and build long-term resilience.

This module, developed in line with the WHO Preparedness and Resilience for Emerging Threats (PRET) initiative, provides practical guidance to help countries prepare for known arboviruses, neglected or emerging threats, and potential unknown pathogens (“Arbovirus X”). It is intended for multisectoral stakeholders at national, subnational, regional, and global levels involved in arbovirus epidemic and pandemic preparedness and response planning. The module has three core objectives:

1. Guide countries and partners in developing or updating integrated plans for arbovirus epidemic and pandemic preparedness to enable equitable and effective responses.
2. Recommend actions to enhance preparedness and response for arbovirus epidemics and pandemics, in alignment with the International Health Regulations (IHR, 2005) core capacities.
3. Offer an organizing framework, actionable steps, and an outline to guide the development and implementation of arbovirus preparedness and response plans.

By taking early, coordinated, and integrated action, guided by this module, countries can strengthen their preparedness for arbovirus epidemics and pandemics, protect vulnerable populations, and build resilient systems capable of responding to both known and emerging threats.

Organization of the PRET documents

As of 2025, the PRET approach comprises three core technical documents that guide epidemic and pandemic planning:

- “Getting started with pandemic planning”: This foundational document explains the rationale for pandemic planning (“Why”) and outlines general principles and approaches (“What” and “How”) that are applicable across the different modes of transmission.
- “Module 1: Planning for respiratory pathogen pandemics”: This Module presents key themes and planning considerations to guide stakeholders in strengthening preparedness for epidemics and pandemics caused by respiratory pathogens.
- “Module 2: Planning for arboviral pathogen epidemics and pandemics”: This Module presents key themes, planning considerations and guidance to support stakeholders in strengthening preparedness for epidemics and pandemics caused by arboviral pathogens.

Throughout this document:



This symbol indicates actions to strengthen preparedness.

(SYMBOL?) This symbol indicates information provided in the “Getting Started” document



This symbol is used to signpost related documents.



Click on the arrows throughout this document to navigate across sections.



Chapter 1: Introduction

Chapter 2: Context for arbovirus epidemic and pandemic preparedness

1 Introduction

1.1 Preparedness and Resilience for Emerging Threats (PRET) as a global initiative

The Preparedness and Resilience for Emerging Threats (PRET) initiative introduces an innovative and forward-thinking approach to enhance epidemic and pandemic preparedness. It recognizes that the same systems, capacities, knowledge, and tools can be leveraged across groups of pathogens based on their modes of transmission (such as respiratory, arthropod-borne, or foodborne) (10).

The first module of the PRET initiative, launched in April 2023, focused on planning for respiratory pathogen epidemics and pandemics. The second module builds on this foundation, focusing on planning for arbovirus epidemics and pandemics. In alignment with the International Health Regulations (2005) and the global framework for health emergency prevention, preparedness, response, and resilience (HEPR), this module draws on evidence-based shared learning and collective action from previous arbovirus (Arthropod-borne virus) outbreaks and large-scale epidemics. It promotes a whole-of-government and whole-of-society approach to strengthen coordinated preparedness and response efforts.

Designed as a living document, this module will evolve over time, integrating emerging evidence, data, technical resources and lessons learned through its implementation.

See the [Getting Started with Pandemic Planning](#) document, Section X for more information on the PRET initiative (ref)

1.2 Arbovirus epidemics

Arboviruses are a diverse group of viruses from several viral families, all transmitted by arthropods including mosquitoes, ticks, midges and sand flies. These viruses pose significant and growing public health challenges worldwide. Over the past two decades, arbovirus epidemics have markedly increased (Figure 1). Considering *Aedes*-borne arboviruses as an example, an estimated 5.66 billion people (7 in 10 globally) live in areas at risk of dengue, chikungunya, and Zika, spanning 169 countries (11). Similarly, about 1.54 billion people (2 in 10 globally) are at risk of yellow fever, primarily in 54 countries across South America and Africa (11).

Several factors are driving the rising incidence of arboviral diseases and the escalating frequency and scale of arbovirus outbreaks. These include environmental factors (climate change, deforestation, natural disasters), vector factors (changes in vector distribution, vector adaptation, insecticide resistance), viral factors (evolution, mutation), human factors (globalization and travel, population growth and uncontrolled rapid urbanization), and socioeconomic factors (poor housing and sanitation) (12). Given this trajectory, arboviruses are expected to continue causing widespread large regional epidemics and may even cause a pandemic. Despite the awareness of these driving factors, some are harder to quantify or forecast, and outbreaks can be unpredictable. For example, the unexpected geographical expansion of Oropouche virus in the Americas, among

immunologically naïve populations, caused more than 10,000 cases in 2024 alone and raised concerns about previously unappreciated sequelae of infection (13). Arboviruses are therefore likely to continue causing widespread large regional epidemics and may even cause a pandemic.

Arbovirus epidemics pose severe challenges to both individual health and healthcare systems. Clinically, these diseases range from asymptomatic or mild infections to severe acute illness, chronic complications, and death. These epidemics often overwhelm healthcare systems, straining human resources, infrastructure, and medical supplies.

Beyond the health sector, arbovirus epidemics have profound socioeconomic consequences, and the true cost of their impact is likely underestimated. Economically, they have been shown to reduce productivity due to illness and costly emergency responses, straining national budgets and slowing economic growth (14–16). Socially, arbovirus epidemics exacerbate inequalities, disproportionately affecting communities that lack the resources for effective response and recovery (17).

Arbovirus transmission cycles are influenced by multiple interacting factors. These, together with factors increasing vulnerability to disease and sequelae underscore the need for proactive, integrated and comprehensive public health strategies at the individual, community, national, regional, and global levels. The PRET initiative offers a valuable framework for harmonizing preparedness efforts across multiple arbovirus pathogens and across societal sectors. By leveraging routine systems, the PRET approach can improve efficiency, build capacities, and address both known threats and potential emerging pathogens (“Arbovirus X”). This coordinated strategy represents an opportunity to strengthen global resilience and reduce the burden of arboviral diseases on health systems, economies, and societies.

1.3 Purpose of the module

The objectives of this module are to:

1. Guide countries and partners in developing or updating integrated plans for arbovirus epidemic and pandemic prevention and preparedness to enable equitable and effective responses.
2. Recommend actions to enhance preparedness and response for arbovirus epidemics and pandemics, in alignment with the International Health Regulations (IHR, 2005) core capacities.
3. Offer an organizing framework, actionable steps, and an outline to guide the development and implementation of arbovirus preparedness and response plans.

1.4 Scope of the module

This module addresses preparedness and response planning for arboviruses transmitted by a range of arthropod vectors including mosquitoes, ticks, and sandflies. While much of the global disease burden is attributable *Aedes*-borne arboviruses such as dengue, chikungunya, Zika, and yellow fever, this module equally recognizes the significant threats posed by other mosquito-borne arboviruses (e.g., West Nile virus, encephalitic alphaviruses), tick-borne viruses (e.g., tick-borne

encephalitis, Crimean-Congo hemorrhagic fever) and sandfly-borne viruses (e.g., some bunyaviruses). Examples throughout the document often highlight mosquito-borne arboviruses due to their widespread incidence, risk of epidemic transmission and associated health impacts. However, the planning principles, frameworks, and recommended actions are intended to apply across all arbovirus threats, including those not yet recognized or fully characterized (“Arbovirus X”).

1.5 What’s new in this module?

This module represents a comprehensive, forward-thinking approach to arbovirus epidemic and pandemic preparedness, ensuring countries are equipped to detect and respond to both current and future arbovirus threats. The module:

- Uses a mode of transmission approach to help countries and partners prepare for arbovirus epidemics, Public Health Emergencies of International Concern (PHEIC) and potentially, pandemics. This approach enables countries to create a core preparedness plan for a group of arboviruses with shared transmission patterns, including unknown threats like "Arbovirus X," while recognizing that some interventions should be tailored to specific arboviruses.
- Aligns with existing global and regional health frameworks such as IHR (2025), HEPR, Global Arbovirus Initiative (GLAI), Global Vector Control Response (GVCR) 2017 – 2030, Eliminate Yellow Fever Epidemics (EYE) strategy 2017 – 2026, providing harmonized actions that complement these initiatives.
- Provides an organizing framework with operational stages, triggers and assumptions that countries can use to structure arbovirus pathogen epidemic and pandemic plans
- Outlines methods to monitor and evaluate arbovirus preparedness, providing a stepwise approach and a detailed plan outline to facilitate implementation
- Highlights emerging technologies and strategies, including, novel vector control methods to address evolving vector resistance and distribution and community engagement strategies to build trust and foster collaboration for enhanced surveillance and response.

1.6 Target audience

This module is intended for a broad range of stakeholders within and beyond the health sector, involved in arbovirus epidemic and pandemic preparedness and response at the subnational (including local/municipal), national, regional, and global levels.

For a detailed list of stakeholders typically engaged in epidemic and pandemic planning, please refer to Section X of the [Getting Started with Pandemic Planning document](#) (ref).

In addition to those listed, it is essential to engage technical experts and institutions with specialized knowledge in arbovirus research, surveillance, and control. A multisectoral whole-of-government, whole-of-society approach is critical to ensure comprehensive and coordinated preparedness efforts.

2 Context for arbovirus epidemic and pandemic preparedness

This chapter outlines the historical timeline of some arbovirus epidemics, key global and regional preparedness initiatives, and the guiding principles that shape effective response. It highlights the complex nature of arboviruses, the multisectoral interdependencies involved in preparedness and response, and how these efforts align with broader health policy and planning frameworks. It also underscores the unique challenges posed by arboviruses, providing a foundation for a whole-of-society, whole-of-government approach to epidemic and pandemic preparedness.

2.1 Timeline of arbovirus epidemics from 1970 to 2025

Figure 1 highlights a non-exhaustive list of several major arbovirus epidemics since the 1970s. It clearly illustrates a growing trend: arboviruses have been expanding into new geographic areas and triggering larger, more frequent epidemics. For example, among *Aedes*-borne arboviruses, dengue has circulated for decades with steadily increasing incidence and numbers of countries reporting cases; over 14 million annual cases were reported in 2024 alone. Chikungunya outbreaks escalated in magnitude and global distribution from 2004 onwards, followed by Zika, with the first recognized outbreak transmission in the Western Pacific in 2007, and subsequent spread to the Americas less than a decade later, with concomitant recognition of adverse pregnancy and neurological disease outcomes. Non-*Aedes*-borne arboviruses have also demonstrated epidemiological shifts, such as the emergence of West Nile virus fever and neurological disease in the Americas following the introduction of lineage 1 virus in New York in 1999, followed by subsequent spread westwards across the country in subsequent years (18). These examples underscore the increasing global threat posed by arboviruses, one that is exacerbated by climate change, unplanned urbanization, the spread of vector populations into new areas, and increased human mobility.

Please refer to Annex 2 for details on the methodology used in developing this timeline.



Figure 1: Timeline of some major arbovirus epidemics from 1970 to 2025

2.2 Global and regional initiatives for arbovirus epidemic and pandemic planning

Effective epidemic and pandemic planning requires cross-border coordination through global, regional and national initiatives that promote collaboration, knowledge sharing, and resource mobilization to mitigate the risk posed by arboviruses. Such collaboration relies upon and should therefore seek to promote locally tailored responses that reflect ecological, epidemiological, cultural, political, and resource contexts to ensure interventions are practical and effective.

At the global level, frameworks such as the IHR (2005) and the HEPR provide a foundation for strengthening core capacities to detect, assess and respond to epidemics and pandemics, including those caused by arboviruses (1,19). Taking an integrated and coordinated approach, the Global Arbovirus Initiative (GLAI) builds a global coalition of countries and partners to lead pandemic preparedness for arboviruses (20). It fosters the optimal use of resources to achieve the greatest impact in areas with the highest arboviral burden and areas at risk of emergence of arboviruses. The GLAI connects programmes and strategies that target various aspects of arboviral disease preparedness and control, including (i) the Global Vector Control Response (GVCR) 2017–2030 strategy that implements actions to strengthen vector control through improved capacity, enhanced surveillance, better coordination and integrated action across sectors and diseases (21), and (ii) the Eliminate Yellow Fever Epidemics (EYE) strategy 2017 – 2026 (22). The EYE strategy aims to end yellow fever epidemics by 2026 by protecting at-risk populations, preventing international spread, and containing outbreaks rapidly. In addition, the Global Yellow Fever Laboratory Network, an international coalition, supports active national surveillance by routinely testing for yellow fever in endemic areas across Africa, the Eastern Mediterranean, and the Americas (23). These laboratories serve as frontline diagnostic hubs, playing a vital role in detecting yellow fever outbreaks.

At the regional level, contextual factors such as those relating to epidemiological dynamics, country capacities and priorities have necessitated tailored approaches to arbovirus epidemic and pandemic planning. Table 1 highlights the regional initiatives being implemented for arbovirus epidemic and pandemic planning.

Table 1: Regional initiatives for arbovirus epidemic and pandemic planning

Region	Initiatives for arbovirus epidemic and pandemic planning
African region	- West African <i>Aedes</i> Surveillance Network (24) - Global Yellow Fever Laboratory Network in Africa (23) - African Network on Vector Resistance (25)
Region of the Americas	- Integrated Management Strategy for Arboviral Disease Prevention and Control (IMS-Arbovirus) (26) - Arbovirus Diagnosis Laboratory Network of the Americas (RELDA) (27)
Eastern Mediterranean region	Establishing syndromic surveillance and event-based surveillance systems for Zika, dengue and other arboviral diseases (28)

European region

- Regional framework for surveillance and control of invasive mosquitoes and re-emerging mosquito-borne diseases (29)
- European Emerging and Vector-borne Diseases Network (EVD-Net) (30)
- European network for medical and veterinary entomology (VectorNet) (31)
- Emerging Viral Diseases-Expert Laboratory Network (EVD-LabNet) (32)

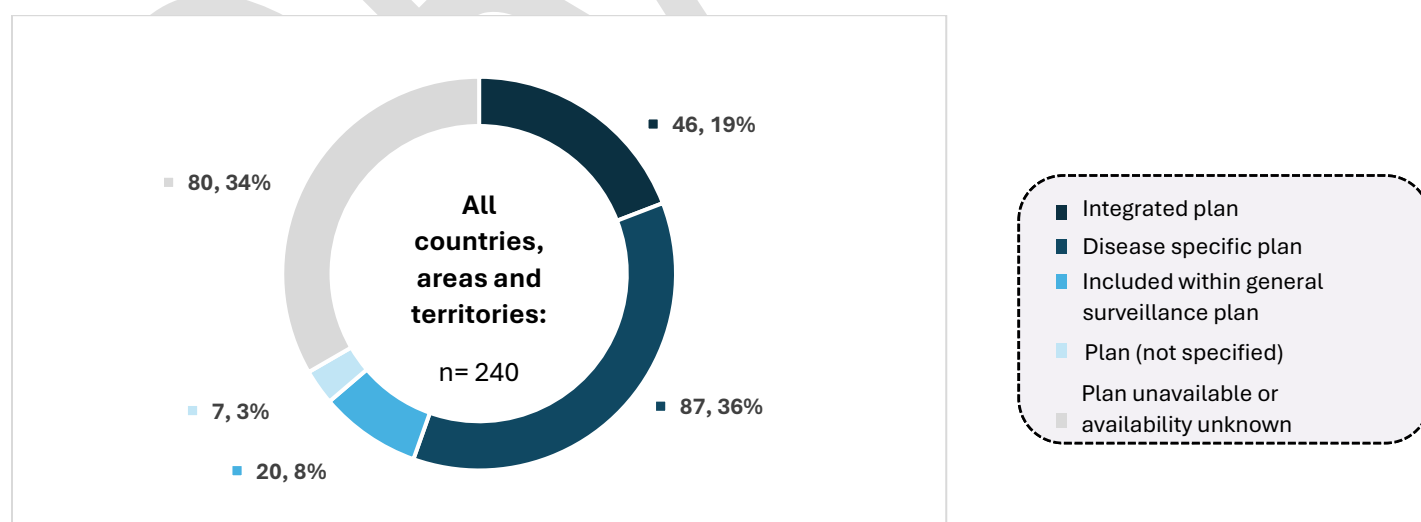
South-East Asia region

Western Pacific region

- United in tackling epidemic dengue (33)
- United in tackling epidemic dengue (33)
- Roadmap to Advance Dengue Prevention & Control in APEC Economies 2026 – 2030 (34)
- United Against Dengue' alliance to combat escalating threat of dengue (35)

2.3 National plans for arbovirus epidemics

As of December 2024, 66% of countries, areas and territories (160 out of 240 countries/areas/territories) reported having a plan, strategy, or guideline for arbovirus prevention and control. Among these, 19% (46 countries/areas/territories) have an integrated arbovirus plan, covering multiple arboviral diseases within a single framework; 36% (87 countries/areas/territories) have disease-specific plans, with at least one plan or guideline focused on a single arbovirus; and 8% (20 countries/areas/territories) include arboviruses within general surveillance plans, without dedicated arbovirus-specific documents (Figure 2).



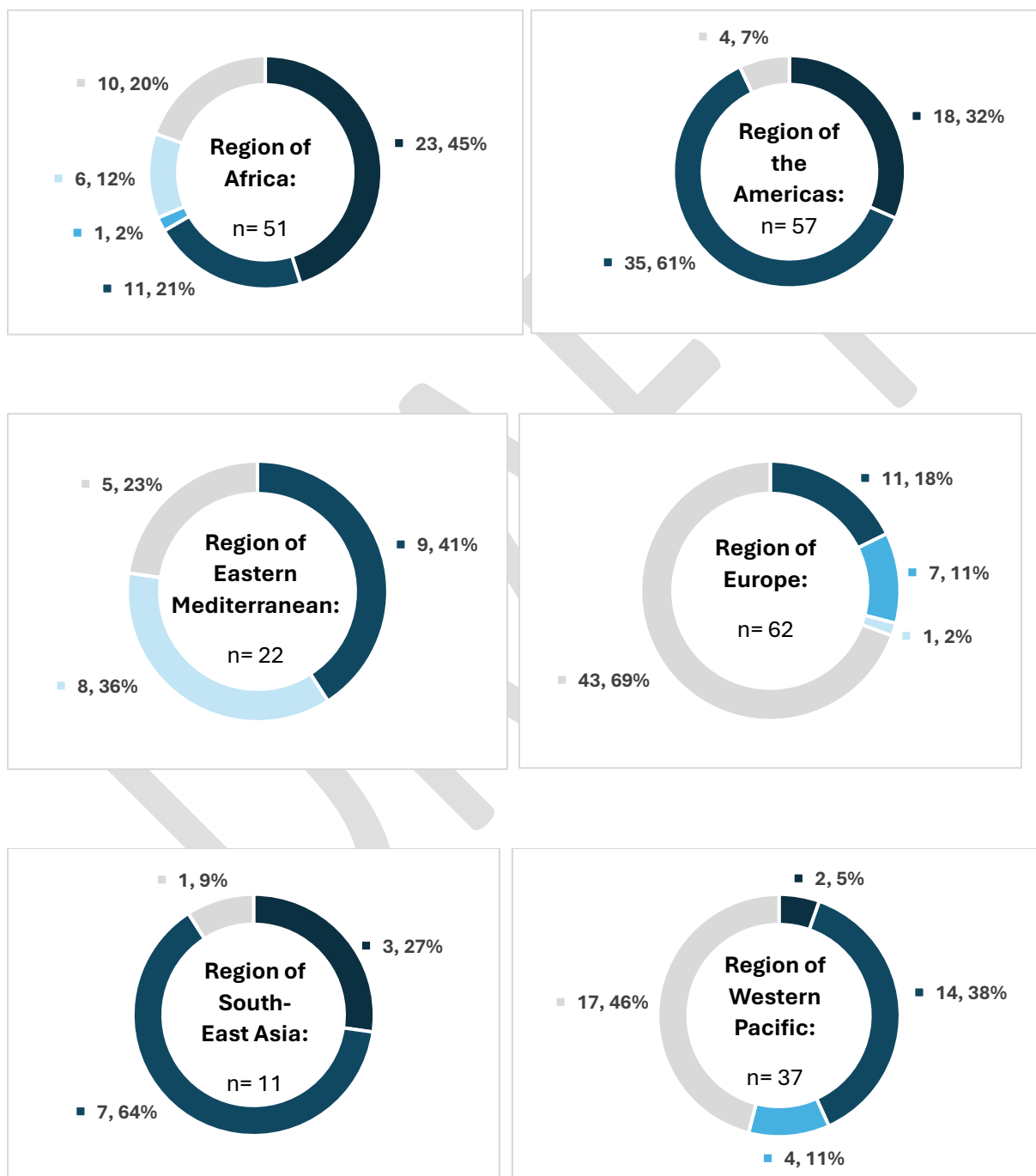


Figure 2: Availability of national arbovirus plans globally and by WHO Region

Source: WHO Regional Offices

Please refer to Annex 3 for the list of countries, areas and territories included in this analysis.

The deficit in integrated planning, applicable to 81% of responding countries, is especially critical in regions where multiple arboviruses co-circulate, as fragmented strategies may hinder effective surveillance, vector control, and outbreak response. Strengthening and sustaining integrated planning is essential for achieving coordinated, multisectoral preparedness that improves early detection, enhances resource efficiency, and reduces the burden on populations and health systems.

Although not all countries currently face a burden of arboviral diseases, the recent spread of arboviruses into previously unaffected areas underscores the importance of proactive planning. All countries are encouraged to adopt and maintain preparedness plans to address the rising and unpredictable threat of arboviral epidemics.

2.4 Guiding principles

Similar to other pathogens, the following principles guide the arbovirus epidemic and pandemic preparedness for effective response.

- Equity based on public health needs: protect all risk groups and ensure no one is left behind
- Inclusiveness: take a person and community centred approach
- Coherence: reduce fragmentation and competition to maximize trust and agility
- Equality and non-discrimination: prevent all forms of discrimination
- Evidence-informed decision-making: use data to inform policies, recommendations and decisions
- Forward-looking and transparent: take a transparent proactive approach to build and maintain trust
- Technical and financial sustainability: implement sustainable policies, resources and programmes
- Strengthening existing systems: leverage routinely used systems and capacities
- Continuous learning for improvement: routinely use lessons from research and experiences to strengthen planning

Learn more about these guiding principles in *Getting Started with Pandemic Planning* document, Section X (ref)

2.5 Multisectoral interdependencies

Arbovirus epidemics are driven by several complex factors outside the health sector. Therefore, the engagement of the non-health sector is key to ensuring coordinated, effective, and efficient preparedness and response to arbovirus epidemics and pandemics.

