DRAFT

Urban Yellow Fever Risk Management

DRAFT Handbook for National Preparedness and Response Planning

DRAFT for consultation only

Version 22 October 2025

NOTE: This is a draft of the Urban Yellow Fever Risk Management handbook for consultation. The final version of the handbook will be made publicly available after consideration of the proposed revisions arising from the consultation and once it has been approved for publication.

Contents

Abbreviations

AEFI	Adverse Events Following Immunization
BI	Breteau Index
CDC	United States Centers for Disease Control and Prevention
CFR	Case Fatality Rate
CI	Container Index
CSO	Civil Society Organization
EPI	Expanded Programme on Immunization
EYE	Eliminate Yellow Fever Epidemics
GIS	Geographic Information System
GPS	Global Positioning System
HI	House Index
HSCP	Hazard Specific Contingency Plan
ICG	International Coordinating Group
ICU	Intensive Care Unit
IFRC	International Federation of Red Cross and Red Crescent Societies
IgM	Immunoglobulin M
IHR (2005)	International Health Regulations (2005)
IVM	Integrated Vector Management
MEURI	Monitored Emergency Use of Unregistered and Investigational Interventions
MMR1	First Dose of Measles-Mumps-Rubella Vaccine
MoH	Ministry of Health
MSF	Médecins Sans Frontières (Doctors Without Borders)
NAPHS	National Action Plan for Health Security
NHP	Non-Human Primates
NGO	Non-Governmental Organization
OCHA	United Nations Office for the Coordination of Humanitarian Affairs
PAHO	Pan American Health Organization
PCR	Polymerase Chain Reaction
PHC	Primary Health Care
RCCE	Risk Communication and Community Engagement
RNA	Ribonucleic Acid
RT	Reverse Transcription
SAGE	Strategic Advisory Group of Experts

SoPs	Standard Operating Procedures
SPAR	State Party Self-Assessment Annual Report
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
UNICEF	United Nations Children's Fund
VHF	Viral Haemorrhagic Fever
WFP	World Food Programme
WHA	World Health Assembly
WHO	World Health Organization
YF	Yellow Fever

This symbol is used when readers are signposted to related guidance and tools

This symbol is used when readers are signposted to related webpages

Glossary

Autochthonous transmission: Transmission of a pathogen with in a geographic area that is acquired locally. This contrasts with disease importation whereby an individual contracts the disease outside the area and brings it into the local population.

Capacity: Combination of all the strengths, attributes and resources available within an organization, community or society to manage. Capacity may include infrastructure, institutions, human knowledge and skills, and collective attributes such as social relationships, leadership and management [1].

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 [2] .

Community protection: Proactively building trust with communities through risk communication and infodemic management, community engagement to help design and implement public health and social measures and multisectoral action to address community concerns [2].

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 (WHO, 2020) [1] .

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 [2] .

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 [1].

Epizootic: The occurrence of a disease event in an animal population that is in excess of normal expectancy.

Extrinsic Incubation Period: Time between the bite when the mosquito acquires the virus and when it becomes capable of transmitting the virus to another person through another bite.

Gender: The socially constructed roles and differences between males and females, and the relationships between these groups. Gender changes over time, within and between cultures, and is dependent on both context and time. Gender and other diversity factors, such as sexual orientation, age group, disability, and socioeconomic status, among others, determine daily responsibilities, access to resources, and power dynamics [3].

Incubation period : Period between the entry of a pathogen into a host and the appearance of symptoms.

Intermediate transmission of yellow fever: Transmission of yellow fever virus from mosquitoes to humans living or working in jungle border areas. In this transmission cycle, the virus can be transmitted from non-human primate to human or from human to human via mosquitoes.

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 [4].

Outbreak: Used synonymously with “epidemic”, usually to indicate localized as opposed to a generalized epidemic [1].

1. Glossary of Health Emergency and Disaster Risk Management Terminology. Geneva: World Health Organization; 2020 (https://apps. who.int/iris/handle/10665/331716, accessed 31 December 2022
2. 10 Proposals to build a safer world together: Strengthening the global architecture for health emergency preparedness, response and resilience. White paper for consultation. Geneva: World Health Organization; 2022 (link, accessed 31 December 2022
3. Key considerations for integrating gender equality into health emergency and disaster response: COVID-19. Washington: Pan American Health Organization; 2020 (https://iris.paho.org/ handle/10665.2/52247, accessed 31 December 2022
4. One Health. In: World Health Organization /Health topics (https://www.who.int/health-topics/onehealth#tab=tab_1, accessed 31 December 2022.