Multisectoral collaboration provides co-benefits that extend beyond arbovirus control to broader gains across health and non-health sectors. For instance, improving housing and sanitation through the cleanup of waste to reduce mosquito breeding sites not only lowers the risk of dengue

and other infectious diseases such as cholera, but also supports environmental sustainability. A practical example comes from community-based programmes that combine household waste management, composting of biodegradable waste, awareness campaigns on solid waste practices, and improved garbage collection supported by local authorities (36). Such initiatives reduce vector populations, foster environmental improvements, and strengthen partnerships between health, environmental, and municipal sectors.

In addition to multisectoral collaboration for preparedness, collaboration across administrative tiers of government is essential, with alignment of preparedness and response strategies from national to local/municipal level.

Box 1 outlines the sectors relevant to multilevel and multisectoral arbovirus epidemic and pandemic preparedness, recognizing the varying contexts and diversity in governance and operational structures.

Box 1: Sectors relevant for arbovirus epidemic and pandemic preparedness

Engaging the appropriate sectors and their relevant public, private, and humanitarian entities in arbovirus epidemic and pandemic preparedness is essential to saving lives and protecting livelihoods. Relevant sectors may include:

- Environment
- Food, agriculture and wildlife
- Urban planning and housing
- Education
- Economic and finance
- Transportation and logistics
- Travel and tourism
- Information, communication and technology
- Defense and security
- Critical manufacturing
- Dams
- Energy

Box 1: Sectors relevant for arbovirus epidemic and pandemic preparedness

For recommended priority actions to engage these sectors early in the planning process, refer to Section X of the *Getting Started with Pandemic Planning* document (ref)

Please refer to Annex 4 for practical examples of critical interdependencies between health sector and other sectors for arbovirus epidemic and pandemic preparedness

2.6 Health policy and planning context

Effective preparedness for arbovirus epidemics and pandemics requires integrating planning within the national health policy framework and embedding it into broader intersectoral governance

strategies. This approach enhances coordination, optimizes resource allocation, and strengthens the capacity of health systems to respond effectively to emerging threats. For maximum impact, national planning processes for emergency preparedness and response including for arboviruses, should align with the country's long-term health policies, as well as its budgeting and planning cycles.

Learn more about health policy and planning context for pandemic planning in Section X of the *Getting Started with Pandemic Planning* document, on (ref)

2.7 Challenges posed by arboviruses

2.7.1 Arboviruses

Arboviruses are a group of viruses from several families which share common transmission mechanisms through arthropod vectors. Table 2 shows examples of arboviruses with epidemic and pandemic potential. Human infection with these phenotypically different arboviruses commonly presents with similar clinical features, particularly in the initial days following symptom onset. Disease manifestations can include acute undifferentiated febrile illness, rash, musculoskeletal (including arthritic) pain syndromes, neurological disease, or haemorrhagic phenomena, depending on the infecting virus. Overlapping and nonspecific presentations pose challenges to clinical recognition of arboviral diseases and may lead to misdiagnosis.

Understanding the transmission dynamics of arboviruses and quantifying their burden can be challenging. Their transmission involves complex interactions between humans, vectors, and, for some viruses, non-human vertebrate reservoirs or hosts. Arboviruses can also evolve through various mechanisms including acquired mutations and reassortment, potentially increasing their virulence, host range, and transmissibility, which may lead to large-scale epidemics or pandemics (37). For example, the Oropouche epidemic in Latin America in 2024 extended unexpectedly beyond traditional areas of transmission and included newly recognized adverse sequelae; genetic sequencing and entomological research is underway to determine the drivers of this epidemiological shift (38).

Surveillance data often underestimate the true incidence of arboviral infections because of the large proportion of unrecognized asymptomatic or mild cases, frequent misdiagnosis due to nonspecific symptoms resembling common illnesses and limited surveillance capacity that is often constrained by inadequate diagnostic infrastructure. Although diagnostic assays exist for most arboviruses, their accessibility and utilization remain limited, and confirmatory testing is not available in many settings. Even when available, the limitations of diagnostic assays must be recognized. The typically short viremia seen in humans in most arboviral infections and the low concentration of viral RNA in blood in neurotropic arbovirus infections limits the detection of cases using molecular assays. Moreover, serological tests frequently cross-react within viral families, particularly within the same genus, limiting the specificity of the results.

The geographical footprint of arbovirus transmission is expanding, particularly for those historically considered threats confined to tropical and subtropical regions (39). Transient autochthonous transmission of *Aedes*-borne viruses by locally established mosquitoes has now been reported in

non-endemic regions, including dengue virus in Europe (Croatia, Italy, France and Spain) and the United States of America (USA), chikungunya virus in Europe (France, Italy) and the USA, and Zika virus in France and the USA (40–42); but ongoing/sustained endemic transmission or viral overwintering has not yet been documented in these areas. This geographic expansion is driven by lack of effective mosquito control, changing lifestyles, unplanned urbanization and globalization (43). As a result, countries where arboviruses were absent are increasingly reporting cases, highlighting the growing global nature of the threat.

Preventive measures such as vaccination exist for some arboviral diseases like yellow fever, dengue, chikungunya, Japanese encephalitis, and tick-borne encephalitis. However, vaccine use and access are hindered by factors including cost constraints, supply chain challenges, vaccine hesitancy, and lack of data for decision-making e.g., gaps in clinical efficacy and effectiveness data for some recent vaccines in the absence of predictable transmission settings to conduct necessary trials (44,45). Even when these vaccines are available, issues such as insufficient efficacy, limitation of indications to certain subpopulations, precautions/contraindications for use, and vaccine hesitancy have been noted have been noted (44,45). In the absence of disease-specific antiviral treatments, therapeutic management heavily relies on supportive and symptomatic management (46).

Table 2: Examples of known virus groups with epidemic and pandemic potential

Virus Family	Genus	Known Pathogens	Relevance	Clinical presentation
<i>Flaviviridae</i>	<i>Orthoflaviviruses</i>	Dengue virus Yellow Fever virus Zika virus West Nile virus Japanese Encephalitis virus Tick-borne Encephalitis virus Ilheus virus Usutu virus Rocio virus Wesselsbron virus Spondweni virus Jingmenvirus Alkhurma Hemorrhagic Fever virus Murray Valley Encephalitis virus Saint Louis Encephalitis virus Kyasanur Forest Disease virus Powassan virus Omsk Haemorrhagic virus	Members of the <i>Flaviviridae</i> family, genus <i>Orthoflavivirus</i> , include arboviruses causing the highest disease incidence in humans globally, particularly among those transmitted by <i>Aedes</i> (Stegomyia) mosquitoes some of which are human-amplified. Large yellow fever outbreaks occurred in 2016-2019 in Africa and in the Americas. In 2024-2025, a resurgence of yellow fever in the Americas, in a broader geographical distribution than recent decades, prompted concern of increasing potential for urban (<i>Aedes</i> -borne) transmission and international spread to lower risk areas. Several viruses with human pathogenic potential in this family are tick-borne, thus less likely to cause pandemics but are of concern in people with increased exposure to ticks for residential (rural locations in endemic areas), occupational, or recreational reasons, and where movement of infected animals can introduce viruses to areas with competent tick vectors.	Dengue, yellow fever, and Zika viruses cause febrile and/or rash illness that are often non-specific in nature in the early stages. West Nile, Japanese encephalitis, tick-borne encephalitis, Powassan, Usutu, Murray Valley encephalitis, and Saint Louis encephalitis viruses can cause neurological disease, either through direct neuronal invasion or nervous system inflammation. Humans are typically dead-end hosts, with disease transmission requiring intermediate vertebrate hosts.

Togaviridae	Alphaviruses	Chikungunya virus Venezuelan Equine Encephalitis virus Eastern Equine Encephalitis virus Mayaro virus Madariaga virus Ross River virus O'nyong'nyong virus Western Equine Encephalitis virus Sindbis virus Barmah forest virus Semlike forest virus Middelburg virus	Chikungunya virus continues to cause outbreaks across multiple countries and regions. For example, introduction into the Americas in late 2013 resulted in an extensive multi-country outbreak within 18 months; a resurgence of chikungunya in the Indian Ocean islands occurred in 2024-2025, resembling a similar transmission pattern seen in the region in 2004-2007.	Alphaviruses including chikungunya, Mayaro, Ross River and O'nyong nyong viruses cause acute debilitating arthritis, with prolonged disease in some patients. The equine encephalitis viruses cause neurological disease with associated sequelae and mortality. Humans are typically dead-end hosts, with disease transmission requiring intermediate vertebrate hosts.
Peribunyaviridae	Orthobunyaviruses	Oropouche virus California encephalitis virus Cache Valley virus La Crosse virus Bunyamwera virus Bwamba virus Ilesha virus Jamestown Canyon virus Shunivirus	Recent large outbreaks include the Oropouche outbreak in the Americas in late 2023-2025.	Viruses in this family most often cause febrile illness and neurological disease.
Phenuiviridae	Phleboviruses	Rift Valley Fever virus Severe Fever with Thrombocytopenia Syndrome Toscana phlebovirus	Includes multiple pathogens with high virulence.	These viruses often start off with flu-like symptoms like fever, headache, diarrhoea, nausea, or stiffness in the muscles. Severe cases may develop into haemorrhagic symptoms, multi-organ failure, or neurological

		Naples phlebovirus Sicilian phlebovirus Heartland virus		involvement (encephalitis). While case fatality rates are generally low, they are greater among older or immunocompromised patients for Heartland virus and Rift Valley Fever. Majority of diseases are self-limiting, and humans are typically accidental or dead-end hosts.
<i>Nairoviridae</i>	<i>Orthoniavirus</i>	Crimean-Congo Hemorrhagic virus	The main arbovirus of significance in this family is the Crimean-Congo Haemorrhagic Fever virus, that is tick-borne and has a broad distribution in Africa, the Middle East, and Asia. This virus is of concern in people with increased exposure to ticks for residential (rural locations in endemic areas), occupational, or recreational reasons, and where movement of infected animals can introduce the virus to areas with competent tick vectors. Blood or body fluid transmission from viremic patients to health care workers can occur in health care settings. Sexual transmission of Crimean-Congo Haemorrhagic Fever virus has been described.	Febrile illness and haemorrhagic fever can occur, with notable skin or mucosal bruising and case fatality rate of up to 40%.
<i>Rhabdoviridae</i>	<i>Vesiculovirus</i>	Chandipura virus	Chandipura virus is endemic in India and has caused sporadic cases and outbreaks of acute encephalitis syndrome, particularly in children under 15 years of age. There is no treatment or vaccine available. It is transmitted by vectors such as sandflies, mosquitoes and ticks. To date, no human-to-human transmission has been reported, and cases have not been reported outside of India.	Chandipura infection causes acute encephalitis syndrome and the case-fatality rate is typically high (>50%).
<i>Orthomyx</i>	<i>Thogoto</i>	Thogoto virus Bourbon virus	Primarily transmitted to humans and other vertebrates through the bite of infected ticks,	These viruses can cause febrile rash illness and neurological

<i>oviridae</i>	<i>virus</i>		with known fatalities in animals and humans.	disease.
-----------------	--------------	--	--	----------

DRAFT

2.7.2 Modes of transmission and transmission cycles

Arbovirus transmission involves a complex interplay between the respective virus and its arthropod vectors and vertebrate hosts. Humans may be amplifying hosts or incidental (“dead end”) hosts. Non-human hosts, such as non-human primates, mammals, and birds, can act as reservoirs, amplifying arboviruses and sustaining transmission cycles within ecosystems. Arthropod vectors acquire arboviruses while taking bloodmeal from infected vertebrate hosts with sufficiently high viraemias and subsequently, after a period of replication and tissue dissemination within the vector (extrinsic incubation period), transmit the viruses to infected to another vertebrate host (47). Key arthropod vectors for arboviruses include mosquitoes, ticks, sand flies, and midges.

While the vector-borne transmission dynamics of individual arboviruses vary, their transmission cycles can broadly be categorized as follows (48–50):

- Urban cycle (epidemic cycle, human amplified): This cycle involves the transmission exclusively between arthropod vectors and humans and requires that humans develop sufficient viral blood concentrations to maintain circulation without requiring non-human hosts. The urban cycle describes the transmission of arboviruses in human hosts through peri-domestic mosquitoes, especially *Aedes aegypti*. In this cycle, the virus spreads in urban centres through a vector mediated human transmission leading to significant outbreaks in urban areas where favourable vector habitats and close human contact enable rapid spread of the disease.
- Sylvatic cycle (enzootic cycle): this cycle occurs in sylvatic (forest/jungle) habitats and involves transmission between arthropod vectors and non-human vertebrate hosts, such as wildlife. Arboviruses can spill over into human populations via enzootic arthropod vectors that incidentally feed on humans, or through bridge vectors that feed on humans and wildlife, leading to occasional outbreaks. The sylvatic cycle describes the transmission of arboviruses between wildlife reservoirs such as non-human primates and the jungle mosquito vectors. Zoonotic spillover to humans may occur when humans are exposed to forest habitats and are bitten by infected bridge vectors that transmit the virus.
- Epizootic cycle: in this cycle, vectors transmit arboviruses from the enzootic cycle to domestic animals that can serve as amplifying hosts such as pigs or horses. Bridge arthropod vectors can then further transmit the virus to humans after feeding on these sufficiently viraemic infected domestic animals.

A consolidated representation of common transmission cycles of arboviruses is depicted in Figure 2A, while examples of the transmission cycles of specific arbovirus are illustrated in Figure 2B (48,51).

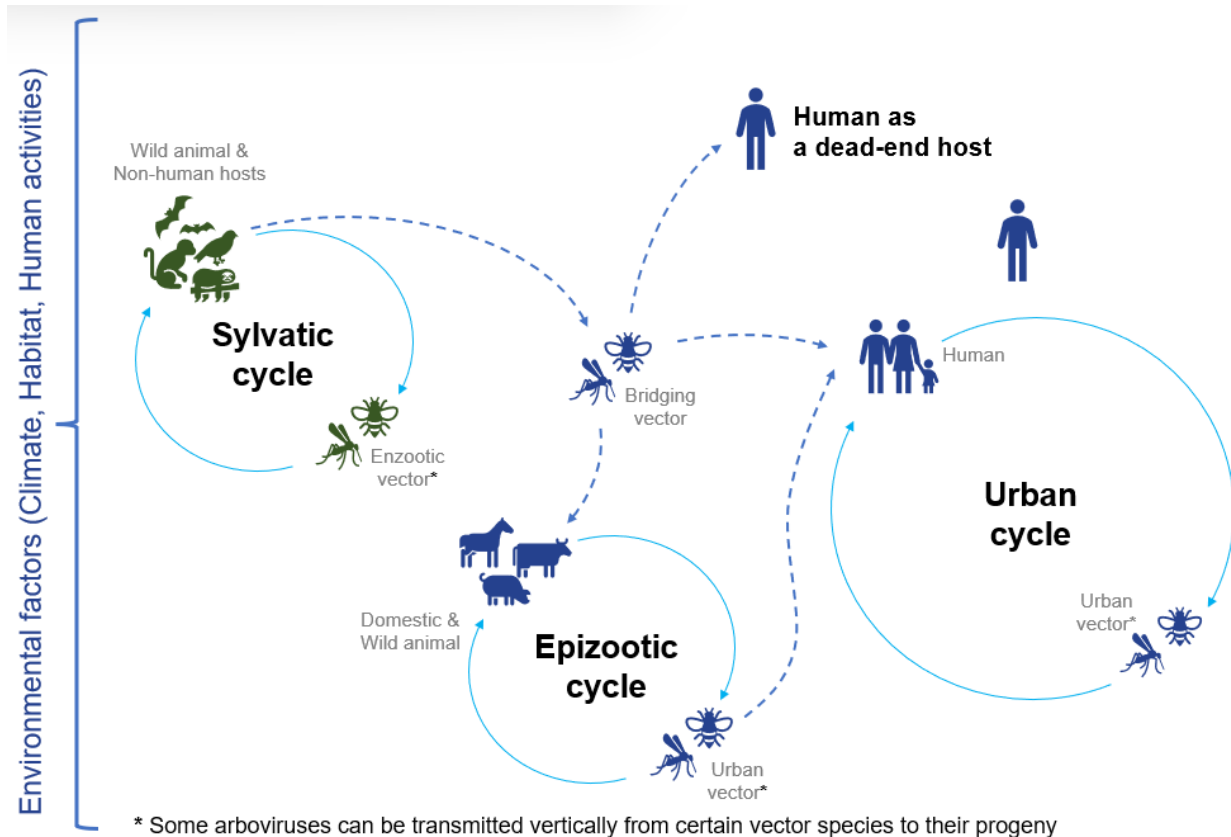


Figure 2A: Consolidated representation of common transmission cycles of arboviruses

Footnote:

Each arbovirus has a distinct transmission cycle. This figure provides a generalized illustration of possible transmission routes for arboviruses and does not represent the specific transmission cycle of any particular pathogen. Several arboviruses have known non-vector-mediated routes of transmission that typically account for fewer human infections; those are not included in this diagram and are dealt with separately in the text. In addition, vertical transmission (adult to progeny) in arthropod vectors has been noted for several arboviruses.

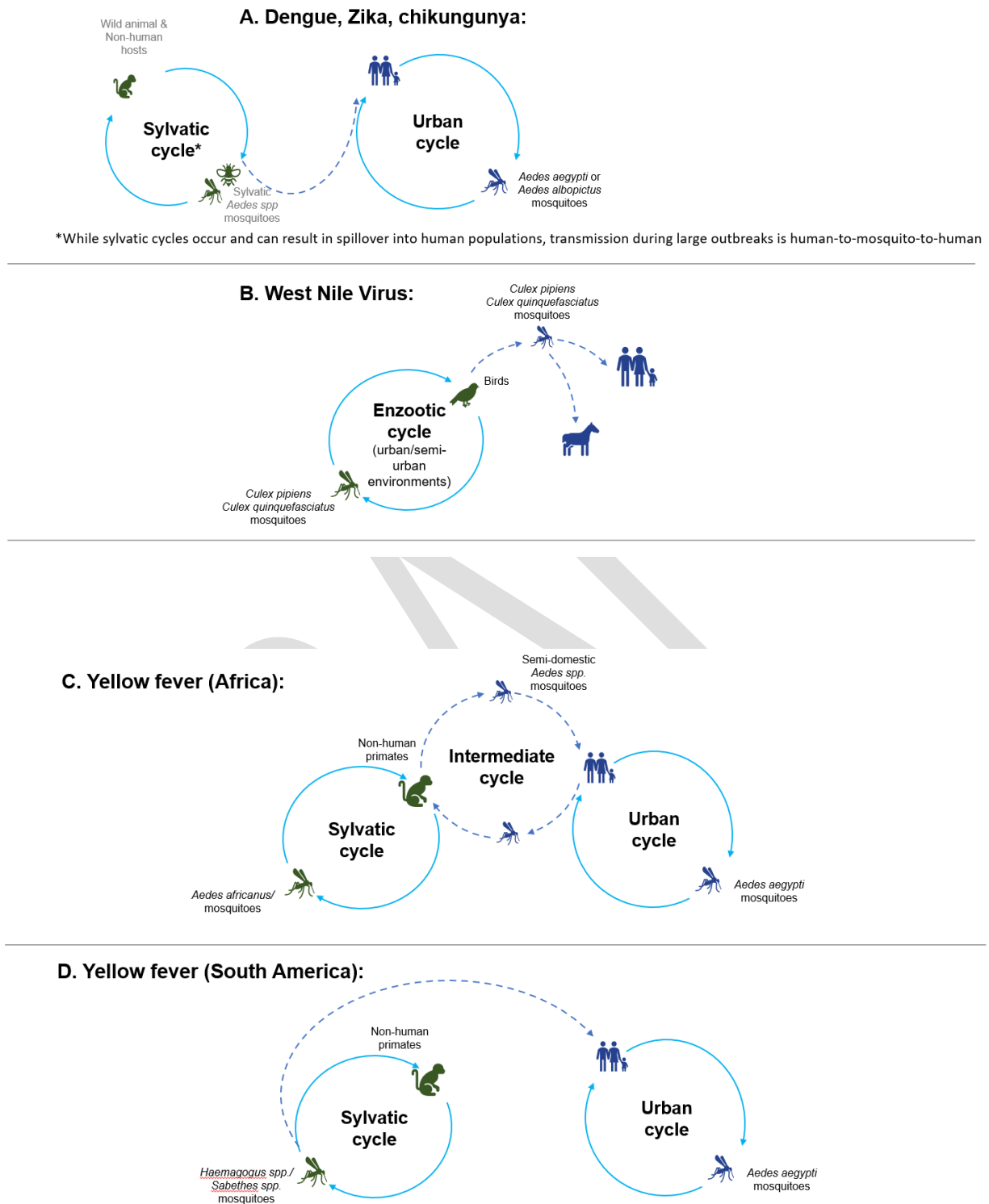


Figure 2B: Transmission cycles for specific arboviruses

Footnote

A. Dengue, chikungunya and Zika viruses are mainly transmitted via a human-amplified cycle, predominantly in urban areas. Sylvatic transmission cycles also occur and indeed are considered the source of initial introduction into human populations; however, it is not clear to what extent sylvatic cycles affect current human disease incidence.

B. West Nile virus is transmitted via an enzootic cycle with accidental spread to humans and horses as dead-end hosts.

C and D. Yellow fever virus can be transmitted through a sylvatic or an urban cycle, depending on the mosquito species involved. The specific transmission cycle varies by geographical location and is not necessarily occurring in all areas at all times. In Africa, there is an intermediate cycle where semi-domestic mosquitoes transmit the pathogen to both non-human primates and humans.

E. Japanese encephalitis and multiple equine encephalitis viruses are transmitted via a sylvatic cycle. They could be amplified in an epizootic cycle and incidentally spread to humans as a dead-end host.

Additional transmission routes of arboviruses

Although less common, some arboviruses can also be transmitted through blood transfusion, organ transplantation, sexual contact, and vertical transmission through the placenta (mother to child transmission) during pregnancy or at birth (52).

2.8 Epidemiological parameters for arbovirus transmission

Understanding the transmission dynamics of arboviruses requires consideration of key parameters identified through studies on mosquito-borne arboviruses that influence the probability of hosts and vectors becoming infected and being infectious. These parameters include vertebrate host population density, behaviour, immunity, viremia, and (intrinsic) incubation period, as well as vector density, insecticide resistance, survival rates, frequency of taking human bloodmeals, and extrinsic incubation periods in vectors (53). In addition, parameters such as likelihood of symptomatic infection among infected hosts, as well as severity, mortality, and complication ratios, play a pivotal role in shaping the transmission dynamics and impact of arboviruses.

Certain population groups, such as older adults, pregnant individuals, persons with comorbidities, immunocompromised persons, and young children can be particularly vulnerable to severe outcomes, obstetric and foetal complications, and long-term complications, depending on the infecting arbovirus. These vulnerabilities contribute to increased morbidity and mortality, with potential impacts on healthcare systems and societal stability at large. Consequently, when a new arbovirus is detected, it is essential to investigate its transmission dynamics, host range, clinical manifestations, and broader healthcare implications to inform response strategies effectively. Table

3 outlines a non-exhaustive list of questions and parameters to guide decision-making processes when a new arbovirus has been detected.

Epidemiological case and outbreak investigations, complemented by research studies are necessary to collect data that inform surveillance and public health response. Key objectives include articulating case definitions for surveillance and clinical diagnosis, determining optimal strategies for vector control measures, assessing the necessity and strategies for deploying medical countermeasures, and estimating workforce and medical supply requirements. Analysis of these data also improves understanding of disease transmission, implementation of control and prevention strategies, and evidence-based public health actions. Effective communication of findings to stakeholders, including policymakers, healthcare providers, and the public, is integral to these efforts.

Incorporating epidemiological data into mathematical models enables forecasting disease trends, evaluating intervention strategies, and exploring outbreak scenarios, providing critical insights into epidemic or pandemic risks. However, modelling arbovirus transmission is complex due to factors like vector biology, environmental variability, and incomplete data, with assumptions and simplifications sometimes limiting accuracy (54). Despite these challenges, models remain essential for public health decision-making, though their outputs require cautious interpretation and integration with empirical data.

Table 3: Examples of questions to ask about an emerging or less characterized arbovirus and the epidemiological parameters and considerations that need to be assessed to inform response actions

Question	Epidemiological parameters and considerations	Responsible actors	Effective use
How does it transmit?	Modes of transmission • What is the transmission cycle of the pathogen? • Which vectors and reservoirs species or types are involved in the transmission cycle • Are humans amplifying hosts or incidental (dead-end) hosts? • What are all the possible routes of transmission to humans (e.g. vector bite, contact with blood/tissue, vertical, ingestion) • What is the cellular/tissue entry mechanism of the virus	Entomologists, laboratories, veterinary services	Used to guide vector control priorities, personal protective measures (RCCE) and donor screening policies
When does it transmit?	Infectious period, incubation period • How long is the infectious period and what is the incubation period in humans (intrinsic incubation period)? • How long is the infectious period and what is the extrinsic incubation period in vectors? • Is there presymptomatic, asymptomatic or/and symptomatic transmission?	Clinical researchers, hospitals, epidemiologists	Informs case definitions, timing of intervention initiation and scale-back, determination of epidemic phase,
How transmissible is it?	Effective reproduction number (R), population density, vectorial capacity (including vector density, biting rate), underlying population immunity • How does this vary across different contexts and settings? • What is the duration of immunity post-infection?	Public health institutes, academic modelers, vector control programmes	Supports forecasting and resource allocation
How quickly does it evolve?	Genomic and phenotypic characteristics • What are the molecular markers for changing pathogenicity or	Genomic surveillance labs, regional networks	Used for vaccine updates, diagnostic validation

	transmissibility? • Is there geographic variation in the virus evolution? • What are the implications of viral evolution (e.g., impact on vector species efficiency of transmission)		
What disease does it cause?	Range and frequency of clinical symptoms and syndromes, duration of symptoms • Does this differ across population sub-groups? • Does this differ across different virus lineages, strains? • Are there distinct phases of disease associated with risks of clinical deterioration?	Clinicians, hospitals, research consortia	Improves case management guidelines and differential diagnosis
Who is at risk of severe disease, complications?	Range and frequency of underlying medical conditions, population demographic characteristics, infection fatality ratio, proportion of cases (a) hospitalized (b) admitted to intensive care units (ICU) (c) develop obstetric and foetal complications (d) develop long-term complications (e) die • Are secondary infections observed among cases?	Ministries of health, hospitals, maternal/child health programmes	Informs prioritization for vaccines or prophylaxis
What is the burden on health care facilities?	Median number of days from symptom onset to hospitalization Median number of hospitalization days among those not admitted to ICU Median number of days of hospitalization among those admitted to ICU Percentage of patients admitted to ICU among those hospitalized Percentage of patients who die among those hospitalized (includes both non- ICU & ICU admissions) Median number of days from symptom onset to death (for fatal cases)	Health facilities, health information systems	Used for surge planning, staffing, and supply chain preparedness

2.8.1 Vulnerable groups

Groups at increased risk of arbovirus infection include:

- Residents of endemic regions in tropical and subtropical areas where arthropod vectors such as mosquitoes and ticks are prevalent.
- Outdoor workers in endemic areas, such as those in agriculture, forestry, or construction, who are at higher risk of vector exposure.
- Travelers to endemic areas (tourists, migrants or workers) with active arbovirus transmission, especially if preventive measures (like vaccination or vector protection) are not in place.
- People living in urban slums or areas with poor sanitation, overcrowded living conditions, inadequate water supply and associated increased vector breeding sites are more likely to be exposed to arboviruses.
- Caregivers of patients with arbovirus infections transmissible through blood and body fluids (e.g., Crimean Congo Hemorrhagic Fever virus)

Groups at increased risk of severe disease and sequelae of infection include:

- Pregnant women who are particularly vulnerable to certain arboviruses – Zika virus infection during pregnancy can lead to congenital defects in the foetus, and chikungunya viremia at the time of delivery carries a high risk of intrapartum vertical transmission and severe disease in the neonate (55).
- Young children and elderly individuals who are more likely to have severe arboviral disease compared to other age groups, depending on the infecting virus (56).

2.8.2 Disease severity and impact of arbovirus epidemics and pandemics

The severity and impact of large-scale arbovirus epidemics and potential pandemics depend not only on the pathogen's epidemiological characteristics and host factors but also on contextual factors such as social inequities and the capacity of health systems to detect and respond effectively.

1. Viral factors

- Viral load and virulence: virus transmissibility to vectors is generally increased in the presence of high viral loads, and disease severity depends upon the virulence of the infecting arbovirus species, serotype or strain (57).
- Variations in the viral genome: variations in the viral genome can influence infectivity, pathogenicity, vector fitness and transmissibility (58). Different strains of the same arbovirus can have varying levels of virulence; some dengue virus serotypes, for example, are associated with more severe disease outcomes (59).
- Tissue tropism: Some arboviruses possess the ability to invade the central nervous system, causing conditions such as myelitis, neuritis, meningitis, and encephalitis (60). Neuroinvasive diseases, particularly encephalitis, are associated with higher mortality rates (61).

2. Vector factors

- Species diversity: different arthropod species vary in their competence to transmit arboviruses, influencing arbovirus transmission intensity and geographic distribution (62)
- Behaviour: changes in feeding preferences (preferred bloodmeal sources), biting patterns (e.g., daytime vs nighttime, indoor vs outdoor) and indoor vs outdoor resting behaviour determine transmission likelihood to humans and should inform targeted vector control strategies (63)
- Insecticide resistance: the widespread and growing resistance to commonly used insecticides reduces the effectiveness of core vector control interventions, increasing epidemic potential (64)
- Abundance patterns: seasonal and climate-driven changes in vector density influence outbreak timing, size, and severity (65)
- Ecological changes: urbanization, deforestation, and irrigation can alter habitats and create new breeding sites (62)
- Vector competence: evolutionary changes can enhance a vector's efficiency in transmitting pathogens, as seen with chikungunya virus and *Aedes albopictus* (66).

3. Host factors

- Immune status: the infected person's immune status influences disease outcomes. Immunocompromised individuals, including those with pre-existing chronic health conditions and/or undergoing immunosuppressive therapy, are more prone to severe disease (67).
- Age: young children and the elderly are at greater risk of severe manifestations for certain arboviral infections. For example, young children may experience more severe illness when infected with certain arboviruses like Eastern equine encephalitis and La Crosse virus encephalitis viruses (66); whereas older persons are at greater risk of hospitalization and neuroinvasive disease from West Nile virus (70). Patients at both extremes of age are at higher risk of developing severe chikungunya disease requiring hospitalization, and of fatal outcomes among those hospitalized (71).
- Previous exposure: prior natural infection with the same arbovirus can confer long-lasting immunity and may also influence susceptibility and disease severity in subsequent infections with the same virus or related arbovirus. For instance, natural dengue infection can induce long-lasting protective immunity to the same serotype and short-term protection with other serotypes. However, secondary infections with different dengue virus serotypes can lead to antibody-dependent enhancement, increasing the risk of severe disease (72).
- Genetic factors: host genetic factors can also influence the severity of arbovirus infections. Some genetic variations may predispose individuals to more severe disease outcomes (58).

4. Social inequities

- Socioeconomic disparities: low socioeconomic status increases vulnerability to arboviral diseases, often due to factors such as inadequate housing, limited access to clean water, and interrupted water supplies. These conditions exacerbate exposure to vectors and the risk of infection (73).

5. Health system capacity

- System vulnerabilities: limited resources, insufficient laboratory diagnostic capacity, delayed reporting, inadequate workforce, and inability to access essential services during epidemics could exacerbate the severity and societal consequences of arboviral epidemics.

2.9 Technical implications for arbovirus epidemic and pandemic planning

Effective planning for arbovirus epidemics and pandemics requires a comprehensive, context-sensitive approach that addresses the biological, social, and systemic challenges they pose. This has the following technical implications:

Multisectoral planning and resourcing

- A well-coordinated multisectoral system, involving health, environment, agriculture, urban planning, education, research, industry, and other relevant sectors, is necessary to provide reliable and comprehensive data for effective surveillance, prevention, preparedness and response strategies.
- Epidemic and pandemic planning must include building of agile and sustainable systems, as well as developing strong financing mechanisms to sustain long-term preparedness efforts.

Risk-based approach

- Considering the unpredictability of arbovirus epidemics, a precautionary approach to infection prevention early and preparedness will save lives and livelihoods
- In the pre/interepidemic period and during epidemics, conduct iterative risk assessments to drive evidence-informed decisions and better-tailored actions

Integrated surveillance

- Robust surveillance systems that integrate data from human health, animal health, and environmental sectors are vital for early detection and response
- These systems must be maintained during inter-epidemic periods to ensure readiness

Integrated vector management

- Adopting an integrated vector management approach that involves community participation, advocacy, social mobilization, and collaboration across different sectors is essential for sustainable vector control.
- Through multidisciplinary collaboration, effective public health interventions for vector and humans, aimed at reducing vector population and the chance of vector biting respectively should be implemented

Community empowerment

- Foster resilience by empowering and engaging communities in the development and implementation of prevention and control measures. Even before an epidemic, work with communities to reduce their exposure and enhance their response to arboviruses
- Promote messaging about: arbovirus disease trends, personal protection and vector control measures in community, signs and symptoms, when to seek health care, and access to support and advice including mental health services.

Diagnostic access

- Arbovirus epidemics and pandemics could go undetected in the initial phase of the event, especially in the localities with limited diagnostic capacities
- Strengthening access to reliable arboviral diagnostic testing by incorporating technologies such as point-of-care diagnostics and strong reference laboratory networks to confirm the identity of the circulating virus
- In the case of suspected novel arbovirus transmission where routine diagnostics fail to detect endemic pathogens, employment of next-generation sequencing for viral identification

Medical countermeasure development, evaluation, and deployment

- Lack of availability of medical countermeasures, low vaccination coverage and the paucity of effective drugs and vaccines exacerbate the impact of arbovirus epidemics
- Promote initiatives that support the development and deployment of new diagnostics, drugs, and vaccines

Surge capacity

- Availability of healthcare facilities, workforce, and essential services, including hospitalization and intensive-care unit capacities, is crucial
- Arboviruses can spread extensively in the community resulting in overwhelming demand for health services, including ICU beds
- Health systems must be prepared to handle increased demand during outbreaks

Ongoing analysis of evidence

- High-quality operational and implementation research about the transmission of different arboviruses is needed to drive infection prevention, preparedness and response actions. This includes operational and implementation research, but also incorporate other data sources such as basic science studies, case investigations et
- Promote research that brings medical professionals, evolutionary biologists, entomologists, environmentalists, and behavioural and social scientists and other stakeholders together to understand the human, viral, vector and environmental factors that facilitate transmission (transmission cycle involved) as well as the related, culturally and socially acceptable solutions to reduce transmission.

Figure 3: Technical implications for arbovirus epidemic and pandemic planning



Chapter 3: Organizing framework for arbovirus epidemic and pandemic planning

Chapter 4: System components for arbovirus pathogen epidemic and pandemic preparedness

DRAFT

3 Organizing framework for arbovirus epidemic and pandemic planning

This chapter provides an organizing framework for arbovirus epidemic and pandemic planning to provide clarity as to what needs to be done when, so that attention is given to the systems and capacities that need to be strengthened for operations before, during and after an epidemic or pandemic.

3.1 Foundation for arbovirus epidemic and pandemic preparedness and response

Resilient communities, multisectoral systems, and core capacities are the foundation for effective and sustainable arbovirus epidemic and pandemic preparedness and response. Resilient communities, empowered with knowledge and trust, act as the first line of defence, enabling early detection, response, and recovery from an epidemic or pandemic. Multisectoral systems foster collaboration across human, animal, and environmental health sectors, breaking silos to ensure a coherent and cohesive approach is employed. In addition, IHR core capacities provide a global framework for capacities required to detect, assess, notify and report events, and respond to public health risks and emergencies of national and international concern. Together, these interconnected elements create a robust foundation for building sustainable health security, fostering resilience and mitigating the impact of arbovirus epidemics and pandemics.

3.2 Arbovirus epidemic and pandemic surveillance and risk assessments

Arbovirus surveillance and risk assessment are key elements of epidemic and pandemic preparedness, informing actions at the country, regional and global levels. By monitoring human cases, animal reservoirs and vector populations, effective surveillance systems enable the detection of arbovirus circulation and inform the development of interventions, as well as monitor their effectiveness. Risk assessment complements surveillance by analysing multisource data to determine the likelihood and impact of an epidemic. This process involves integrating microbiological, epidemiological, entomological, environmental, clinical data, and other relevant data to generate actionable insights.

At the global level, WHO appoints an Emergency Committee comprised of international experts to assess available evidence and provide technical advice to the WHO Director General by determining whether an event constitutes a PHEIC under the IHR (2005), where a PHEIC refers to “an extraordinary event which is determined, to constitute a public health risk to other States through the international spread of disease and to potentially require a coordinated international response” (6). Depending on the risk assessment and context, the WHO Director-General may also declare an event as a pandemic emergency. A pandemic emergency means “a public health emergency of international concern that is caused by a communicable disease and has, or is at high risk of having, wide geographical spread to and within multiple States; and is exceeding, or is at high risk of exceeding, the capacity of health systems to respond in those States; and is causing, or is at high risk of causing, substantial social and/or economic disruption, including disruption to international traffic and trade; and requires rapid, equitable and enhanced coordinated international action, with whole of-government and whole-of-society approaches” (4). In February

2016, the first arbovirus-related PHEIC was declared because of Zika virus-related microcephaly (74).

Because regional and global risk assessments lack the resolution to differentiate risk at subnational level, countries are encouraged to use the information to inform their own assessments as well as the timing and scale of operations. To support countries in systematically assessing arbovirus risks, WHO developed the PRET Arbovirus Risk Assessment Tool (ART). The tool provides a structured framework for governments at subnational, national, and regional levels to conduct comprehensive strategic risk assessments for arbovirus epidemics and potential pandemics (ref). Using a risk-based approach, PRET ART facilitates the identification and prioritization of arbovirus risks in specific geographic contexts, enabling tailored preparedness and response strategies. Sharing surveillance and risk assessments information between countries and coordinating cross border operations serve to enhance global effectiveness and equity in risk mitigation.

3.3 Periods and operational stages

An organizing framework guides decision-makers in identifying the necessary actions at each stage, ensuring that systems and capacities required for operations are addressed before, during, and after an epidemic or potentially, a pandemic. It is important to remember that response and recovery strategies must be adapted to the specific circumstances of the event.

Figure 4 shows this organizing framework for planning in the context of arbovirus pathogen epidemics and pandemics.

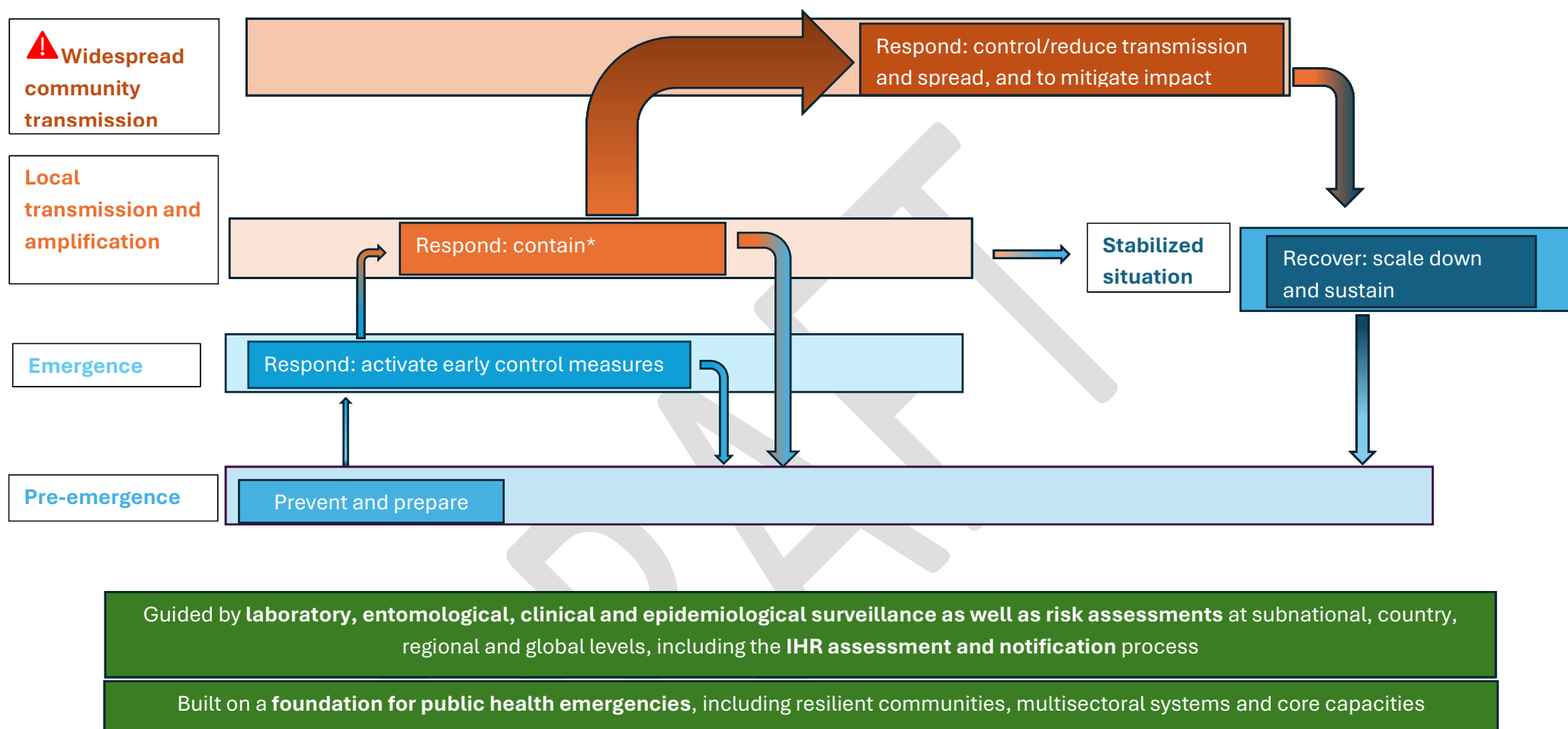


Figure 4: Organizing framework for arbovirus epidemic and pandemic planning

*Including localized control and mitigation as applicable

Global Spread: Potential Public Health Emergency of International Concern or Pandemic Emergency



During this phase, global spread may occur in the form of a PHEIC or an arbovirus pandemic emergency requiring a coordinated international response. This could involve the emergence of a novel arbovirus ("Arbovirus X") or the widespread transmission of a known arbovirus already causing multiple outbreaks in at least one country. If transmission extends to other countries with consistent disease patterns, particularly those associated with significant morbidity or mortality in specific population groups, a global health threat would be evident, necessitating urgent, collaborative action.

Non vector modes of transmission such as blood transfusion, contact with blood or other fluids of an infected animal (different than then vector), contact with blood or other fluids of an infected human, organ transplantation, sexual contact and vertical transmission may also occur.

Box 2: Effective reproduction number (R_t) and basic reproduction number (R_0)

The effective reproduction number (R_t) quantifies the epidemic potential of a pathogen by estimating the number of secondary cases caused by a single infectious case in a population composed of both susceptible and non-susceptible individuals (71). The basic reproduction number (R_0), similarly, estimates the number of secondary cases a single infectious individual would generate but in a completely susceptible population, such as might be the case upon introduction of an emerging arbovirus (Arbovirus X) (72). For vector-borne diseases, both R_0 and R_t are primarily influenced by the density, abundance, and survival of both vectors and hosts (72). Additional factors include the probability and latency of viral infection and transmission between vectors and hosts, the rate of contact and interaction between these populations, and the duration of infectiousness in hosts (73).

Box 2: Effective reproduction number (R_t) and basic reproduction number (R_0)

Pre-emergence period

One or more competent arthropod vector species are present, however, arbovirus transmission to humans has not been observed, and any cases detected are in persons with a travel history to a country or region where transmission is occurring (i.e., imported cases) or cases have only occurred through non-vector-borne transmission (e.g., sexual transmission of Zika virus). The virus may be present in arthropod vectors and/or in animal vertebrate hosts in the country. Favourable environmental factors such as rainfall, temperature, and humidity which are conducive to vector breeding and transmission may be present. Vectors may also be present but climatic factors may not allow for the extrinsic cycle to be completed.

Prevent and prepare

The pre-emergence period corresponds to the “Prevent and prepare” operational stage where actions implemented are aimed at preventing the occurrence and expansion of autochthonous vector-borne transmission to humans. The surveillance objectives during this stage include the early detection of virus circulation and vector-borne transmission to humans or resumed virus transmission. When autochthonous sporadic cases or clusters of arbovirus infections are detected, actions shift to response mode.

Emergence period

Autochthonous sporadic cases or small clusters of arbovirus infections are detected, which may signal the early stages of an epidemic. Epidemics are often driven by the combination of vector abundance, viral amplification in animal reservoirs, and susceptible human populations.