Preparedness: Having the knowledge, capacities, and systems that work to reduce vulnerability and enhance resilience [1].

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 [2].

Response: The provision of emergency services and public assistance during or immediately after a disaster in order to save lives, reduce health impacts, ensure public safety and meet the basic subsistence needs of the people affected [3] .

Surge: Sudden demand for services, necessitating additional capacities in terms of the amount of personnel, specialized expertise, equipment or supplies [3].

Surveillance: Public health surveillance is the ongoing systematic collection, analysis and interpretation of health data. It includes the timely dissemination of the resulting information to those who need them for action (Public Health Surveillance | WHO | Regional Office for Africa). For yellow fever: the system that supports early detection of outbreaks and supports rapid implementation of control measures, identifies high-risk areas and vulnerable populations for yellow fever outbreaks, and monitors and measures the impact of preventive and control measures [4].

Sylvatic transmission of yellow fever: When the yellow fever virus is transmitted between non-human primates and mosquito species found in the forest. The virus can be transmitted by mosquitoes to humans when humans spend time in the jungle.

Urban area: For the purpose of this document, an urban area or city simply refers to areas with a large and dense population that may be within certain administrative or political boundaries (single or multiple), under the national structure [5].

Urban transmission of yellow fever: When the yellow fever virus is transmitted between humans and urban mosquitoes, almost exclusively of the species *Aedes aegypti*.

Vulnerability: The conditions determined by physical, social, economic and environmental factors or processes which increase the susceptibility of an individual, a community, assets or systems to the impacts of a hazard [3].

1. WHO Strategic Framework for Emergency Preparedness. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/254883, accessed 31 December 2022).
2. Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction (Seventy first session). Geneva: United Nations General Assembly; 2016 (Report of the Open-ended Intergovernmental Expert Working Group on Indicators and Terminology relating to Disaster Risk Reduction :, accessed 7 October 2025).
3. Glossary of Health Emergency and Disaster Risk Management Terminology. Geneva: World Health Organization; 2020 (https://apps. who.int/iris/handle/10665/331716, accessed 31 December 2022).
4. Yellow fever: Vaccine Preventable Diseases Surveillance standards. Geneva: World Health Organization; 2020. https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-yellow-fever, accessed 31 December 2022)
5. United Nations Expert Group Meeting on Sustainable Cities, Human Mobility and International Migration, New York, 7–8 September 2017: report of the meeting. New York: United Nations; 2017.

1 Introduction

Yellow fever (YF) is caused by yellow fever virus (YFV), the prototype member of the *Orthoflavivirus* genus in the family Flaviviridae. A substantial proportion of the orthoflaviviruses are mosquito-borne, including YF, dengue and Zika viruses.

While a single YF case is an emergency, in countries at high risk of YF, outbreak dynamics differ between urban areas and non-urban areas (rural settings, forests). Urban transmission involves humans and mosquitoes of the species *Aedes aegypti*, while sylvatic transmission involves non-human primates as primary hosts of YFV. If the YFV is introduced into urban areas with high vector density and low immunity, explosive outbreaks with high morbidity and mortality are likely. The necessity of preventing explosive outbreaks requires the implementation of specific measures for timely detection, investigation and response.

The emergence and reemergence of the YFV is driven by increased sylvatic exposure, human displacement, and immunity gaps, particularly among underserved and vulnerable population groups. Urbanization and forest encroachment, combined with the potential spread of *Ae. Aegypti* – difficult to control – create conditions ripe for urban YF outbreaks. Furthermore, autochthonous transmission in low-risk areas with *Ae. aegypti* and populations lacking immunity can lead to severe epidemics.

Given the increasing threat of urban YF epidemics in areas with low vaccination coverage – and the associated risk of international spread – strengthening early detection and rapid response capacities is urgently needed. Effective risk mitigation requires tailored preparedness strategies and coordinated multisectoral response plans. Therefore, optimal planning for the prevention and control of urban YF outbreaks is a critical and immediate priority.