Respond: activate early control measures

The emergence period corresponds to the “Respond: activate early control measures” operational stage where actions are aimed at preparing for an epidemic. The surveillance objectives during this stage include early detection of arboviral infections in humans,

detection of serotype shift or genetic lineage (where applicable), and detection of indicators of an impending outbreak (e.g., increase in human cases, increase in detection of virus in non-human sentinel species, clusters of febrile illness with rash or arthralgia).

Amplification and local transmission period

This period is characterized by the amplification of the virus in vertebrate hosts and vectors, which could result in continuous local transmission of the arbovirus and disease in humans within a defined community or region. The transmission cycle is self-sustaining and does not rely on further importation of cases. Typically, this occurs in specific hotspots where ecological, environmental, and socioeconomic factors favour vector breeding and human-vector interactions. These hotspots often serve as the epicentre of transmission, creating localized epidemics that can expand if not effectively controlled.

Respond: contain

The amplification and local transmission period corresponds to the “Respond: contain” operational stage, including localized control and mitigation as applicable. The aim is to stop transmission and halt the epidemic by reducing the R_t / R_0 to less than 1. This can be achieved by interrupting transmission cycles and suppressing new infections.

All countries, including those with competent vectors and potential for introduction from areas with circulation, are urged to elevate their alert levels, enhance operational readiness, and proactively review epidemic and pandemic preparedness plans. Actions should align with the latest available information and contribute to global containment efforts in a spirit of solidarity. For arboviruses that have not yet been well characterized (e.g., newly emerging), it is imperative to prioritize efforts to understand their clinical, epidemiological, and microbiological profiles. This includes: (a) investigating vectors and potential animal reservoirs, (b) gaining insights into modes of transmission, transmission patterns, the spectrum of clinical presentations, and risk factors for infection and severe outcomes, and (c) identifying and implementing effective preventive and therapeutic countermeasures.

Widespread community transmission period

During this period, the arbovirus typically spreads through human amplification (i.e., sufficiently viraemic human, to arthropod vector, to human), across multiple communities or geographic areas, transitioning from localized clusters to widespread transmission within and between regions. Key drivers include human mobility (migration, travel, and trade that facilitate the movement of infected individuals and vectors) and introduction into immunologically susceptible populations where competent vectors are abundant. This level of transmission signifies a large-scale epidemic with potential to cause a PHEIC or pandemic.

Respond: control/reduce transmission and mitigate impact

The widespread community transmission period corresponds to the “Respond: control/reduce transmission and mitigate impact” operational stage. Response efforts are scaled up, informed by comprehensive risk assessments including viral factors such as intensity of viral transmission and circulating variants; human factors such as population density, population at risk, mobility patterns; and contextual factors such as health system capacities, population vulnerabilities, and socioeconomic conditions. Efforts should be made to slow transmission by reducing R_t/R_0 to less than 1 to contain, or by reducing it to as close to 1 as possible to control community transmission and mitigate health and socioeconomic impacts.

Slowing transmission affords all countries, including those initially affected, critical time to strengthen emergency response systems, implement targeted PHSM, enhance case detection and patient care capacities, and deploy countermeasures and socioeconomic interventions that save lives and protect livelihoods.

Recognizing that transmission levels can vary within a country, subnational risk assessments are critical for tailoring interventions at the lowest administrative levels. Regional or global coordination may be required to address cross border threats and ensure equitable access to resources. Response actions should continue to be applied until the situation stabilizes throughout the country and risk assessments indicate that response systems can cope under routine non-emergency conditions.

Stabilized situation

This period is marked by a decline in disease transmission to a manageable disease burden. Transmission rates are low, with R_t/R_0 consistently maintained below 1 or at an endemic level). Health systems recover operational capacity, enabling them to provide both routine and emergency care without strain, while sustained vector control efforts ensure that vector populations remain below transmission-sustaining thresholds. Although the event is reduced to a manageable public health concern, there might be ongoing risk of reintroduction with subsequent local transmission.

Recover: scale down and sustain

The stabilized situation corresponds to the “Recover: scale down and sustain” operational stage. Response actions are progressively scaled down, transitioning to sustainable, long-term strategies for disease control and impact mitigation. Possible scenarios in which acute response actions are discontinued include interruption of transmission (cessation of transmission for prolonged periods), reduced endemic transmission, or detection of only sporadic cases. However, the potential for arbovirus reintroduction, continued evolution of endemic arboviruses, including the emergence of variants with greater transmissibility or severity, necessitates ongoing surveillance and adaptive response mechanisms to prevent re-escalation. As emergency operations de-escalate, efforts shift toward the pre-emergence period, focusing on strengthening preparedness, building resilient health systems, and integrating lessons learned. This ensures readiness for future respiratory

pathogen threats while sustaining public health gains achieved during the epidemic response.

DRAFT

4 System components for arbovirus epidemic and pandemic preparedness

This chapter outlines the key actions required to prepare for an arbovirus epidemic or pandemic. The content is structured around the five components of the HEPR framework and aligned with the relevant IHR 2005 core capacities relevant for arbovirus preparedness and response (1,75) .

Learn more about each of these five components and the relevant IHR (2005) capacities in Section X of the *Getting Started with Pandemic Planning* document (ref)

4.1 Emergency coordination

The IHR (2005) core capacities relevant for arbovirus epidemic and pandemic preparedness include policy, legal and normative instruments; coordination and financing.

4.1.1 Policy, legal and normative instruments

Countries should develop and implement comprehensive policies and legal frameworks for arbovirus preparedness and response, addressing both existing and emerging threats (Arbovirus X). These frameworks should establish roles, responsibilities, and accountability mechanisms across all governance levels and sectors. They should also provide a legal basis for implementing vector control measures, importing and licensing medical countermeasures to enable equitable access to vaccines, diagnostics, therapeutics, PPE, and other interventions.

4.1.2 Coordination

Countries should implement effective coordination mechanisms that outline clear delineation of roles, responsibilities, and timelines for all stakeholders involved. Emergency mechanisms should also include technical advisory committees to support government decision-making and actions, ensuring that scientific evidence and technical risk assessments inform responses. The success of these efforts hinges on engaging political leadership at the highest levels to drive a whole-of-society and whole-of-government approach.

4.1.3 Financing

Countries are encouraged to ensure the availability of sufficient and sustainable funding for effective arbovirus epidemic and pandemic preparedness and response. Emergency response requires access to contingency funds that are immediately deployable when outbreaks occur. Governments should establish mechanisms to quickly mobilize and disburse funds across national and subnational levels, with clear operational procedures to ensure their efficient use.

4.1.4 Human resources

A well-prepared, multisectoral, and scalable workforce is essential for effective arbovirus epidemic and pandemic preparedness. Meeting the requirements of the IHR (2005) necessitates a trained and resourced health workforce capable of early detection, prevention, and response at all levels of the health system. This includes the ability to scale operations during surges by redeploying personnel, optimizing roles, relaxing certain regulations temporarily, and expanding the workforce

as needed. Such a workforce not only strengthens health service continuity but also enhances trust in the health system and improves overall community health.

For recommended actions applicable to strengthening preparedness for arbovirus emergency coordination, refer to Section X of the *Getting Started with Pandemic Planning* document (ref)

4.2 Collaborative surveillance

Effective arbovirus surveillance requires multi-source, collaborative and integrated real-time monitoring to support prevention, preparedness, response, and recovery. It extends beyond the health sector, incorporating One Health strategies that link human disease surveillance with vector indices, veterinary data (where arboviruses have non-human vertebrate hosts), laboratory surveillance, and environmental monitoring.

Collaborative surveillance aims to strengthen national integrated disease, threat, and vulnerability surveillance to detect and track arbovirus risks while enhancing diagnostic and laboratory capacity, including genomic surveillance, for timely and accurate pathogen identification. It also establishes coordinated mechanisms for event detection, risk assessment, and response monitoring across sectors and administrative levels. Achieving these objectives requires robust data-sharing systems, interoperable surveillance platforms, and cross-sectoral collaboration from local to global levels to ensure rapid detection and comprehensive threat management.

The IHR (2005) core capacities relevant for arbovirus epidemic and pandemic preparedness include surveillance and laboratory capacities.

4.2.1 Surveillance

Surveillance systems need to function continuously, generating critical data during interepidemic periods while remaining adaptable to emergencies. Given the complexity of arboviruses, no single system suffices; multiple, complementary systems and targeted studies are needed to capture risk, transmission dynamics, severity, and impact comprehensively. These include human surveillance (such as traditional indicator-based surveillance, event-based surveillance, and enhanced clinical surveillance incorporating syndromic patterns, disease outcomes, and exposure history), animal host surveillance (where applicable and including enzootic and epizootic monitoring, reservoir competency studies, and for some arboviruses, sentinel animal seroconversion), vector surveillance (such as sentinel entomological monitoring and targeted surveillance around human cases in households, workplaces, and schools) and environmental surveillance.

These systems should be cost-effective and scalable, particularly in resource-constrained settings, to avoid unsustainable pressures. Resilient surveillance ensures timely, data-driven decision-making, improving public health preparedness and response.

Recommended actions to strengthen arbovirus surveillance

- Identify priority surveillance objectives, select appropriate approaches (e.g. sentinel surveillance, syndromic surveillance, event-based surveillance, laboratory-based surveillance, special investigations and research studies), and develop implementation plans based on local context, resources, and needs. Supplement routine surveillance with targeted investigations and multi-sectoral contextual data to improve risk assessments. See Annex 5 for examples of multi-sector data commonly available at local level.
- Review and strengthen multi-source surveillance by integrating human, vector, and veterinary data. Incorporate additional methods such as environmental surveillance, comprehensive case finding, and population studies during response phases to map disease spread effectively.
- Implement innovative digital health technologies (e.g. geographic information system, artificial intelligence) for real-time data collection and predictive modelling
- Train healthcare workers and public health professionals to identify, report, and analyse arboviral syndromes. Equip clinicians to recognize early warning signs, familiarize community health workers with digital tools, and train data analysts in trend interpretation for actionable insights.
- Develop centralized, integrated data systems capable of sharing and analysing information across sectors and levels. Leverage technological advancements for real-time data linkage and build contingency plans to ensure operational continuity during emergencies.
- Assess and prepare to scale up surveillance systems during future emergencies by mapping data requirements and resource needs according to surveillance objectives across the operational stages of an arbovirus epidemic.
- Evaluate evidence for cost effectiveness of surveillance approaches tailored to country and specific arbovirus context

4.2.2 Laboratory

Laboratory systems are essential for arbovirus epidemic and pandemic preparedness, enabling timely and accurate diagnostic testing and interpretation of results, as well as pathogen characterization and risk-assessment. Countries should prioritize building and strengthening laboratory capacity and networks, and capabilities to diagnose, characterize, assess and monitor arboviral diseases, particularly in regions where multiple arboviruses co-circulate. Laboratory results should be integrated with clinical, environmental, and epidemiological data to provide a holistic understanding of outbreaks and shared with relevant international entities, such as WHO, the World Organisation for Animal Health (WOAH), the United Nations Environment Programme (UNEP), and the Food and Agriculture Organization of the United Nations (FAO) and regional entities. These systems should incorporate advanced diagnostic tools, genomic sequencing capabilities, and robust quality assurance mechanisms to support risk-assessment prevention, detection, and control efforts. An adaptable laboratory framework is critical for routine diagnostics and for scaling up capacity during outbreaks to meet increased testing demands effectively.

Learn more about [laboratory capacity for arboviruses in *Recommendations for Laboratory Detection and Diagnosis of Arbovirus Infections in the Region of the Americas* \(76\)](#)

For recommended actions to strengthen preparedness for laboratory, refer to Section X of the *Getting Started with Pandemic Planning* document (ref)

4.3 Community protection

Community protection refers to inclusive, community-centred actions that meaningfully engage and empower populations to safeguard their health and well-being. Effective community protection against arboviruses requires engaging populations as active partners in designing and implementing preparedness and response strategies. These strategies should address public health and social measures (PHSM), vector control, risk communication and community engagement, and points of entry and border health measures.

A community-focused approach ensures interventions are contextually relevant, equitable, and sustainable by fostering trust and collaboration among communities, policymakers, and the health workforce. It also promotes informed decision-making and local ownership, leading to more effective and lasting protection for populations at risk of arbovirus threats.

The IHR (2005) core capacities relevant for arbovirus epidemic and pandemic preparedness include infection prevention and control (IPC) in community settings (covering public health and social measures and vector control measures), risk communication and community engagement, point of entry and border health.

4.3.1 Public health and social measures

Public health and social measures are non-pharmaceutical interventions implemented at the individual, community and governmental levels to protect the health and well-being of communities affected by health emergencies (77). Key strategies include active-case finding and contact identification, personal protection, environmental measures, social measures, and international travel and trade measures (77). For arbovirus epidemics, the focus is on reducing vector-human contact by addressing environmental, behavioural, and systemic factors that influence transmission. For some arboviruses, it also includes safety measures for substances of human origin (SoHO), such as blood and organs (including donor deferral, blood product screening, or pathogen reduction technology), measures to prevent sexual transmission as in the case of Zika virus, and other specific interventions to interrupt cycles involving peridomestic animals, when applicable. These should be combined with vector control in a coordinated manner across sectors ensuring an efficient and sustainable approach to outbreak prevention and control.

For recommended actions to strengthen preparedness for PHSM, refer to Section X of the *Getting Started with Pandemic Planning* document (ref)

4.3.2 Vector control measures

Vector control measures include environmental, chemical, and biological approaches that target vector populations and habitats to disrupt transmission cycles. Since most arbovirus diseases are preventable through vector control, these measures are central to community protection frameworks. Integrating vector management within community protection strategies enhances sustainability and aligns efforts with broader public health goals.

Recommended actions to strengthen preparedness for multisectoral government-led vector control measures

- Develop and strengthen integrated vector management strategies that align with other vector-borne prevention programs, such as malaria, to maximize resource efficiency and impact.
- Invest in innovative vector control technologies and integration with other existing control efforts. Strengthen public health infrastructure to lead coordinated vector control efforts, ensuring that all interventions are guided by epidemiological, entomological and veterinary data. Coordinate multisectoral actions, monitor progress, and disseminate findings to relevant stakeholders.
- Ensure communities, particularly vulnerable populations, have access to vector control interventions and other public health measures that reduce arbovirus transmission. This includes distributing bed nets to prevent secondary transmission from viremic patients and protection of vulnerable populations sleeping indoors during the day, and barrier protection (e.g., condoms) to prevent infections with sexually transmitted infections like Zika. Reduce vector presence in public areas by installing window screens and promoting the use of air conditioning. Implement source reduction efforts, such as eliminating standing water and managing waste effectively.
- Collaborate with transportation ministries to ensure vector-proofing of ports, airports, and transit hubs to prevent the importation and exportation of arbovirus vectors. Implement regular inspections of public transportation systems, including buses, trains, and ships, to identify and eliminate potential breeding sites. Develop policies for vector control measures during the construction and maintenance of transport infrastructure, such as ensuring proper drainage and waste management at sites (points of entry, transit hubs etc).
- Work with agriculture ministries to monitor and manage vector-breeding conditions in irrigation systems, farmlands, and livestock facilities. Promote the use of eco-friendly pesticides and larvicides in agricultural settings to reduce vector populations, while minimising harm to the environment and human health. Engage farmers and agricultural workers in community awareness campaigns that highlight the links between farming practices and vector control.
- Collaborate with urban planning departments to minimize stagnant water collection by integrating proper drainage systems and landscaping practices. Develop zoning regulations that enforce the construction of vector-proof infrastructure, such as sealed water storage facilities and window screens in residential and public buildings. Partner with waste management authorities to establish efficient garbage collection and disposal systems, reducing potential vector breeding sites in urban and peri-urban areas. Promote sustainable environmental practices, including reforestation and ecosystem restoration, to naturally disrupt vector habitats.

Recommended actions to strengthen preparedness for community-led vector control measures

- Invest in community-led surveillance and source reduction initiatives that engage community volunteers and residents in participatory vector surveillance programmes to

identify and report breeding sites and vector activity. Train these volunteers to monitor environmental conditions conducive to vector proliferation, such as stagnant water and waste accumulation, and to collect vectors for identification to support entomological surveillance.

- Organize regular community clean-up drives to eliminate mosquito breeding sites, such as discarded tires, containers, and clogged drains. Provide essential tools and resources, like waste disposal bins and educational materials, to support sustained community action.
- Empower local leadership and promote education by training and equipping community leaders, health workers, and teachers to serve as champions for vector control, mobilizing their communities to take ownership of interventions. Encourage community networks that can mobilize resources, share information, and provide mutual support during epidemics. Integrate vector control education into school curricula and organize student-led campaigns to spread awareness among peers and families. Partner with local businesses and workplaces to ensure they adopt and promote clean surroundings and vector-free practices.
- Strengthen community ownership of protective practices by encouraging households to engage in vector source management, such as covering water storage containers, applying larvicides to stagnant water, and maintaining clean surroundings. Provide training and necessary tools to ensure these practices are safe and effective. Promote the use of personal protective measures, such as insecticide-treated bed nets, window screens, and repellents, by conducting educational campaigns that emphasize their benefits in preventing arboviral infections.
- Foster participation in technology, research, and feedback for vector control programmes. This can be achieved by introducing mobile apps or community-based platforms that enable residents to report vector hotspots, track intervention coverage, and provide feedback on vector control measures. Support community-based research through citizen science to identify effective, locally tailored vector control practices and encourage innovation through small-scale projects (Box 3). Maintain open communication channels using local media, community meetings, and digital platforms to provide updates on vector control progress and gather community input, ensuring transparency and fostering trust.
- Utilise trained volunteers, schoolteachers, members of the civil services to meet emergency needs in the event of surges in arboviral diseases.

Learn more about vector control in *Integrated vector management* (78); *Global vector control response 2017–2030* (21); *Multisectoral approach to the prevention and control of vector-borne diseases: a conceptual framework* (79)

Box 3: Empowering Communities Through Citizen Science for Aedes Mosquito Control

Citizen science refers to the deliberate engagement of communities and active public participation in scientific research and practice. It leverages digital technologies and platforms to expand the scope of data collection and analysis, while simultaneously building local capacity, enhancing skills, fostering motivation, and opening new communication pathways between communities and key stakeholders (70–72).

This approach has proven particularly effective in the surveillance and control of Aedes mosquitoes, vectors of diseases such as dengue, Zika, and chikungunya, across diverse geographical settings. Notable examples include the Mosquito Alert Project in Spain (73), the TopaDengue Community-Based Dengue Prevention Programme in Paraguay (74), the Vector Surveillance and School-Based Programmes in the Solomon Islands (75,76), and both the Zika Mozzie Seeker and the World Mosquito Programme in Australia (77,78).

Citizen science offers multifaceted benefits for vector control. It is a cost-effective method for collecting extensive data at scale, and empowers communities through collaborative partnerships, often embedded locally with community organizations or focal points. These initiatives not only generate actionable knowledge but also build long-term community capacity by enhancing skills, motivation, and self-efficacy. Sustainability is reinforced by integrating citizen science into school curricula, public health practices, or existing local systems, and by utilizing community resources to maintain ongoing engagement and participation.

Box 3: Empowering communities through citizen science for Aedes mosquito control

4.3.3 Risk communication and community engagement

Risk communication and community engagement aim to empower people at risk to make informed decisions to protect themselves and reduce the impact of health threats such as epidemics. While widespread access to information can support the sharing of accurate messages, it can also lead to information overload and the spread of false or misleading information (in both digital and physical environments), contributing to an ‘infodemic’ during a disease outbreak.

Community engagement aims to empower communities to actively participate in leading, planning and implementing initiatives throughout the health emergency response cycle. This includes sector-specific stakeholder engagement, including faith-based groups and youth networks, to build and maintain partnerships with communities or networks connected by shared history, values, objectives or interests. These stakeholder groups operate at global, regional, national and local levels, each contributing uniquely to health systems and health emergency preparedness and response.

Learn more about risk communication and community engagement in *Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and*

practice (80); *WHO Community engagement framework for quality, people-centred and resilient health services* (81). *Health Promotion* (82);

For recommended actions to strengthen preparedness for risk communication and community engagement, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

4.3.4 Points of entry and border health

Points of entry (PoE) and border health measures are critical in the context of arbovirus epidemic and pandemic preparedness. Airports, seaports, and land crossings could serve as areas for the potential introduction and spread of arboviral diseases, making them essential spots for surveillance and control efforts. A robust border health system helps detect and mitigate the cross-border movement of infected individuals, vectors, or goods that may harbour arboviruses. PoE measures should complement national surveillance and public health systems by preventing outbreaks and ensuring early detection of imported cases. Effective border health strategies rely on multisectoral collaboration, real-time data exchange, and engagement with travellers and transport operators.

In countries that require an International Certificate of Vaccination against yellow fever for incoming visitors, vaccination for this purpose should be done in authorized sites using WHO prequalified YF vaccine (83). Policies related to border entry/exit should consider the accessibility of vaccines to ensure that travel does not exacerbate vaccine inequity.

For recommended actions to strengthen preparedness for points of entry and border health, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

4.4 Clinical care

Effective clinical care depends on a health system that can respond to arbovirus epidemics while maintaining essential health services. Clinical management of arboviral diseases requires timely diagnosis, appropriate treatment, and coordinated healthcare services to reduce morbidity and mortality. WHO recently published guidelines for the clinical management of Aedes-borne arboviral diseases (dengue, chikungunya, Zika, and yellow fever) emphasizing that in the absence of diagnostic tests, as is often the case in low resourced settings, clinicians face challenges in differentiating clinically between arboviral infections presenting with similar syndromes, particularly in the early phases of illness (46). Thus, patients without a specific diagnosis need to be treated empirically, for example, applying judicious fluid management and avoidance of nonsteroidal anti-inflammatory drugs for patients with dengue-like illness. Healthcare facilities must be equipped to handle both routine cases and severe complications, ensuring equitable access to quality care.

Infection prevention and control (IPC) measures are equally critical to minimize transmission risks within healthcare settings, safeguarding both patients and healthcare workers. Strengthening clinical care involves enhancing healthcare infrastructure and equipping healthcare professionals with the knowledge, skills, and tools needed to respond effectively.

The IHR (2005) core capacities relevant for arbovirus epidemic and pandemic preparedness include health services provision and IPC in healthcare facilities.

4.4.1 Health services provision

Health service provision during arbovirus epidemics requires a well-coordinated, efficient, and resilient healthcare system to manage the surge in demand for care (46). A robust governance structure is essential to streamline decision-making, allocate resources efficiently, and coordinate multi-level responses across local, regional, and national healthcare systems. Countries should ensure the availability of healthcare professionals skilled in arbovirus case management, essential medicines, diagnostic tools, and functional health facilities to meet the needs of affected populations. Strengthening referral systems is critical for ensuring timely access to specialized care, especially for severe or complicated arboviral cases. Equitable access to healthcare is a priority, particularly for vulnerable populations, to prevent disparities in treatment and outcomes. Integrating arbovirus-specific services into routine healthcare delivery enhances early detection, management, and continuity of care.

For recommended actions to strengthen preparedness for health service provision, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

For clinical management of arboviral diseases, refer to the WHO guidelines for clinical management of arboviral diseases: dengue, chikungunya, Zika and yellow fever (46).

4.4.2 Infection prevention and control in healthcare facilities

Effective IPC measures are essential for reducing the transmission of arboviruses within healthcare facilities and safeguarding patients, healthcare workers, and visitors. During arbovirus epidemics, healthcare systems may be overwhelmed, making robust IPC practices pivotal in maintaining safe environments for service delivery. Strengthening IPC frameworks enhances epidemic preparedness while mitigating the risks of nosocomial (hospital-acquired) and occupational transmissions. These strategies should address both vector-borne and non-vector modes of transmission, ensuring comprehensive protection for all individuals involved in the care process. An effective IPC system will not only limit arbovirus transmission but also enhance the overall effectiveness of the healthcare response.

Recommended actions to strengthen preparedness for infection prevention and control in healthcare facilities

- Ensure all healthcare workers are equipped with the necessary IPC knowledge and skills through mandatory training programs and regular refresher courses. This training should cover both vector-borne and non-vector transmission routes (e.g., needle-stick injuries, blood transfusions, and contaminated medical equipment). Focus should also be placed on early detection and reporting of suspected arbovirus cases, with healthcare workers trained in safe injection practices, PPE usage, and the handling of contaminated materials. Ongoing awareness programs should foster a culture of safety and accountability through leadership engagement and team-based support, ensuring adherence to IPC protocols.

- Implement rigorous IPC protocols specifically designed to mitigate the risk of transmission through needle-stick injuries, contaminated medical equipment, and unsafe blood transfusions. This includes adopting safe injection practices, proper disposal of sharps, and enhanced blood safety measures. Blood donations should be screened for arboviruses, and all blood products must be properly stored, handled, and transfused following strict safety standards. Healthcare workers should receive continuous training on these protocols to ensure a high level of compliance and safety.
- Ensure safe environment in health facilities by enforcing robust vector control strategies within healthcare facilities to minimize the risk of arbovirus transmission. This involves eliminating vector breeding sites within and around healthcare settings, using insecticide-treated nets or screens for patient wards, and implementing vector-proofing measures in high-risk areas. Insecticide spraying should be carried out in accordance with national and international guidelines to avoid unnecessary exposure and ensure the health and safety of patients and healthcare workers. Regular monitoring of vector control interventions should be established to maintain optimal protection during epidemics.
- Enhance healthcare-associated infection (HAI) surveillance focused on tracking infections linked to arbovirus transmission within healthcare settings. This includes regularly monitoring, collecting, and analysing data on infections that may be acquired within healthcare facilities. Implement data-driven interventions based on surveillance findings and integrate HAI data with broader epidemic response efforts to rapidly identify and mitigate nosocomial transmission. Engage healthcare workers in recognizing and reporting HAI cases promptly, fostering a culture of vigilance and accountability to prevent outbreaks from spreading within healthcare environments.

For other recommended actions to strengthen preparedness for infection prevention and control, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

4.5 Access to countermeasures

Ensuring timely access to effective countermeasures which diagnose, prevent, protect from or treat illnesses is critical to mitigating the impact of arbovirus outbreaks. This involves the coordinated and efficient delivery of medical countermeasures (MCMs) such as diagnostics, vaccines, therapeutics, and other relevant health products (e.g. personal protective equipment) to affected populations, supported by a robust framework for their timely and equitable distribution.

The relevant IHR (2005) core capacity relevant for arbovirus epidemic and pandemic preparedness is health emergency management, which includes vaccination and chemoprophylaxis.

4.5.1 Health emergency management

The national health emergency management framework should be robust and operationally ready to respond to health emergencies, including arbovirus epidemics. This framework must integrate several core capacities: an effective incident management system (IMS) for coordinating across sectors, agile regulatory systems to fast-track research, development, and approval of countermeasures, scalable manufacturing systems, and a reliable supply chain and integrated delivery management system to ensure the timely availability and distribution of countermeasures.

Strengthening these components enhances a country's ability to ensure timely and equitable access to safe and effective MCMs when needed.

For recommended actions to strengthen preparedness for health emergency management, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

Learn more about access to countermeasures in *Interim Medical Countermeasures Network* (84); *Defining access to countermeasures* (85)

Vaccination and chemoprophylaxis

Vaccines can be used to prevent replication in humans by inhibiting, suppressing or clearing the virus, thereby playing a significant role in reducing severity of illness and deaths caused by arboviruses (86). Where safe and effective vaccines exist (such as for yellow fever, dengue, Japanese encephalitis, and tick-borne encephalitis), countries should incorporate them into national preparedness plans based on endemicity, risk assessments, and cost-effectiveness analyses. Epidemic-ready vaccine supply chains should also be maintained to ensure timely access, robust cold chain management, and the capacity for targeted or mass distribution capacity, especially for high-risk and underserved populations to ensure equitable access. Preparedness planning should anticipate supply constraints, varying product characteristics, and the need for rapid regulatory pathways during emergencies.

Chemoprophylaxis including antivirals and monoclonals are currently under development for several arboviruses including dengue, Zika, chikungunya and West Nile viruses (87). If proven efficacious, and are available, such medical countermeasures can prove useful for pre- or post-exposure protection of high-risk groups, including health workers and close contacts of confirmed cases. Clear guidance on the use of vaccines and chemoprophylaxis, alongside strategies for community engagement strategies, regulatory preparedness, and cross-border coordination, will be essential to ensure effective, timely, and equitable response efforts.

For recommended actions to strengthen preparedness for vaccination and chemoprophylaxis, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

Box 4: Singapore's Comprehensive Dengue Control Strategy: A Model of Integrated Surveillance, Community Engagement, and Innovation

Since the 1960s, Singapore has developed a highly adaptive, science-driven dengue control strategy centred on source reduction, surveillance, public engagement, and legislation. Early success in reducing *Aedes* mosquito populations led to national rollout of integrated source reduction and public education efforts, supported by strong laws such as the Destruction of Disease Bearing Insects Act (1968). Over five decades, Singapore maintained a proactive, inter-epidemic surveillance and control system, mandating dengue case reporting and deploying real-time virus monitoring. Vector control operations, house inspections and legal enforcement, are intensified before the dengue season.

Singapore's dengue control efforts have consistently followed an evidence-based approach for over fifty years, with policies and operations shaped by scientific research and data. The evolution of the system has been anchored in four core principles aligned with World Health Organization recommendations: (i) inter-epidemic surveillance and control; (ii) risk-based prevention and intervention; (iii) coordinated inter-sectoral cooperation; and (iv) development and adoption of science and technology.

Learn more here: Singapore's 5 decades of dengue prevention and control—Implications for global dengue control (85) .

Box 4: Singapore's Comprehensive Dengue Control Strategy: A Model of Integrated Surveillance, Community Engagement, and Innovation

Box 4 highlights how Singapore employs a comprehensive dengue control strategy, using integrated surveillance, community engagement, and innovation. Technical resources and other case studies from various countries and regions are included in Annex 6 to illustrate successful implementation of collaborative surveillance and prevention, community participation and protection, emergency coordination, access to countermeasures and clinical care. These examples showcase diverse approaches that have proven effective in different contexts. By integrating lessons learned from these examples, stakeholders can adapt strategies to their unique operational landscapes, ensuring that preparedness measures are both context-specific and scalable.



Chapter 5: Implementing arbovirus pathogen epidemic and pandemic preparedness

Chapter 6: Monitoring in arbovirus pathogen epidemic and pandemic preparedness

Chapter 7: Research in arbovirus epidemic and pandemic preparedness

Chapter 8: Suggested outline for a national arbovirus pathogen epidemic and pandemic preparedness plan

5 Implementing arbovirus pathogen epidemic and pandemic preparedness

This PRET module has outlined the importance of arbovirus epidemic and pandemic preparedness (Chapters 1 and 2), introduced an organizing framework for epidemic and pandemic planning (Chapter 3), and detailed the core capacities needed for enhanced preparedness (Chapter 4). This chapter transitions into the "how" by integrating the organizing framework with the required core capacities, focusing on the approaches to strengthen arbovirus preparedness and the necessary actions during each operational stage.

5.1 Approaches to strengthen preparedness

Countries are encouraged to adopt two mutually reinforcing strategies: a cross-cutting all-hazards approach and a vertical hazard-specific (mode of transmission) approach. The vertical hazard-specific approach complements the broader all-hazards approach by addressing the technical specificities such as the epidemiological characteristics and transmission dynamics of individual arboviruses (Figure 5). For example, while both dengue and Zika viruses are transmitted by *Aedes* mosquitoes, some prevention and response measures differ. Dengue prevention largely focuses on mosquito vector control measures. On the other hand, while Zika virus transmission is primarily mosquito-borne, prevention messaging must also address the risk of sexual and vertical transmission in humans. Pregnant women, in particular, require specialized attention due to the risk of congenital Zika syndrome. In areas where Zika virus is circulating, public health measures include educating the public on safe sexual practices and emphasizing the use of condoms to reduce transmission risks.

These complementary approaches enable health systems to build on existing capacities while addressing the unique challenges posed by arboviruses. This approach can help countries optimize resource allocation, enhance the impact of interventions, and create a robust foundation for arbovirus epidemic and pandemic preparedness, while implementing targeted interventions.

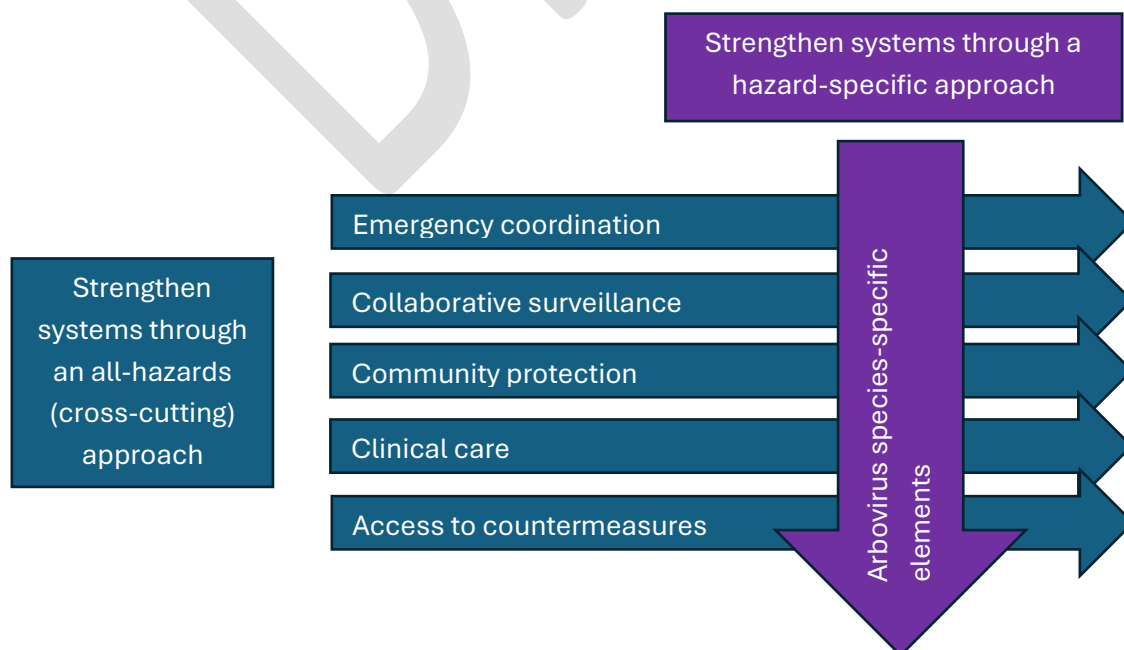


Figure 5: Two mutually reinforcing approaches to strengthen arbovirus epidemic and pandemic preparedness

5.2 What to do when: the focus of actions during different periods

Effective preparedness and response require a phased approach aligned with the progression of an epidemic or pandemic. The following are suggested actions countries could do across the distinct periods and operational stages outlined in the organizing framework (Figure 4).

It is important to note the specific measures implemented during each stage may vary depending on the arbovirus involved and the epidemiological context. For example, a single yellow fever case detected in an urban area with no travel history, or in a non-endemic setting, could be sufficient to trigger the activation of the Emergency Operations Centre (EOC).

Pre-emergence period: Prevent and prepare

Arbovirus transmission to humans has not yet been detected, though imported or non-vector-borne cases (e.g., sexual transmission of Zika virus) may occur. The virus may already circulate in vectors or animal reservoirs, and environmental conditions may be favourable for transmission.

- Strengthen multisectoral collaboration across public health, urban planning, agriculture, environmental management, etc to address the environmental and socioeconomic drivers of arbovirus outbreaks. For example, urban planning can integrate drainage systems to reduce water stagnation, while agriculture programmes can promote vector-safe irrigation practices.
- Conduct strategic risk assessments for arbovirus epidemics and potential pandemics. Using a risk-based approach, this process helps to identify and prioritize arbovirus risks in specific geographic contexts, enabling tailored preparedness and response strategies (Ref: Arbovirus risk assessment tool).
- Enhance cross-border coordination with neighbouring countries to monitor and control disease transmission. Share resources, epidemiological data, and best practices to ensure a unified response across regions. Countries at risk of yellow fever virus transmission can apply the IHR provisions to prevent introduction of potentially viraemic travellers.
- Establish and maintain robust, integrated systems for detecting arbovirus circulation in animal reservoirs such as birds (West Nile virus) or non-human primates (yellow fever). Incorporate environmental monitoring to track climate factors like rainfall, temperature, and humidity that affect vector breeding.
- Monitor vector population dynamics regularly through entomological surveys and implement strategies like habitat destruction, insecticide application, and larval source reduction. These efforts should focus on high-risk areas where vectors are abundant and likely to breed. Novel tools such as Wolbachia and SIT could be introduced and integrated into the integrated vector management strategies.
- Engage and educate communities using a structured communication plan through tailored awareness campaigns and initiatives on vector prevention (e.g. eliminating standing water, using bed nets or repellents, and wearing protective clothing), especially for vulnerable and at-risk populations. Ensure messages are clear, consistent, and counter misinformation and disinformation before and during a crisis.
- Invest in laboratory infrastructure and workforce training to ensure timely and accurate arbovirus diagnosis and pathogen characterization. Stockpile or secure procurement

pipeline for reagents and maintain a reliable supply chain for diagnostic equipment to avoid delays during outbreaks.

- Conduct periodic simulation exercises to test epidemic plans, to help identify gaps in coordination and response capacity, enabling timely corrective actions.
- Support R & D, manufacturing, and supply chain for medical countermeasures such as vaccines, diagnostics and therapeutics for arboviruses with epidemic potential. For example, countries could establish agreements with manufacturers to ensure rapid procurement and distribution during emergencies.
- Build and maintain a roster of multidisciplinary experts who can be mobilized when the IMS is activated, while the EOC is in watch mode.

Emergence period: Respond – activate early control measures

There are reports of autochthonous sporadic cases or small clusters of arbovirus infections in humans. Actions are aimed towards breaking the early transmission chains.

- Enhance surveillance and implement active case finding to identify new cases and monitor trends. The EOC may be in alert mode during this time. Community health workers and local volunteers can be engaged to report suspected cases, ensuring comprehensive case detection.
- Deploy targeted vector control interventions, using entomological data to guide localized larval and adult control measures along with source reduction and environmental cleanup in outbreak zones. Provide rapid diagnostic and clinical support in healthcare facilities, and train staff on case management. Equip hospitals with essential supplies to manage severe cases, such as intravenous fluids for dengue, and other recommended and approved medications and equipment for supportive case management.
- Engage community leaders in developing and disseminating risk communication messages tailored to local contexts. Promote protective behaviours (e.g. use of repellents) and early care-seeking. Implement social listening systems to identify and address rumours, misinformation and disinformation.
- In the event of yellow fever case detection, protect the local population by aiming to achieve at least 80% vaccination coverage. This can be done through implementing reactive vaccination campaigns ensuring that high-risk individuals are targeted. Countries can access the global stockpile of YF vaccines through the ICG mechanism. Roll out vaccination campaigns by deploying vaccines for other arboviruses where available, prioritizing high-risk groups such as healthcare workers, pregnant women, and residents of endemic regions. Monitor vaccine uptake and address hesitancy through targeted interventions and campaigns.
- Enhance operational readiness by scaling up stockpiles of PPE, diagnostic tools, and vector control supplies. Conduct refresher training for rapid response teams to maintain readiness for escalating situations.

Amplification and local transmission period: Respond – contain

There is continuous local transmission from arthropod vectors to humans (with or without other intermediate vertebrate hosts) within a defined area. Actions are needed to interrupt transmission and control the epidemic. Scale up the actions above. In addition to the actions above,

- Activate the incident management system to mobilize a centralized multisectoral coordination mechanism to lead and align all response efforts. Notably, activation of the IMS and grading mechanism is dependent on the criteria defined by the country, in line with national policies, plans and procedures (88).
- Scale up coordinated response as needed. Adapt the national risk assessment to the subnational level and use epidemiological data to identify transmission hotspots and prioritize interventions. Tailor strategies to the specific needs of each area, such as focusing vector control in urban centres or improving healthcare access in rural communities, and conducting reactive vaccination to contain the outbreak, if appropriate.
- Scale up vector control measures by implementing large-scale, community-wide vector control programmes, including fumigation, larvicide application, and habitat modification. Coordinate efforts across neighbouring regions to reduce the likelihood of reintroduction of vectors into controlled areas.

Widespread community transmission: Control/reduce transmission and spread to mitigate impact

Cases have spread across multiple communities or geographic areas, transitioning from localized clusters to widespread transmission within and between regions. Actions are needed to contain the outbreak and suppress transmission within the affected area. Scale up the actions above. In addition to the actions above,

- Strengthen subnational response systems by empowering subnational and local authorities to lead risk-informed and context-specific actions
- Expand health and social protection to provide support to affected households, maintain essential health services and protect health workers
- Coordinate regionally and globally, facilitating joint procurement, information exchange and harmonized responses with other governments and international partners

Stabilized situation: Recover

When transmission declines and health systems regain stability, focus on transitioning to long-term control measures and preparing for future outbreaks.

- Maintain vector control efforts by continuing regular monitoring and interventions to keep vector populations below transmission thresholds. Engage communities in sustained activities such as eliminating breeding sites and using protective measures.
- Review response actions through after-action reviews to identify gaps and lessons learned. Use these insights to update national plans and enhance future response strategies. Use the experience of the outbreak to enhance community awareness and preparedness.

Maintain ongoing communication campaigns to keep the public engaged in prevention and readiness activities.

- Strengthen community-based surveillance networks to detect early signs of resurgence. Empower local health workers to act as the first line of defense against future outbreaks.
- Support studies on arbovirus evolution, transmission dynamics, and new countermeasures to foster research and innovation. Partner with academic institutions and international organizations to advance the understanding of arbovirus threats.

DRAFT

6 Monitoring in arbovirus pathogen epidemic and pandemic preparedness

Monitoring is a critical component of epidemic and pandemic preparedness, enabling countries to assess their readiness, identify gaps, and implement corrective actions to strengthen response systems. This chapter focuses on monitoring core capacities under the IHR 2005 and highlights practical indicators for evaluating the functionality of arbovirus epidemic and pandemic plans.

6.1 Monitoring relevant International Health Regulations (2005) core capacities

The IHR (2005) provides a comprehensive global framework enabling countries to detect, assess, notify, report, and respond effectively to public health events of international concern. To support the implementation and monitoring of these regulations, the IHR Monitoring and Evaluation Framework (MEF) outlines approaches to assess country-level core capacities (89).

For information on monitoring relevant IHR (2005) core capacities, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

6.2 Monitoring functional arbovirus pathogen epidemic and pandemic preparedness planning

Targeted measures are essential for monitoring the functional preparedness and planning for arbovirus epidemics and pandemics. These measures enable countries, partners, and WHO to track progress, identify existing gaps, and implement necessary adjustments to strengthen preparedness efforts. To ensure sustained effectiveness, monitoring should be conducted at regular intervals rather than as a one-time assessment. Table 1 outlines a set of measures designed to promote continuous improvement in planning and preparedness activities.

Table 4: Indicators to monitor functional capacities for arbovirus epidemic and pandemic preparedness and planning

Component	Measure
Emergency coordination	• Presence of an arbovirus epidemic and pandemic plan • Presence of a functional incident management system for arboviruses • Presence of an active multisectoral group or taskforce for arbovirus epidemic and pandemic preparedness that meets at least once a year • Routine review, testing, and updating of arbovirus preparedness plans through simulation exercises and actionable recommendations at least once every two years
Collaborative surveillance	• Access to funding for emergency response • Integration of arbovirus surveillance into national health information systems, with consistent and timely data reporting from local to national and regional levels

Community protection

- Presence of an interdisciplinary/multisectoral reporting system with defined roles and data flow
- Availability of diagnostic capacity for arboviruses, including antigen tests, RT-PCR or serological testing, as appropriate to the respective arbovirus (90,91)
- Local capability or established agreements with reference laboratories for timely genomic sequencing of arbovirus pathogens to monitor genetic changes, track variants, and support epidemiological investigations
- Active participation in regional and global arbovirus surveillance networks to facilitate information sharing and coordinated responses
- Presence of designated personnel in ministries of health to address misinformation and improve public trust during arbovirus outbreaks trained infodemic manager/s in ministries of health
- Evidence of ongoing risk communication campaigns and community engagement initiatives that build public awareness of arbovirus transmission, prevention and control measures
- Evidence of community engagement during acute arbovirus disease events including dengue, chikungunya, yellow fever

Clinical care

- Presence of community-based surveillance systems for early detection of arbovirus cases and reporting of unusual events, like clusters of febrile illness
- Presence of national guidance on clinical management of arbovirus infections, including dengue, chikungunya, yellow fever, and Zika
- Presence of training and retraining programmes for healthcare workers on clinical management of severe arbovirus cases
- Availability of essential medical supplies, such as fluids for managing severe dengue cases, and access to intensive care units for critical patients

Access to countermeasures

- Presence of a National Vaccination and Deployment Plan that outlines priority populations and vaccination strategies for arboviruses with available vaccines, such as yellow fever
- Presence of a streamlined regulatory framework to expedite the approval and distribution of vaccines, diagnostics, and treatments during arbovirus epidemics and pandemics
- Establishment of procurement and stockpiling mechanisms for arbovirus countermeasures, including insecticides, diagnostic kits, and medical supplies

- Strengthened capacity to deploy mass vaccination campaigns during outbreaks, supported by pre-existing logistics, supply chains, and community mobilization plans
- Collaboration with international partners to ensure equitable access to countermeasures

DRAFT

7 Research in arbovirus epidemic and pandemic preparedness

Research preparedness is a cornerstone for a robust and equitable response to future arbovirus epidemics and pandemics. This chapter outlines the research systems and strategies needed to strengthen preparedness and response efforts across five critical components: emergency coordination, collaborative surveillance, community protection, clinical care, and access to countermeasures. By investing in research infrastructure, fostering collaborations, and prioritizing research agendas, countries and stakeholders can enhance their readiness for arbovirus-related public health emergencies.