In response to the 2016 YF outbreak in Angola and the threat of international spread, Gavi, the Vaccine Alliance, UNICEF, and WHO developed a comprehensive, multipartner strategy to Eliminate Yellow fever Epidemics (EYE Strategy) 2017–2026 based on three strategic objectives: 1) protect at-risk populations, 2) prevent international spread, and 3) rapidly contain outbreaks.

During the 2024 Annual Partners' Meeting in Addis Ababa, Ethiopia, Member States were invited to develop YF-specific contingency plans that include a focus on urban YF preparedness to address this specific risk. Low-risk countries with *Ae. aegypti*, even without evidence of current YFV circulation but considered at risk of introduction, must anticipate at least by limiting importation of YF. This preparedness will also benefit the management of other *Aedes*-borne viral diseases lsuch as dengue, Zika and chikungunya.

Scope

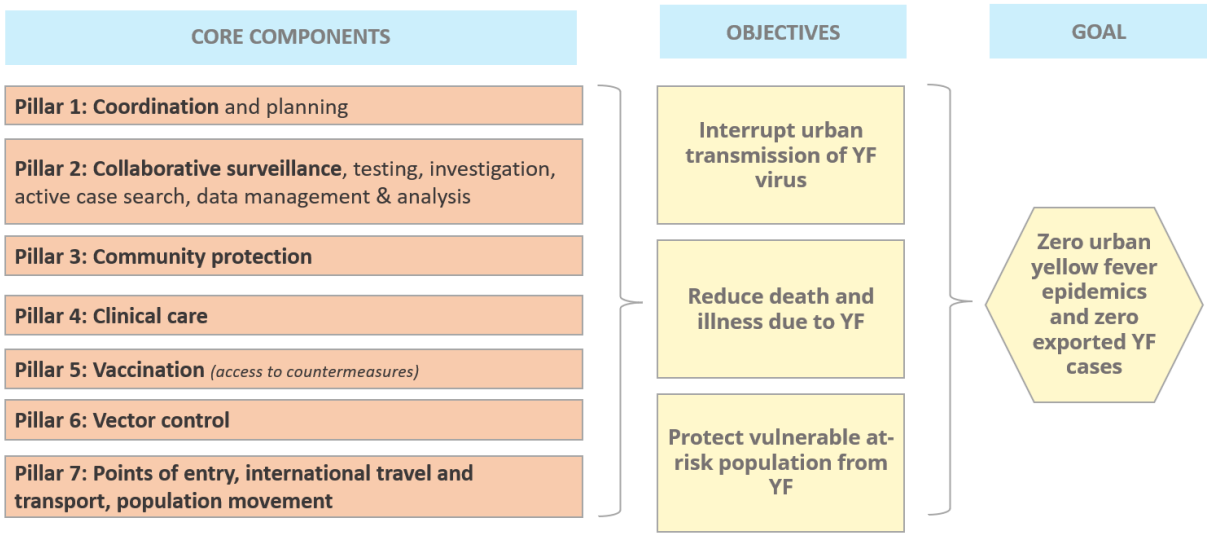
This handbook aims to address the absence of guidance for effectively managing YF in urban settings, both in high-risk and low-risk countries. It aims to support countries in strengthening preparedness for YF outbreaks in urban settings. The proposed approaches and actions outlined in this document are meant to support the development of a tailored plan to prevent and respond to the urban YF epidemic threat, resulting in minimizing urban transmission, reducing illness, death, and the risk of spread. The document provides Member States with advice for practical actions under each of seven preparedness and response pillars that can be adapted as appropriate and implemented at national and subnational levels to achieve the following objectives in relation to urban YF transmission (Fig. 1):

- **Prevent and interrupt urban transmission of YFV**

- **Reduce death and illness due to YF in urban areas**
- **Protect vulnerable groups* at risk of YF in urban areas**

**Examples of vulnerable groups at risk of YF in urban areas* include low-income families with poor sanitation and inadequate housing favorable to vectors breeding sites, migrants and displaced persons who may live in temporary shelters and/or overcrowded conditions, increasing exposure to mosquitoes, outdoor workers, especially those with occupational exposure to sylvatic YF, underserved urban population groups in high-risk countries who may have limited access to routine immunization.