7.1 Building a strong research ecosystem for arbovirus preparedness

A strong foundation for arbovirus research includes basic, translational, clinical, and operational research to develop and deploy effective public health and medical countermeasures. While not all countries may prioritize these areas, engaging with regional and global research networks is essential to bolster preparedness. The pre-epidemic period offers a strategic window to develop and validate research protocols that can be rapidly deployed during active transmission, ensuring timely and ethically sound data collection when an epidemic emerges.

Basic research is fundamental for understanding the biology, ecology, and epidemiology of arboviruses and their vectors (92). Examples of relevant focus areas include:

- Pathogen biology and host interactions: studies on arbovirus replication, pathogenesis, and host immune responses, and genotype-to-phenotype studies
- Vector biology and control: research on vectors, their behaviours, as well as novel and effective vector control strategies
- Zoonotic spillover mechanisms: investigations into the interface between humans, vectors and animals to identify risk factors for arbovirus emergence
- Prototype pathogen approach: selection and study of representative viruses from arbovirus families to prepare for potential epidemics caused by unknown pathogens

Translational and clinical research support the development and deployment of diagnostics, therapeutics, and vaccines. Essential priorities include:

- Accelerating the development of candidate vaccines and therapeutics for priority arboviruses, including vaccines for dengue, chikungunya, Zika and Oropouche viruses, and therapeutics for high-mortality arboviruses such as Crimean-Congo haemorrhagic fever (93)
- Conducting clinical trials for novel countermeasures using standardized protocols and leveraging innovative platforms
- Strengthening regulatory science to expedite approvals and ensure the safety and efficacy of medical products during emergencies

Operational research plays a critical role in supporting timely, evidence-based decision-making during arbovirus outbreaks, ensuring response strategies are informed by real-time data. Some key areas include:

- Estimating disease incidence, morbidity, and mortality associated with various interventions. These estimates enable public health authorities to assess the effectiveness of ongoing measures and adjust strategies to optimize outcomes.
- Researching infection kinetics to determine optimal timing of specimen collection for laboratory diagnostic testing.
- Evaluating the effectiveness of vector control strategies, such as insecticide-treated nets, larvicides, and environmental modifications, as well as innovative strategies for *Aedes aegypti* control (such as genetically engineered mosquitoes and biologically engineered mosquitoes with Wolbachia)
- Assessing the impact of risk communication and community engagement on behaviour change and epidemic containment
- Optimizing healthcare delivery systems, resource allocation, and clinical management protocols for arbovirus patients
- Evaluating the resilience of healthcare systems under the strain of an outbreak. This involves identifying gaps in clinical care pathways, workforce capacity, and supply chains that could hinder effective response efforts.

7.2 Strengthening research systems and networks

A well-coordinated research response requires pre-existing capacities, networks, and funding mechanisms.

Developing and prioritizing national and global research agendas is vital to focus resources on high-impact areas. For arboviruses, this includes:

- Establishing research priorities for endemic and emerging arboviruses based on national and regional disease burdens
- Securing sustainable funding for research preparedness through public-private partnerships, international donors, and domestic investments

Pre-existing research networks are critical for facilitating rapid responses to arbovirus epidemics and pandemics. Examples include:

- The WHO Research and Development (R&D) Blueprint, which guides global efforts to accelerate the development of countermeasures for epidemic-prone pathogens (94)
- Global and regional networks for genomic surveillance and data sharing to track arbovirus evolution and spread (95)
- Collaborative platforms like the Coalition for Epidemic Preparedness Innovations (CEPI), which supports vaccine development for emerging threats, including arboviruses.

Strengthening national and regional research capacities is essential for arbovirus preparedness.

Key actions include:

- Training researchers and healthcare workers in research methodologies as well as outbreak investigation methods

- Creating enabling environments for research through policies on data sharing, ethical approval processes, and benefit-sharing agreements.

7.3 Leveraging advances in technology

Emerging technologies present transformative opportunities to strengthen arbovirus research, enabling more effective prevention, surveillance, diagnostics, and outbreak response. By integrating technological innovations into research systems, stakeholders can address the unique challenges of arboviruses, such as their epidemiological characteristics, transmission dynamics and environmental complexity. Some areas of innovation include:

- Artificial intelligence (AI) is a powerful tool that can process large datasets from diverse sources, including environmental, epidemiological, and entomological data (96). These technologies can enhance outbreak modelling that predict the spread and severity of arboviral outbreaks, enabling timely and informed interventions.
- Next-generation sequencing (NGS) technologies, particularly metatranscriptomic sequencing, can revolutionize genomic surveillance for arboviruses (97). These tools facilitate the rapid detection of novel or re-emerging arboviruses, even within complex environmental samples, and enable real-time tracking of viral evolution. Insights from genomic data allow researchers to monitor mutations and assess their implications for virulence, transmissibility, as well as the effectiveness of medical countermeasures.
- Digital tools and mobile applications further complement traditional surveillance systems, enhancing the timeliness and flexibility of data collection and analysis (98). Mobile apps and social media platforms can be used to enhance rapid reporting and monitoring of outbreaks, particularly in remote or underserved regions. These tools facilitate community engagement by disseminating accurate and timely information to the public, countering misinformation, and fostering trust in public health interventions. In addition, social media platforms can offer real-time insights into disease trends, allowing health authorities to detect early warning signals and implement timely responses.
- Advances in vaccine technology are also accelerating the development of effective countermeasures for arboviruses (86). Novel vaccine platforms being explored include insect-specific viruses, mRNA technology, vaccines against mosquito salivary proteins, nanoparticle-based vaccines and DNA vaccines.
- Several isothermal nucleic acid amplification techniques (INAAT) are currently being explored to enhance the speed, sensitivity, and accuracy of arboviral disease detection (99). Looking ahead, novel sample-to-answer INAAT-based devices are expected to emerge, offering transformative potential in diagnostics. These next-generation tools are anticipated to be more cost-effective to manufacture, user-friendly, and suitable for point-of-care applications. Their portability and ease of deployment will make them invaluable for diagnosing arboviral diseases in remote and underserved areas, strengthening outbreak detection and response efforts.

8 Suggested outline for a national arbovirus pathogen epidemic and pandemic preparedness plan

This chapter outlines steps for developing or updating a comprehensive arbovirus epidemic or pandemic plan, and provides a suggested outline for a national arbovirus epidemic and pandemic plan. Wherever applicable, existing plans, such as those for dengue or chikungunya, can serve as a foundation. The goal is to create plans that are practical, feasible, and streamlined, enabling easy operationalization.

8.1 Essential steps in pandemic planning

The planning process involves four key steps:

1. Prepare, analyze the situation and engage stakeholders
2. Draft the plan
3. Evaluate, finalize, and disseminate the plan
4. Implement, monitor, and continuously improve the plan.

For detailed information on the essential steps in pandemic planning, refer to Section X of the *Getting Started with Pandemic Planning* document (ref).

8.2 Suggested outline for a national arbovirus epidemic and pandemic plan

The outline offers a suggested and adaptable structure and includes an approach for documenting context and objectives (Part A), planning considerations and assumptions (Part B), country systems and capacities (Part C), triggers and activation of the plan (Part D), and actions required during each operational stage (Part E). Relevant additional information or procedures can be included as annexes (Part F), such as pathogen-specific considerations for priority arboviruses (e.g., dengue, chikungunya, Zika, or yellow fever viruses).



Part A: Introduction

This section provides the overall context for the arbovirus epidemic and pandemic preparedness plan, outlining the country's specific vulnerabilities and existing health and disaster management systems. It sets the scope, objectives, and intended audience for the plan, clarifying its purpose as a tool for operational readiness, coordination, and advocacy.

Consider including:

- a. Country context
 - i. Country overview, including demographics, geography, climate, and disaster risk profile, particularly as they relate to arbovirus outbreaks (e.g., regions prone to vector proliferation, climatic factors, or urbanization).
 - ii. Description of the relevant existing systems such as disaster risk management structures, public health systems, and national frameworks for managing arboviruses.
 - iii. Arbovirus prevention and control landscape:
 - Status of arbovirus surveillance and response programmes
 - Vector control programmes, including coverage and gaps in implementation
 - Health promotion and clinical care programs targeting arboviruses
- b. Purpose and scope of document
 - i. To outline the existing systems and capacities relevant for arbovirus epidemic and pandemic planning
 - ii. To describe the operational actions and roles and responsibilities of different stakeholders during the different epidemic or pandemic periods
 - iii. To serve as a tool for advocacy, resource mobilization and monitoring to strengthen preparedness
- c. Objectives of the plan
 - i. To minimize the risk of an arbovirus epidemic or pandemic, including the transmission, morbidity and mortality, and socioeconomic impacts
 - ii. To enable appropriate and timely actions for emergency coordination, collaborative surveillance, community protection, clinical care and access to countermeasures during each operational stage
 - iii. To inform, engage and empower the public to maximize community resilience
- d. Target audience
(see Table 1 of the *Getting Started with Pandemic Planning* document)
- e. Risk of arbovirus epidemics and pandemics
(see Chapter 2, section 2.7)

Part B: Planning considerations and assumptions

This section lays out the foundational principles, legal frameworks, and methodological approaches that guide the development of the preparedness plan. It ensures the plan is ethically sound, inclusive, legally compliant, and built on realistic assumptions with defined funding and coordination mechanisms.

Consider including:

- | | |
|---|--|
| a. Principles and ethical considerations | <ul style="list-style-type: none"> i. Consider equity, gender, and human rights, inclusiveness, coherence, and others, according to the country context ii. Describe the purpose of principles and ethical considerations. This can include (a) balancing rights, interests and values, (b) setting priorities, (c) implementing public health measures, and (d) having equitable access to life-saving measures if scarce. |
| b. Legal and policy considerations | <ul style="list-style-type: none"> i. Legislative framework for health emergency preparedness and response/arbovirus preparedness and response, including coordinating frameworks between sectors and legal basis for public health measures ii. Roles and responsibilities in epidemic and pandemic preparedness and response, including those that are legally mandated and those for technical advisory groups iii. Compliance with obligations under the IHR (2005) and any other international agreements iv. Policies for data sharing and decision making v. Policies for research and innovation including participation in regional/global platforms focused on research during public health emergencies. |
| c. Methods for plan development | <ul style="list-style-type: none"> i. Planning committee terms of reference ii. Multisector and multi-level consultations (see Box 1) iii. Analysis of existing in-country and external systems, capacities and capabilities |
| d. Approach for planning (can include the following) | <ul style="list-style-type: none"> i. Needs-based and scalable ii. Integrated across society iii. Leveraging existing systems and capacities iv. Regular updating of plan based on preparedness and response needs v. Indicators and milestones for preparedness including for the planning process vi. Others, as indicated by country context. |
| e. Epidemic and pandemic preparedness and response periods and operational stages | (see Chapter 3, section 3.3) |
| f. Planning assumptions | (see Annex 7) |
| g. Funding for multisector preparedness and response | (see Chapter 5, section 5.1 of the <i>Getting Started with Pandemic Planning</i> document) |

- h. Other national or subnational considerations (as needed)

Part C: Country systems and capacities relevant for arbovirus epidemics and pandemics

This section details the existing national and subnational systems for emergency coordination, surveillance, community protection, clinical care, and access to countermeasures. It identifies gaps and capacities in these systems, ensuring alignment and readiness for an effective response to arbovirus outbreaks.

Consider including:

- a. Emergency coordination: describe systems and procedures
 - i. How this plan fits with other emergency response operations plans
 - Describe the roles and responsibilities at national, subnational and local levels during an arbovirus epidemic or pandemic
 - Describe the command-and-control structures, including if there is an Emergency Operations Centre
 - Describe the frameworks for multi-agency and multi-sector coordination
 - ii. Describe emergency funding triggers, mechanisms and measures to streamline the utilization of funds
 - iii. Describe plans for exercising emergency coordination across sectors, across levels and with other stakeholders (communities, international partners etc)
 - iv. How human resources will be surged
 - What methods are used to address skills shortages if they exist
 - How emergency medical teams (national and international) will be used
 - v. Other national or sub-national considerations.
- b. Collaborative surveillance: describe systems and procedures
 - i. What One Health surveillance and coordination mechanisms are in place nationally and internationally, and how they will support epidemic or pandemic preparedness and response
 - ii. How signals will be verified and investigated
 - iii. The role of health emergency alert and response teams
 - functions, standards and deployment criteria
 - support for and coordination of team deployments
 - involvement of and access to global or regional networks/teams

- iv. How data will be promptly synthesized, assessed and used to inform action
- v. What the triggers will be and how risk assessments will be done and by whom
- vi. What surveillance approaches will be put in place for:
 - coordination and information sharing concerning pathogens circulating in animals prior to emergence among humans
 - rapid detection and assessment of an emerging or re-emerging (including new variant or sub-type) arboviruses
 - monitoring epidemiological characteristics of arboviruses with sustained circulation in human populations (epidemic and pandemic surveillance)
 - monitoring epidemiological characteristics of arboviruses in the inter-epidemic period
 - monitoring the effectiveness of human health interventions.
- vii. How access to laboratory services will be ensured, such as:
 - what subnational, national and international networks and reference laboratories for arboviruses exist and how these will enable sharing of biological samples and genetic data
 - how other laboratories may be co-opted if there is a surge in demand
 - how specimens will be transported or shipped to referral laboratories nationally or internationally
 - how laboratory data will be integrated with other data (e.g., clinical)
- vi. How multi-source data from the health system and other sectors will be used to comprehensively inform risk assessment and response actions, including:
 - hospital and other health care facility capacity monitoring
 - supply chain system monitoring
 - infodemic monitoring and insights generation
 - urban and disaster risk management data
 - humanitarian assistance monitoring systems
- ix. Other national or subnational considerations on surveillance.

c. Community protection

- i. What mechanisms will be used to deliver arbovirus infection prevention interventions in alignment with local contexts and customs, such as:
 - public health and vector control measures to interrupt or control chains of transmission

- social welfare and protection measures including for marginalized or at risk groups requiring greater support livelihood and economic safety nets and food security to minimize poverty, civil unrest and harm
- measures for the continuation of essential services
- ii. How vector control measures will be considered
 - how evidence of effectiveness of vector control measures will be gathered (including research)
- iii. What two-way communications mechanisms will be used
 - how community insights and sentiments will be monitored and analysed
 - what processes will be used to develop health/other messages as the situation evolves
 - how will messages be adapted to community context/customs
 - what community networks/influencers will be engaged to ensure community inclusion and consistency of outreach
 - how will media groups (e.g., social media, radio, print etc) be engaged
 - who is responsible to coordinate messaging and set the frequency of communication
 - what languages will be used in which communities, if appropriate
- iv. How misinformation and disinformation will be monitored and addressed
 - what processes will be used to empower and strengthen community resilience against misinformation and disinformation
 - how scientific literacy will be strengthened
- v. How travel and trade will be maintained
 - how risk communication and risk mitigation measures will be designed and delivered to travellers
 - how surveillance and case management at points of entry and onboard conveyances will be conducted when these measures are indicated
 - how essential travel such as humanitarian corridors or cargo transport of critical supplies will be managed when these measures are indicated
 - how decisions on targeted screening, testing or quarantine will be made and how they will be operationalized
- vi. Other national or subnational considerations on protecting the community

- d. Clinical care: describe systems and procedures
- i. How facilities will be scaled up, including for
 - clinical care pathways that account for patient flow, triage and isolation
 - point of care diagnostic tests
 - severe arbovirus infection case management
 - use of tele-medicine and use of private sector facilities, if applicable
 - waste management.
 - ii. How the availability of supplies and equipment will be sustained at facilities
 - systems to report shortages or stock-outs
 - security measures to safeguard stocks.
 - iii. How essential individual and population-based services will be maintained
 - define the priorities of essential health services and mechanisms
 - identify trained health workforce and staff from other sectors to supplement in case of workforce shortages
 - procedures and platforms to monitor disruptions and trigger corrective actions to essential services
 - approaches and procedures to facilitate the recovery of services after the emergency.
 - iv. How health and care workers, patients and communities will be protected
 - access to infection, prevention and control methods, materials and training including water, sanitation and hygiene capacities, as well as occupational health
 - adequate WASH services in health facilities
 - mechanisms to monitor and mitigate attacks on health and care workers.
 - v. The roles of different sectors, different levels, private sector, and civil- and nongovernmental organizations in the above interventions
 - vi. How research will support the above processes and what research networks/platforms enable these efforts
 - vii. Other national or subnational considerations to provide clinical care
- e. Access to countermeasures
- i. Is there a pre-defined list of essential supplies including diagnostics and therapeutics for managing arboviruses?
 - ii. Are there supply and manufacturing platforms nationally or regionally that can scale rapidly, including for essential items such as PPE, therapeutics and vaccines?
 - iii. Will a national stockpile or access to an international stockpile be implemented to support emergency response needs?

- iv. How will access to countermeasures be maximized through global, regional or country level pre-negotiated agreements?
- v. What are the regulatory frameworks and procedures for new countermeasures at the time of an emergency?
- vi. How will liability and indemnification be managed for emergency medical countermeasures?
- vii. How will linkages to upstream (global and regional) supply chains and delivery be ensured?
- viii. How will systems for downstream (in-country) supply chains and delivery be ensured and is there a national vaccination and deployment plan?
- ix. How will an enabling environment for research and development be ensured?
- x. Other national or subnational considerations for having access to life-saving countermeasures.

Part D: Plan activation including triggers for shifting between operational stages

This section defines how and when the plan will be activated, escalated, or de-escalated in response to changing outbreak conditions. It establishes clear roles, triggers, and procedures for reassessing and adapting measures during different phases of an epidemic or pandemic.

Consider including:

- a. Activation of plan
 - i. What body makes decisions to escalate and de-escalate between the operational stages in the plan?
 - ii. What are the roles and responsibilities of different stakeholders including technical advisory groups in this process?
 - iii. How and who communicates the escalation and de-escalation?
- b. Triggers for shifting between operational stages: escalation and de-escalation
 - (see Annex 8 for examples of triggers and a format for layout)
- c. Procedures for assessing and adjusting response measures at the country and subnational levels.
 - i. What body will conduct the situational assessments that may lead to adjustment of response measures?
 - ii. What systems and data points will be used in the assessments to account for the intensity of transmission, the coping capacity of health and other sector systems to provide essential services, and the overall health and socioeconomic well-being of communities?

Part E: Actions during each operational stage

This section outlines the specific actions that need to be taken during each operational stage—prevent, prepare, respond, and recover—across core response components. It provides a structured approach for implementation, accountability, and budgeting throughout the outbreak lifecycle.

a. Prevent and prepare stage

Component	Actions	Sector	Responsible agency	Budget estimate
Emergency coordination				
Collaborative surveillance				
Community protection				
Clinical care				
Access to countermeasures				

Part F: Annexes

This section includes supplementary materials that support implementation of the main plan, such as pathogen-specific annexes, technical guidance, case management protocols, and monitoring tools. These annexes provide practical resources for operationalizing and tailoring the plan to specific scenarios or diseases.

Consider including:

- Pathogen-specific annexes for priority arboviruses (e.g., dengue, chikungunya, Zika, yellow fever viruses).
- Technical guidelines for vector control, vaccination, or outbreak investigation.
- Case management protocols for arbovirus diseases
- Templates for monitoring and evaluation tools

9 References

1. World Health Organization. Strengthening the global architecture for health emergency prevention, preparedness, response and resilience. (2023) <https://www.who.int/publications/m/item/strengthening-the-global-architecture-for-health-emergency-prevention--preparedness--response-and-resilience> [Accessed December 13, 2024]
2. World Health Organization. *Glossary of health emergency and disaster risk management terminology*. World Health Organization. (2020). <https://iris.who.int/handle/10665/331716> [Accessed July 16, 2025]
3. World Health Organization. One health. (2025) https://www.who.int/health-topics/one-health#tab=tab_1 [Accessed July 16, 2025]
4. World Health Organization. Strengthening preparedness for and response to public health emergencies through targeted amendments to the International Health Regulations (2005). (2024) https://apps.who.int/gb/ebwha/pdf_files/WHA77/A77_R17-en.pdf [Accessed February 1, 2025]
5. World Health Organization. *A strategic framework for emergency preparedness*. World Health Organization. (2017). <https://iris.who.int/handle/10665/254883> [Accessed July 17, 2025]
6. World Health Organization. Emergencies: International health regulations and emergency committees. (2019) <https://www.who.int/news-room/questions-and-answers/item/emergencies-international-health-regulations-and-emergency-committees> [Accessed December 17, 2024]
7. UN. Secretary-General, UN. Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction eds. *Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction: note*. New York: UN. (1). 41 p. <https://digitallibrary.un.org/record/852089> [Accessed July 17, 2025]
8. Centers for Disease Control and Prevention. Arbovirus Catalog. (2025) <https://wwwn.cdc.gov/arbocat/> [Accessed July 21, 2025]
9. Zhang W-X, Zhao T-Y, Wang C-C, He Y, Lu H-Z, Zhang H-T, Wang L-M, Zhang M, Li C-X, Deng S-Q. Assessing the global dengue burden: Incidence, mortality, and disability trends over three decades. *PLoS Negl Trop Dis* (2025) 19:e0012932. doi: 10.1371/journal.pntd.0012932
10. World Health Organization. *Preparedness and Resilience for Emerging Threats Module 1: Planning for respiratory pathogen pandemics*. Geneva: World Health Organization. (2023). <https://www.who.int/publications/i/item/9789240084674> [Accessed December 9, 2024]

11. Lim A, Shearer FM, Sewalk K, Pigott DM, Clarke J, Ghouse A, Judge C, Kang H, Messina JP, Kraemer MUG, et al. The overlapping global distribution of dengue, chikungunya, Zika and yellow fever. *Nat Commun* (2025) 16:3418. doi: 10.1038/s41467-025-58609-5
12. Kraemer MUG, Reiner RC, Brady OJ, Messina JP, Gilbert M, Pigott DM, Yi D, Johnson K, Earl L, Marczak LB, et al. Past and future spread of the arbovirus vectors *Aedes aegypti* and *Aedes albopictus*. *Nat Microbiol* (2019) 4:854–863. doi: 10.1038/s41564-019-0376-y
13. World Health Organization. Oropouche virus disease. (2024) <https://www.who.int/news-room/fact-sheets/detail/oropouche-virus-disease> [Accessed September 17, 2025]
14. Marczell K, García E, Roiz J, Sachdev R, Towle P, Shen J, Sruamsiri R, da Silva BM, Hanley R. The macroeconomic impact of a dengue outbreak: Case studies from Thailand and Brazil. *PLoS Negl Trop Dis* (2024) 18:e0012201. doi: 10.1371/journal.pntd.0012201
15. Shepard DS, Undurraga EA, Halasa YA, Stanaway JD. The global economic burden of dengue: a systematic analysis. *Lancet Infect Dis* (2016) 16:935–941. doi: 10.1016/S1473-3099(16)00146-8
16. Costa LB, Barreto FK de A, Barreto MCA, dos Santos THP, de Andrade M de MO, Farias LABG, de Freitas ARR, Martinez MJ, Cavalcanti LP de G. Epidemiology and Economic Burden of Chikungunya: A Systematic Literature Review. *Trop Med Infect Dis* (2023) 8:301. doi: 10.3390/tropicalmed8060301
17. LaBeaud AD. Why Arboviruses Can Be Neglected Tropical Diseases. *PLoS Negl Trop Dis* (2008) 2:e247. doi: 10.1371/journal.pntd.0000247
18. Roehrig JT, Layton M, Smith P, Campbell GL, Nasci R, Lanciotti RS. The emergence of West Nile virus in North America: ecology, epidemiology, and surveillance. *Curr Top Microbiol Immunol* (2002) 267:223–240. doi: 10.1007/978-3-642-59403-8_11
19. World Health Organization. *International Health Regulations (2005)*. 3rd ed. Geneva, Switzerland: World Health Organisation. (2016).
20. World Health Organization. Global Arbovirus Initiative. (2024) <https://www.who.int/initiatives/global-arbovirus-initiative> [Accessed December 13, 2024]
21. World Health Organization. Global vector control response 2017–2030. (2017) <https://www.who.int/publications/i/item/9789241512978> [Accessed December 13, 2024]
22. World Health Organization. Eliminate yellow fever epidemics (EYE) strategy 2017-2026. (2017) <https://www.who.int/initiatives/eye-strategy> [Accessed January 24, 2025]
23. TechNet-21. Global Yellow Fever Laboratory Network (GYFLaN). (2025) <https://www.technet-21.org/fr/eye-labs/network> [Accessed February 4, 2025]
24. WAASuN. WAASuN – West African Aedes Surveillance Network. (2025) <https://waasun.org/> [Accessed February 4, 2025]

25. World Health Organization Regional Office for Africa. The work of the African Network on Vector Resistance to insecticides 2000 – 2004. (2005)
https://www.afro.who.int/sites/default/files/2017-06/phe-anvr_tech_report.pdf [Accessed October 29, 2025]
26. Pan American Health Organization. Integrated Management Strategy for Arboviral Disease Prevention and Control in the Americas. (2020)
https://iris.paho.org/bitstream/handle/10665.2/52492/9789275120491_eng.pdf?sequence=1&isAllowed=y [Accessed January 24, 2025]
27. Pan American Health Organization. The Arbovirus Diagnosis Laboratory Network of the Americas (RELDA). (2025) <https://www.paho.org/en/topics/dengue/arbovirus-diagnosis-laboratory-network-americas-relda> [Accessed February 7, 2025]
28. WHO Regional Office for the Eastern Mediterranean. Establishing syndromic surveillance and event-based surveillance systems for Zika, dengue and other arboviral diseases. (2020)
<https://www.who.int/publications/i/item/9789290223443> [Accessed March 6, 2025]
29. World Health Organization Regional Office for Europe. Developing a regional framework for surveillance and control of invasive mosquitoes. (2025) <https://www.who.int/europe/health-topics/vector-borne-diseases/policy-vector-bone-diseases> [Accessed March 6, 2025]
30. European Centre for Disease Prevention and Control. European Emerging and Vector-borne Diseases Network (EVD-Net). (2023) <https://www.ecdc.europa.eu/en/about-ecdc/what-we-do/partners-and-networks/disease-and-laboratory-networks/european-emerging-and> [Accessed September 19, 2025]
31. European network for medical and veterinary entomology (VectorNet). (2011)
<https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/vector-net> [Accessed September 19, 2025]
32. European Centre for Disease Prevention and Control. Emerging Viral Diseases-Expert Laboratory Network (EVD-LabNet). (2017) <https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/disease-and-laboratory-networks/evd-labnet> [Accessed September 19, 2025]
33. UNITEDengue. United in Tackling Epidemic Dengue. (2025)
<https://www.unitedengue.org/index.html> [Accessed February 4, 2025]
34. APEC Health Working Group. Roadmap to Advance Dengue Prevention & Control in APEC Economies 2026 – 2030. APEC (2025) <https://www.apec.org/publications/2025/09/roadmap-to-advance-dengue-prevention---control-in-apec-economies-2026---2030> [Accessed October 14, 2025]
35. IFRC. IFRC and Takeda initiate ‘United Against Dengue’ alliance to combat escalating threat of dengue | IFRC. (2025) <https://www.ifrc.org/article/ifrc-and-takeda-initiate-united-against-dengue-alliance-combat-escalating-threat-dengue> [Accessed October 14, 2025]

36. Abeyewickreme W, Wickremasinghe AR, Karunatilake K, Sommerfeld J, Axel K. Community mobilization and household level waste management for dengue vector control in Gampaha district of Sri Lanka; an intervention study. *Pathog Glob Health* (2012) 106:479–487. doi: 10.1179/2047773212Y.0000000060
37. Weaver SC, Barrett ADT. Transmission cycles, host range, evolution and emergence of arboviral disease. *Nat Rev Microbiol* (2004) 2:789–801. doi: 10.1038/nrmicro1006
38. Naveca FG, Almeida TAP de, Souza V, Nascimento V, Silva D, Nascimento F, Mejía M, Oliveira YS de, Rocha L, Xavier N, et al. Human outbreaks of a novel reassortant Oropouche virus in the Brazilian Amazon region. *Nat Med* (2024) 1–13. doi: 10.1038/s41591-024-03300-3
39. World Health Organization. Geographical expansion of cases of dengue and chikungunya beyond the historical areas of transmission in the Region of the Americas. (2023) <https://www.who.int/emergencies/disease-outbreak-news/item/2023-DON448> [Accessed December 23, 2024]
40. Zatta M, Brichtler S, Vindrios W, Melica G, Gallien S. Autochthonous Dengue Outbreak, Paris Region, France, September–October 2023. *Emerg Infect Dis* (2023) 29: doi: 10.3201/eid2912.231472
41. Souza WM de, Ribeiro GS, Lima STS de, Jesus R de, Moreira FRR, Whittaker C, Sallum MAM, Carrington CVF, Sabino EC, Kitron U, et al. Chikungunya: a decade of burden in the Americas. *Lancet Reg Health – Am* (2024) 30: doi: 10.1016/j.lana.2023.100673
42. World Health Organization. Zika Epidemiology Update. (2022) https://cdn.who.int/media/docs/default-source/documents/emergencies/zika/zika-epidemiology-update_february-2022_clean-version.pdf [Accessed December 23, 2024]
43. Gubler DJ. Dengue, Urbanization and Globalization: The Unholy Trinity of the 21st Century. *Trop Med Health* (2011) 39:3–11. doi: 10.2149/tmh.2011-S05
44. Challenges in combating arboviral infections. *Nat Commun* (2024) 15:3350. doi: 10.1038/s41467-024-47161-3
45. Adekola HA, Onajobi IB, O.Egberongbe H, Samson OJ, Kareem WA, Osipitan GO, Adekola RA. Vaccine Candidates for Arboviruses with Pandemic Potential: A Mini Review. (2023) <https://www.emjreviews.com/microbiology-infectious-diseases/article/vaccine-candidates-for-arboviruses-with-pandemic-potential-a-mini-review/> [Accessed February 13, 2025]
46. World Health Organization. WHO guidelines for clinical management of arboviral diseases: dengue, chikungunya, Zika and yellow fever. (2025) <https://www.who.int/publications/i/item/9789240111110> [Accessed July 21, 2025]
47. Huang Y-JS, Higgs S, Vanlandingham DL. Arbovirus-Mosquito Vector-Host Interactions and the Impact on Transmission and Disease Pathogenesis of Arboviruses. *Front Microbiol* (2019) 10: doi: 10.3389/fmicb.2019.00022

48. Weaver SC, Barrett ADT. Transmission cycles, host range, evolution and emergence of arboviral disease. *Nat Rev Microbiol* (2004) 2:789–801. doi: 10.1038/nrmicro1006
49. Chouin-Carneiro T, Santos FB dos, Chouin-Carneiro T, Santos FB dos. “Transmission of Major Arboviruses in Brazil: The Role of *Aedes aegypti* and *Aedes albopictus* Vectors.” *Biological Control of Pest and Vector Insects*. IntechOpen (2017) doi: 10.5772/66946
50. Valentine MJ, Murdock CC, Kelly PJ. Sylvatic cycles of arboviruses in non-human primates. *Parasit Vectors* (2019) 12:463. doi: 10.1186/s13071-019-3732-0
51. Ramírez AL, van den Hurk AF, Meyer DB, Ritchie SA. Searching for the proverbial needle in a haystack: advances in mosquito-borne arbovirus surveillance. *Parasit Vectors* (2018) 11:320. doi: 10.1186/s13071-018-2901-x
52. Mbaoma OC, Thomas SM, Beierkuhnlein C. Significance of vertical transmission of arboviruses in mosquito-borne disease epidemiology. *Parasit Vectors* (2025) 18:137. doi: 10.1186/s13071-025-06761-8
53. Smith DL, Battle KE, Hay SI, Barker CM, Scott TW, McKenzie FE. Ross, Macdonald, and a Theory for the Dynamics and Control of Mosquito-Transmitted Pathogens. *PLOS Pathog* (2012) 8:e1002588. doi: 10.1371/journal.ppat.1002588
54. Prasad R, Sagar SK, Parveen S, Dohare R. Mathematical modeling in perspective of vector-borne viral infections: a review. *Beni-Suef Univ J Basic Appl Sci* (2022) 11:102. doi: 10.1186/s43088-022-00282-4
55. Hcini N, Lambert V, Picone O, Carod J-F, Carles G, Pomar L, Epelboin L, Nacher M. Arboviruses and pregnancy: are the threats visible or hidden? *Trop Dis Travel Med Vaccines* (2024) 10:4. doi: 10.1186/s40794-023-00213-w
56. Byaruhanga T, Kayiwa JT, Nankya AM, Ataliba JJ, McClure CP, Ball JK, Lutwama JJ. Arbovirus circulation, epidemiology and spatiotemporal distribution in Uganda. *IJID Reg* (2023) 6:171–176. doi: 10.1016/j.ijregi.2023.01.013
57. Dayarathna S, Kuruppu H, Silva T, Gomes L, Shyamali NLA, Jeewandara C, Ariyaratne D, Ramu ST, Wijewickrama A, Ogg GS, et al. Are viral loads in the febrile phase a predictive factor of dengue disease severity? *BMC Infect Dis* (2024) 24:1248. doi: 10.1186/s12879-024-10152-2
58. Ketkar H, Herman D, Wang P. Genetic Determinants of the Re-Emergence of Arboviral Diseases. *Viruses* (2019) 11:150. doi: 10.3390/v11020150
59. Vicente CR, Herbringer K-H, Fröschl G, Malta Romano C, de Souza Areias Cabidelle A, Cerutti Junior C. Serotype influences on dengue severity: a cross-sectional study on 485 confirmed dengue cases in Vitória, Brazil. *BMC Infect Dis* (2016) 16:320. doi: 10.1186/s12879-016-1668-y
60. Salimi H, Cain MD, Klein RS. Encephalitic Arboviruses: Emergence, Clinical Presentation, and Neuropathogenesis. *Neurother J Am Soc Exp Neurother* (2016) 13:514–534. doi: 10.1007/s13311-016-0443-5

61. Mangat R, Louie T. "Arbovirus Encephalitides.," *StatPearls*. Treasure Island (FL): StatPearls Publishing (2024) <http://www.ncbi.nlm.nih.gov/books/NBK560866/> [Accessed January 2, 2025]
62. Manouana GP, Sarah-Matio E-M, Hellhammer F, Zahouli JZB, Tapé ASB, Biré YN, Dibo J-DK, Houriaaidji GE, Maganga GD, Koumba JP, et al. Ecology of arboviruses and their potential mosquito vectors in Benin, Côte d'Ivoire and Gabon: a mini review. *Front Trop Dis* (2024) 5: doi: 10.3389/fitd.2024.1355778
63. Akuoko OK, Dhikrullahi SB, Hinne IA, Mohammed AR, Owusu-Asenso CM, Coleman S, Dadzie SK, Kyerematen R, Boakye DA, Wilson MD, et al. Biting behaviour, spatio-temporal dynamics, and the insecticide resistance status of malaria vectors in different ecological zones in Ghana. *Parasit Vectors* (2024) 17:16. doi: 10.1186/s13071-023-06065-9
64. Guedes RNC, Beins K, Navarro Costa D, Coelho GE, Bezerra HS da S. Patterns of insecticide resistance in *Aedes aegypti*: meta-analyses of surveys in Latin America and the Caribbean. *Pest Manag Sci* (2020) 76:2144–2157. doi: 10.1002/ps.5752
65. Abbasi E. Global expansion of *Aedes* mosquitoes and their role in the transboundary spread of emerging arboviral diseases: A comprehensive review. *IJID One Health* (2025) 6:100058. doi: 10.1016/j.ijidoh.2025.100058
66. Souza-Neto JA, Powell JR, Bonizzoni M. *Aedes aegypti* vector competence studies: A review. *Infect Genet Evol J Mol Epidemiol Evol Genet Infect Dis* (2019) 67:191–209. doi: 10.1016/j.meegid.2018.11.009
67. CDC. Risk and People Who Are Immunocompromised. *Vector-Borne Dis* (2024) <https://www.cdc.gov/vector-borne-diseases/risk-factors/immunocompromised-people.html> [Accessed January 2, 2025]
68. New York State Department of Health. Arboviral (Arthropod-borne Viral) Diseases Fact Sheet. (2017) https://www.health.ny.gov/diseases/communicable/arboviral/fact_sheet.htm [Accessed December 10, 2024]
69. U.S. Centers for Disease Control and Prevention. Risk Factors for Vector-Borne Diseases. *Vector-Borne Dis* (2024) <https://www.cdc.gov/vector-borne-diseases/risk-factors/index.html> [Accessed January 2, 2025]
70. U.S. Centers for Disease Control and Prevention. Clinical Signs and Symptoms of West Nile Virus Disease. *West Nile Virus* (2025) <https://www.cdc.gov/west-nile-virus/hcp/clinical-signs/index.html> [Accessed October 14, 2025]
71. Cerqueira-Silva T, Cardim LL, Paixão E, Rossi M, Santos AC, Portela F de Souza A, Santos G, Barreto ML, Brickley EB, Pescarini JM. Hospitalisation, mortality and years of life lost among chikungunya and dengue cases in Brazil: a nationwide cohort study, 2015-2024. *Lancet Reg Health Am* (2025) 49:101177. doi: 10.1016/j.lana.2025.101177
72. Teo A, Tan HD, Loy T, Chia PY, Chua CLL. Understanding antibody-dependent enhancement in dengue: Are afucosylated IgG1s a concern? *PLOS Pathog* (2023) 19:e1011223. doi: 10.1371/journal.ppat.1011223

73. Power GM, Vaughan AM, Qiao L, Clemente NS, Pescarini JM, Paixão ES, Lobkowicz L, Raja AI, Souza AP, Barreto ML, et al. Socioeconomic risk markers of arthropod-borne virus (arbovirus) infections: a systematic literature review and meta-analysis. *BMJ Glob Health* (2022) 7: doi: 10.1136/bmjgh-2021-007735
74. World Health Organization. WHO statement on the first meeting of the International Health Regulations (2005) (IHR 2005) Emergency Committee on Zika virus and observed increase in neurological disorders and neonatal malformations. (2016) [https://www.who.int/news/item/01-02-2016-who-statement-on-the-first-meeting-of-the-international-health-regulations-\(2005\)-\(ihr-2005\)-emergency-committee-on-zika-virus-and-observed-increase-in-neurological-disorders-and-neonatal-malformations](https://www.who.int/news/item/01-02-2016-who-statement-on-the-first-meeting-of-the-international-health-regulations-(2005)-(ihr-2005)-emergency-committee-on-zika-virus-and-observed-increase-in-neurological-disorders-and-neonatal-malformations) [Accessed December 17, 2024]
75. World Health Organization. States Party self-assessment annual reporting tool second edition. (2024) <https://extranet.who.int/e-spar/> [Accessed December 4, 2024]
76. Pan American Health Organization. Recommendations for Laboratory Detection and Diagnosis of Arbovirus Infections in the Region of the Americas. (2023) https://iris.paho.org/bitstream/handle/10665.2/57555/9789275125878_eng.pdf?sequence=1&isAllowed=y [Accessed January 17, 2025]
77. World Health Organization. WHO Public Health and Social Measures Initiative. (2024) <https://www.who.int/initiatives/who-public-health-and-social-measures-initiative> [Accessed January 16, 2025]
78. World Health Organization. Vector control. (2024) <https://www.who.int/teams/control-of-neglected-tropical-diseases/interventions/strategies/vector-control> [Accessed January 16, 2025]
79. World Health Organization. *Multisectoral approach to the prevention and control of vector-borne diseases: a conceptual framework*. World Health Organization. (2020). <https://iris.who.int/handle/10665/331861> [Accessed December 9, 2024]
80. World Health Organization. *Communicating risk in public health emergencies: a WHO guideline for emergency risk communication (ERC) policy and practice*. Geneva, Switzerland: World Health Organisation. (2017).
81. World Health Organization. WHO community engagement framework for quality, people-centred and resilient health services. (2017) <https://iris.who.int/bitstream/handle/10665/259280/WHO-HIS-SDS-2017.15-eng.pdf>
82. World Health Organization. Health Promotion. (2024) <https://www.who.int/teams/health-promotion/enhanced-wellbeing/seventh-global-conference/community-empowerment> [Accessed January 17, 2025]
83. World Health Organization. Yellow Fever. (2024) <https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/norms-and-standards/vaccine-standardization/yellow-fever> [Accessed January 17, 2025]

84. World Health Organization. Interim Medical Countermeasures Network (i-MCM-Net). (2025) <https://www.who.int/initiatives/i-mcm-net> [Accessed January 21, 2025]
85. World Health Organization. Defining access to countermeasures: landscape report 2024. (2025) <https://www.who.int/publications/i/item/9789240108103> [Accessed October 14, 2025]
86. Pujhari S. Recent Advances in Arboviral Vaccines: Emerging Platforms and Promising Innovations. *Biologics* (2024) 4:1–16. doi: 10.3390/biologics4010001
87. Ormundo LF, Barreto CT, Tsuruta LR. Development of Therapeutic Monoclonal Antibodies for Emerging Arbovirus Infections. *Viruses* (2023) 15:2177. doi: 10.3390/v15112177
88. World Health Organization Regional Office for Africa. Handbook for Public Health Emergency Operations Center Operations and Management. (2021) https://www.afro.who.int/sites/default/files/2021-03/AFRO_PHEOC-Handbook_.pdf [Accessed May 1, 2025]
89. World Health Organization. International Health Regulations Monitoring and Evaluation Framework. (2024) <https://www.who.int/emergencies/operations/international-health-regulations-monitoring-evaluation-framework> [Accessed January 23, 2025]
90. World Health Organization. Laboratory testing for Zika virus and dengue virus infections: interim guidance. (2022) https://www.who.int/publications/i/item/WHO-ZIKV_DENV-LAB-2022.1 [Accessed February 24, 2025]
91. World Health Organization. Laboratory manual for yellow fever. (2024) <https://www.who.int/publications/i/item/9789240084476> [Accessed February 24, 2025]
92. Lackritz EM, Ng L-C, Marques ETA, Rabe IB, Bourne N, Staples JE, Méndez-Rico JA, Harris E, Brault AC, Ko AI, et al. Zika virus: advancing a priority research agenda for preparedness and response. *Lancet Infect Dis* (2025) 25:e390–e401. doi: 10.1016/S1473-3099(24)00794-1
93. World Health Organization. Pathogens Prioritization: A scientific framework for epidemic and pandemic research preparedness. (2024) https://cdn.who.int/media/docs/default-source/consultation-rdb/prioritization-pathogens-v6final.pdf?sfvrsn=c98effa7_9&download=true [Accessed October 1, 2025]
94. World Health Organization. WHO R&D Blueprint. (2024) <https://www.who.int/observatories/global-observatory-on-health-research-and-development/analyses-and-syntheses/who-r-d-blueprint/background> [Accessed January 23, 2025]
95. World Health Organization. Global genomic surveillance strategy for pathogens with pandemic and epidemic potential 2022–2032. (2022) <https://www.who.int/publications-detail-redirect/9789240046979>
96. Taylor-Robinson AW. Harnessing artificial intelligence to enhance key surveillance and response measures for arbovirus disease outbreaks: the exemplar of Australia. *Front Microbiol* (2023) 14: doi: 10.3389/fmicb.2023.1284838

97. Batovska J, Mee PT, Sawbridge TI, Rodoni BC, Lynch SE. Enhanced Arbovirus Surveillance with High-Throughput Metatranscriptomic Processing of Field-Collected Mosquitoes. *Viruses* (2022) 14:2759. doi: 10.3390/v14122759
98. Melo CL, Mageste LR, Guaraldo L, Paula DP, Wakimoto MD. Use of Digital Tools in Arbovirus Surveillance: Scoping Review. *J Med Internet Res* (2024) 26:e57476. doi: 10.2196/57476
99. Varghese J, De Silva I, Millar DS. Latest Advances in Arbovirus Diagnostics. *Microorganisms* (2023) 11:1159. doi: 10.3390/microorganisms11051159

DRAFT

Annexes

Annex 1: Methods for developing this module

In developing this module, the World Health Organization (WHO) undertook a number of steps to assess gaps and needs, identify priorities, gather inputs and develop the document.

- Desk review and internal consultation (September – November 2024): a comprehensive review of scientific literature, technical documents and grey literature documents was conducted.
- Consultations were held with the Technical Advisory Group for Arbovirus (TAG-Arbovirus) and WHO steering committee, comprised of WHO staff from country, regional and headquarters offices, to define the scope of the module and the range of arboviruses covered.
- Development of the first draft: (January to June 2025): The first draft of the module was developed by the WHO technical team in the Epidemic and Pandemic Management department. Consultations with the TAG-Arbovirus and WHO Steering Committee were also held on specific technical components.
- Expert review (July–September 2025): The first full draft was reviewed by the TAG-Arbovirus and the WHO Steering Committee to ensure technical accuracy, validity, and consistency with existing frameworks.
- Development of the second draft (October 2025): The second draft was prepared, incorporating over 160 comments and recommendations received from expert reviewers.
- Public consultation (November 2025): The second draft is posted on the WHO website for public comment for two weeks, accompanied with an online survey. Concurrently, the TAG-Arbovirus and the WHO Steering Committee provided additional input. The process generated [to be quantified] responses from stakeholders including [to be quantified] (e.g. national public health institutes, academic institutions, and international partners). All comments were systematically reviewed and integrated as appropriate.
- Finalization and publication (December 2025): The document will be finalized based on consolidated feedback and approved through WHO's clearance process before publication.

Annex 2: Methodology for the development of the timeline of arbovirus epidemics from 1970 to 2025

The timeline of major arbovirus outbreaks was developed through a structured desk review of publicly available outbreak databases, peer-reviewed literature, and global health surveillance platforms. Primary data sources included the WHO Disease Outbreak News, CDC Morbidity and Mortality Weekly Report, CDC Outbreaks and News reports, European Centre for Disease Control and Prevention reports. Searches were complemented with bibliographic databases such as PubMed and EMBASE, using Boolean search strings that combined outbreak-related terms (e.g., arbovirus outbreak, epidemic timeline, resurgence) with virus-specific keywords (e.g., dengue, yellow fever, chikungunya, Zika).

Outbreaks were defined as “major” if they met at least one of the following criteria: (i) large outbreak magnitude, (ii) introduction into a new geographic area, or (iii) evidence of an epidemiological shift such as emergence of a new serotype, change in transmission dynamics, or unusual severity. Events were cross-verified across multiple sources where possible to ensure accuracy.

The list is not exhaustive but provides a representative chronology of significant arbovirus outbreaks globally between 1970 and early 2025.

Annex 3: Methodology for the Analysis of National Plans for Arbovirus Epidemics

Data on plan availability were systematically collected and compiled by all WHO Regional Offices using standardized Microsoft Excel templates. These data were subsequently validated in collaboration with WHO Country Offices and respective Ministries of Health. The analysis includes all 240 countries, areas and territories, as detailed in the list of countries below.

Region of Africa (51):

Algeria, Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo, Côte d'Ivoire, Democratic Republic of the Congo, Equatorial Guinea, Eritrea, Eswatini, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mayotte, Mozambique, Namibia, Niger, Nigeria, Rwanda, Réunion, Saint Helena, Sao Tome and Principe, Senegal, Seychelles, Sierra Leone, South Africa, South Sudan, Togo, Uganda, United Republic of Tanzania, Western Sahara, Zambia, Zimbabwe.

Region of the Americas (57):

Anguilla, Antigua and Barbuda, Argentina, Aruba, Bahamas, Barbados, Belize, Bermuda, Bolivia (Plurinational State of), Bonaire, Bonaire, Sint Eustatius and Saba, Brazil, British Virgin Islands, Canada, Cayman Islands, Chile, Colombia, Costa Rica, Cuba, Curaçao, Dominica, Dominican Republic, Ecuador, El Salvador, Falkland Islands (Malvinas), French Guiana, Grenada, Guadeloupe, Guatemala, Guyana, Haiti, Honduras, Jamaica, Martinique, Mexico, Montserrat, Nicaragua, Panama, Paraguay, Peru, Puerto Rico, Saba, Saint Barthélemy, Saint Kitts and Nevis, Saint Lucia, Saint Martin, Saint Pierre and Miquelon, Saint Vincent and the Grenadines, Sint Eustatius, Sint Maarten, Suriname, Trinidad and Tobago, Turks and Caicos Islands, United States Virgin Islands, United States of America, Uruguay, Venezuela (Bolivarian Republic of).

Region of Eastern Mediterranean (22):

Afghanistan, Bahrain, Djibouti, Egypt, Iran (Islamic Republic of), Iraq, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Pakistan, Qatar, Saudi Arabia, Somalia, Sudan, Syrian Arab Republic, Tunisia, United Arab Emirates, Yemen, occupied Palestinian territory.

Region of Europe (62):

Albania, Andorra, Armenia, Austria, Azerbaijan, Belarus, Belgium, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Czechia, Denmark, Estonia, Faroe Islands, Finland, France, Georgia, Germany, Gibraltar, Greece, Greenland, Guernsey, Holy See, Hungary, Iceland, Ireland, Isle of Man, Israel, Italy, Jersey, Kazakhstan, Kosovo, Kyrgyzstan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Montenegro, Netherlands, North Macedonia, Norway, Poland, Portugal, Republic of Moldova, Romania, Russian Federation, San Marino, Serbia, Slovakia,

Slovenia, Spain, Sweden, Switzerland, Tajikistan, The United Kingdom, Turkey, Turkmenistan, Ukraine, Uzbekistan.

Region of South-East Asia (11):

Bangladesh, Bhutan, Democratic People's Republic of Korea, India, Indonesia*, Maldives, Myanmar, Nepal, Sri Lanka, Thailand, Timor-Leste.

Region of the Western Pacific (37):

American Samoa, Australia, Brunei Darussalam, Cambodia, China, Cook Islands, Fiji, French Polynesia, Guam, Hong Kong SAR (China), Japan, Kiribati, Lao People's Democratic Republic, Macao SAR (China), Malaysia, Marshall Islands, Micronesia (Federated States of), Mongolia, Nauru, New Caledonia, New Zealand, Niue, Northern Mariana Islands (Commonwealth of the), Palau, Papua New Guinea, Philippines, Pitcairn Islands, Republic of Korea, Samoa, Singapore, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu, Viet Nam, Wallis and Futuna.

* Indonesia became a country in the Western Pacific Region in May 2025

Annex 4: Examples of critical interdependencies between health and other sectors for arbovirus epidemic and pandemic preparedness

Arbovirus epidemic and pandemic preparedness rely on collaboration between the health sector and other sectors to address the diverse challenges posed by these diseases. Below are examples of how various sectors contribute to coordinated efforts. Countries are encouraged to identify which actors are best placed to carry out these tasks in their context, and to put in place platforms that enable regular interaction and joint planning across sectors.

Sector	Interdependencies
Environment; food and agriculture; urban planning; waste management; housing and construction	• Collaborate to design and implement integrated vector control strategies that reduce mosquito breeding habitats and promote environmentally sustainable practices. • Develop agricultural and land-use policies that minimize practices contributing to vector proliferation, such as water stagnation from irrigation. • Promote sustainable urban planning, construction, and housing policies that improve waste management, drainage, and sanitation to reduce vector habitats and enhance urban liveability.
Education and ICT	• Create public awareness campaigns using digital platforms to educate communities about arbovirus prevention • Develop mobile applications for real-time reporting of vector presence and disease symptoms • Integrate arbovirus education into school curricula to promote long-term behavioural changes
Economic and finance; social welfare	• Advocate for, allocate and mobilize sustainable funding mechanisms for arbovirus pathogen preparedness • Develop economic incentives for businesses to develop medical countermeasures • Implement social safety nets and economic recovery plans that mitigate the financial impact of arbovirus epidemics on vulnerable communities
Transportation and logistics; travel and tourism; defense and security	• Strengthen border control measures including surveillance, screening and dissemination of information to travellers, reducing the risk of case importation while preserving safe population mobility without unnecessary restrictions • Utilize military resources for rapid response and distribution of medical supplies during epidemics
Energy; water resource management	• Develop early warning systems that integrate climate and hydrological data to predict arbovirus epidemic risks • Implement water management strategies to reduce mosquito breeding sites
Public and private labour sector	• Implement workforce personal protection measures, including vaccination of high-risk workers (e.g. farmworkers,

construction workers, fishermen) operating in outdoor settings

- Reinforce safe handling practices for blood and body fluids in laboratory, clinical, and research environments
- Adapt outdoor workplaces, such as construction sites, to reduce vector breeding

DRAFT

Annex 5: Data often collected at local administrative offices that can support arbovirus epidemic and pandemic preparedness

Local administrative offices can provide a range of data critical for arbovirus epidemic and pandemic preparedness. These data sources, when integrated and analysed effectively, can enhance situational awareness, risk assessments, and decision-making. Commonly available data include:

Demographic and population data, such as:

- Census data: population size, density, and distribution by age, gender, and socioeconomic status.
- Migration patterns: seasonal or temporary population movements that may influence disease spread.
- Household information: housing density, type, and sanitation conditions.

Environmental and geographic data, such as:

- Land use patterns: urbanization, agricultural activities, and water bodies that may support vector breeding.
- Weather and climate data: rainfall, temperature, and humidity trends that affect vector populations.
- Geospatial mapping: geographic boundaries, administrative divisions, and transportation networks.

Health and surveillance data, such as:

- Healthcare facility records: utilization rates, intensive care admissions, service availability, and outbreaks reported by health centres.
- Disease surveillance data: trends in fever, rash, joint pains, and other syndromic presentations suggestive of arboviral infections.
- Vaccination coverage: data on immunization campaigns and population immunity levels.

Animal and vector surveillance data, such as:

- Livestock and wildlife data: reports on arbovirus vectors or reservoir hosts in animal populations.
- Vector density reports: local vector population data from entomological surveys.
- Insecticide resistance profiles: assess effectiveness of vector control measures.

Social and behavioural data, such as:

- Community practices: information on water storage, waste management, and vector prevention behaviours.
- Public awareness levels: knowledge, attitudes, and practices regarding arbovirus introduction, transmission and prevention.

- Communication networks: popular channels for community outreach and engagement.
- Vaccine receptiveness and hesitancy: insights into public perceptions, concerns, and acceptance of vaccines related to arboviruses.

Infrastructure and resource data, such as:

- Public utilities: water supply, drainage systems, and waste management services.
- Emergency response capacity: local emergency management plans, emergency resources available, supply chains.

Economic data, such as:

- Livelihood patterns: employment sectors and dependency on outdoor activities that increase exposure to vectors.
- Market trends: impact of epidemics on local economies and resource availability.

DRAFT

Annex 6: Country and regional examples and technical resources to support implementation of arbovirus epidemic and pandemic preparedness planning

Country and regional examples were selected from published stories that reflect good practices for arbovirus epidemic and pandemic prevention, preparedness and response:

Component	Country and regional examples, and technical resources
Emergency coordination	Country and regional examples - Arbovirus Diagnosis Laboratory Network of the Americas (RELDA) (1) Technical resources - Zika virus disease epidemic: Preparedness planning guide for diseases transmitted by Aedes aegypti and Aedes albopictus (2)
Collaborative surveillance	Country and regional examples - West Nile virus in the Netherlands. Surveillance and Response 2021-2023 Final Report (3) - Establishment of EU Reference Laboratories for public health in Europe (4) - Arbo-France (5) - Reinforced surveillance of dengue, chikungunya and Zika in metropolitan France, health authorities are reminding people of the importance of protecting themselves from mosquito bites (6) - Genomic monitoring of indigenous cases of arboviruses (7) - Global Yellow Fever Laboratory Network in Africa (8) - African Network on Vector Resistance (9) Technical resources - Public health guidance for assessing and mitigating the risk of locally-acquired Aedes-borne viral diseases in the EU/EEA - E-learning: Assess and Mitigate the Risk of Locally Acquired Aedes-Borne Viral Diseases in the EU/EEA
Community protection	Country and regional examples - Technical resources -
Clinical care	Country and regional examples - Technical resources - Deferral criteria and testing strategies for dengue virus in blood donors returning from affected areas (12) - Guidelines for the diagnosis and treatment of dengue haemorrhagic fever (13)
Access to countermeasures	Country and regional examples - Technical resource

References for Annex 6

1. Pan American Health Organization. The Arbovirus Diagnosis Laboratory Network of the Americas (RELDA). (2025) <https://www.paho.org/en/topics/dengue/arbovirus-diagnosis-laboratory-network-americas-relda> [Accessed February 7, 2025]
2. European Centre for Disease Prevention and Control. Zika virus disease epidemic: Preparedness planning guide for diseases transmitted by *Aedes aegypti* and *Aedes albopictus*. (2016) <https://www.ecdc.europa.eu/sites/default/files/media/en/publications/Publications/zika-preparedness-planning-guide-aedes-mosquitoes.pdf> [Accessed October 15, 2025]
3. van Ewijk C, Feenstra S, ter Bogt-Kappert C, Braks M, Franz E, Geurts van Kessel C. West Nile virus in the Netherlands. Surveillance and Response 2021-2023 Final Report. National Institute for Public Health and the Environment RIVM. (2024). doi: 10.21945/RIVM-2024-0050
4. European Centre for Disease Prevention and Control. Establishment of EU Reference Laboratories for public health in Europe. (2025) <https://www.ecdc.europa.eu/sites/default/files/documents/establishment-EURL-europe.pdf> [Accessed October 15, 2025]
5. Arbo-France. Arbo-France. (2025) <https://arbo-france.fr/en/> [Accessed October 15, 2025]
6. Santé publique France. On the occasion of the launch of reinforced surveillance of dengue, chikungunya and Zika in metropolitan France, health authorities are reminding people of the importance of protecting themselves from mosquito bites. (2025) <https://www.santepubliquefrance.fr/presse/2025/a-l-occasion-du-lancement-de-la-surveillance-renforcee-de-la-dengue-du-chikungunya-et-du-zika-en-france-metropolitaine-les-autorites-sanitaires-r> [Accessed October 15, 2025]
7. Centre National De Reference Arbovirus. Indigenous cases in metropolitan France: Genomic update of 03/10/2025. (2025) <https://cnr-arbovirus.fr/public/> [Accessed October 15, 2025]
8. TechNet-21. Global Yellow Fever Laboratory Network (GYFLaN). (2025) <https://www.technet-21.org/fr/eye-labs/network> [Accessed February 4, 2025]
9. World Health Organization Regional Office for Africa. The work of the African Network on Vector Resistance to insecticides 2000 – 2004. (2005) https://www.afro.who.int/sites/default/files/2017-06/phe-anvr_tech_report.pdf [Accessed October 29, 2025]
10. Public health guidance for assessing and mitigating the risk of locally-acquired *Aedes*-borne viral diseases in the EU/EEA. (2025) <https://www.ecdc.europa.eu/en/publications-data/public-health-guidance-assessing-and-mitigating-risk-locally-acquired-aedes-borne> [Accessed October 14, 2025]

11. European Centre for Disease Prevention and Control. E-learning: Assess and Mitigate the Risk of Locally Acquired Aedes-Borne Viral Diseases in the EU/EEA. (2025)
<https://www.ecdc.europa.eu/en/news-events/e-learning-assess-and-mitigate-risk-locally-acquired-aedes-borne-viral-diseases-eueea> [Accessed October 15, 2025]
12. European Centre for Disease Prevention and Control. Deferral criteria and testing strategies for dengue virus in blood donors returning from affected areas. (2025)
<https://www.ecdc.europa.eu/sites/default/files/documents/Dengue-survey-SoHO-2025.pdf> [Accessed October 15, 2025]
13. Vietnam Ministry of Health. Guidelines for the Diagnosis and Treatment of Dengue Hemorrhagic Fever. THƯ VIỆN PHÁP LUẬT (2024) <https://thuvienphapluat.vn/van-ban/The-thao-Y-te/Quyết-dinh-2760-QĐ-BYT-2023-Hướng-dẫn-chẩn-doan-diệu-tri-Sơ-xuất-huyết-Dengue-572227.aspx> [Accessed October 15, 2025]

Annex 7: Examples of assumptions in the national planning process

National planning for arbovirus epidemics and pandemics involves making assumptions about a variety of factors, given the uncertainties inherent in these outbreaks. These assumptions guide the development of response strategies and resource allocation. Some assumptions may include:

- Unpredictability of arbovirus epidemics: Arbovirus epidemics are likely to occur, but their timing, spread, and severity are unpredictable, which necessitates broad, flexible planning for a range of potential scenarios, including varying transmission dynamics, vectors, and affected populations.
- Severity of the epidemic or pandemic: arbovirus epidemics may vary in severity, ranging from mild to severe, with morbidity and mortality outcomes potentially fluctuating across different regions. The early stages of an epidemic may be marked by uncertainty regarding its severity, making it essential for countries to monitor the spread and impact in real time. National, regional, and global studies, along with timely data collection, can provide valuable insights into the evolving nature of the epidemic and guide response strategies.
- Varying immunity levels: immunity levels may vary across populations based on factors such as age, prior exposure, vaccination coverage, and whether people live in endemic or non-endemic regions. As such, countries should account for variations in susceptibility and tailor interventions accordingly.
- Epidemic duration and seasonality: arboviruses follow seasonal transmission linked to vector abundance, virus overwintering, environmental and other factors. Countries should be anticipate recurring seasonal peaks and develop strategies to manage these predictable cycles effectively.
- Environmental factors and climate: climate conditions play a crucial role in the spread of arboviruses, as vectors thrive in specific environmental conditions. Countries should consider climate data and forecast trends in their preparedness plans, ensuring that vector control measures are adapted to changing environmental conditions.
- Demand for healthcare and resources: The demand for healthcare services, medical countermeasures, personal protective equipment (PPE), and other supplies during an arbovirus epidemic may quickly exceed available resources, especially during the initial stages. National stockpiles of essential products, including diagnostics, medicines, and vector control measures, should be planned and regularly updated. In cases of resource scarcity, equity in access to these critical products must be prioritized to ensure fair distribution, especially for vulnerable populations.
- Absenteeism and disruption of essential services: arbovirus epidemics particularly those with high clinical attack rates occurring in densely populated urban areas, may lead to high rates of absenteeism in the workforce and schools. This absenteeism can disrupt critical services, such as transportation, health systems, and education. Countries should establish multisectoral

contingency plans that address varying levels of absenteeism, ensuring continuity of essential services through flexible work arrangements and cross-sector collaboration.

- Cross-border implications: Given that arboviruses can spread rapidly across borders, particularly in regions with high population mobility, countries should assume the likelihood of transnational transmission. Coordination with neighbouring countries and regional bodies for early detection, information sharing, and coordinated response measures is vital to contain outbreaks at their source and prevent widespread epidemics.
- Long-term health consequences: some arboviruses can cause long-term health complications and sequelae, including developmental defects resulting from maternal Zika infection in pregnancy, neurological disability following Japanese encephalitis, and chronic chikungunya arthritis. National planning should anticipate and incorporate strategies for managing long-term care and rehabilitation needs, which may place additional strain on the healthcare system.
- Whole-of-society impact: socioeconomic and political effects of an arbovirus epidemic may be extensive. Beyond the immediate health impacts, disruptions to businesses, agriculture, tourism, and trade can lead to long-term economic challenges. Critical infrastructure, including water and sanitation systems, electricity, and communication networks, should be available to maintain operations during an epidemic. The private, public, and humanitarian sectors should have the capacity to scale up efforts to ensure continuity of services and mitigate societal disruption.

Annex 8: Examples of triggers for transitioning between operational stages for pandemic preparedness and response

The examples below illustrate possible triggers for transitioning between operational stages. These are indicative and should be adapted to national and subnational contexts. The timing and thresholds for transition will vary depending on surveillance capacity, vector ecology, available laboratory and epidemiological data, and national risk assessment mechanisms. Countries are encouraged to integrate these triggers within existing early warning, alert, and response systems to ensure timely, coordinated, and multisectoral action.

Transition from “Prevent and prepare” to “Respond (activate early control measures)”

Corresponds to the shift from the Pre-emergence to the Emergence stage when the risk of arbovirus introduction or early local transmission increases.

- Information from global or regional surveillance systems, WHO alerts, or partner networks on detection of increased arbovirus activity in neighbouring countries or regions
- Reports from national entomological surveillance systems on significant increase in vector density
- Detection of arbovirus circulation in vectors or animal reservoirs within national borders for the first time
- Seasonal or meteorological forecasts indicating climatic conditions favourable for vector proliferation and virus transmission (e.g. elevated rainfall, humidity and temperature)
- An indication from a national surveillance system of an unusual trend in specific clinical symptoms or syndromes associated with arboviral infections (e.g. fever with rash or arthralgia) which may overwhelm health systems
- Detection of imported cases in travellers or cross-border workers that signal a risk of local transmission
- Declaration by of a Public Health Emergency of International Concern by WHO (or regional health body)

Transition from “Respond (activate early control measures)” to “Respond (contain)”

Corresponds to the shift from the Emergence to the Amplification and local transmission period, when local transmission is confirmed and actions stop transmission and halt the epidemic by reducing the R_t / R_0 to less than 1 are implemented.

- Confirmation of autochthonous (locally acquired) arboviral infection(s) or clusters through laboratory testing, indicating establishment of local transmission
- Alerts/reports from a subnational health authority on unusual increases in case numbers, severity or clustering, requiring national-level assistance

Transition from “Respond (contain)” to “Respond (control/reduce transmission and mitigate impact)”

Corresponds to the shift from the Amplification and local transmission to the Widespread community transmission period, when multiple areas experience sustained community transmission.

- Evidence of sustained community transmission in multiple subnational regions
- Expansion of transmission beyond initial hotspots, including cross-district or cross-border spread
- Regional alerts of widespread arbovirus activity, signalling broader regional or international threat
- Health system strain due to rising case numbers, hospitalizations, or deaths, reducing capacity for effective containment
- Assessment indicating that subnational responses are insufficient, requiring coordinated national or international support

During this operational sub-stage, response measures may be scaled up or adjusted based on:

- Epidemiological trends (cases, hospitalizations, deaths)
- Health system capacity and resource availability.
- Access to and deployment of effective vaccines, therapeutics, or other countermeasures.

Transition from “Respond (control/reduce transmission and mitigate impact)” to “Recover (scale down and sustain)”

Corresponds to the shift from the Widespread community transmission to the Stabilized situation period, when transmission declines, and systems transition to long-term control and recovery.

- Sustained reduction in new cases, hospitalizations, and deaths across affected areas over multiple reporting cycles
- Entomological surveillance showing significant reduction in vector populations, consistent with reduced human case incidence
- Health system recovery, with restoration of essential services and reduced emergency burden
- Formal declaration by the national health authority that the epidemic is over or under control
- Transition of Emergency Operations Centre (EOC) from active response to monitoring mode.