Figure 1. Core components, objectives, and goal of urban preparedness



In countries where YF is a public health threat, this document will propose measures to improve the timely detection of and response to urban YF transmission. It should be considered as a tool to strengthen the current preparedness and response efforts for facing YF. Actions listed must be considered on a case-by-case basis for countries to tailor them to their individual settings and context as they develop their own guidelines, structures and procedures to prevent and respond to urban YF disease.

This disease-specific document supplements response mechanism and health emergency management policies for cities and urban settings. The YF-specific approaches and actions proposed in this document can complement the foundation of common capacities for health emergency management in cities and urban areas where there is a risk of introduction or reintroduction of YFV.

While the handbook focuses on YF in urban areas, several preparedness and response measures also apply to all settings. For completeness and coherence, all relevant preparedness and response measures are included.

The information in this document is based on the most relevant available evidence and is subject to modifications and updates considering new information that may emerge.

Target audience and use

This document is intended for use by national and subnational authorities responsible for preparedness and response planning for urban YF. Countries can use the preparedness checklists to assess their current status in terms of capacities and planning for urban YF risk management to help identify gaps and therefore priority actions to be included in developing

or revising their national instructions on YF. Countries can also use and adapt the response action lists to help operational response to YF cases occurring in urban settings.

2 An overview of urban YF

Urban YF poses a significant public health threat if the virus is introduced into densely populated areas infested with competent *Aedes* sp mosquitoes, particularly where population immunity is low. Proximity to regions with ongoing sylvatic transmission further increases the risk. Urban transmission refers to *Ae. aegypti*-borne spread. However, preparedness and response measures should be initiated for any YF case in an urban setting with the presence of the vector and/or presence of other *Aedes*-borne arbovirus transmission, as the transmission route is only confirmed after thorough investigation.

Recent trends – such as increased air travel between endemic and non-endemic regions with presence of *Ae. aegypti*– have heightened the risk of YF introduction and urban spread. Preventive vaccination for travellers, early detection of the virus, and rapid implementation of control measures are critical to preventing or interrupting urban transmission cycles.

YFV has been responsible for urban epidemics with high mortality, devastating populations in three continents (Africa, America and Europe) since the 17th century *(1,2)* until a combination of vector control and vaccination campaigns managed to drastically reduce the incidence of YF in humans *(3)*. The YFV is now considered endemic in parts of Africa and South America, causing sporadic outbreaks over the past 50 years.

In the Americas, only two suspected urban transmission events involving *Ae. aegypti* have been documented: Santa Cruz, Bolivia (1997) and Asunción, Paraguay (2008) *(4,5)*. Although Brazil experienced large outbreaks in and near urban areas starting in 2016, *Ae. aegypti*-borne transmission was never confirmed *(6,7)*. Molecular and epidemiological evidence pointed to a predominantly sylvatic cycle, and no *Ae. aegypti*-linked transmission has been reported in Brazil since 1942 *(8)*. The recent surge in YF cases in 2025 across five countries in the Americas, including outside the Amazon region, suggests sylvatic transmission in and along forest edges *(9*). However, the detection of cases near urban centres raises concern about potential reurbanization of YF.

In Africa, recent outbreaks have mostly involved sylvatic or intermediate transmissions with different vectors. The last confirmed major urban outbreak attributed to *Ae. aegypti* occurred in Angola in 2016 *(10).* Since 2017*,* no major urban outbreaks have been reported, though YF cases have been reported in densely populated areas such as Abidjan (Côte d'Ivoire), Accra (Ghana), Douala (Cameroon), and increasingly nearer Lagos (Nigeria) *(10)*.

Urban outbreaks are particularly challenging to control as shown by the last major YF urban outbreak in Africa *(11).* Large urban outbreaks also carry a heightened risk of exporting cases to other regions, including non-endemic ones *(12–15)*.The 2016 Angola outbreak was the most extensive urban YF epidemic in Africa in decades, with rapid exponential growth in Luanda – doubling every 5–7 days. Beyond its local public health impact, the outbreak demonstrated the potential for international spread, with imported cases reported in China and Kenya (without secondary autochthonous spread) *(16)*, and confirmed urban transmission in neighbouring Democratic Republic of the Congo *(17)*.

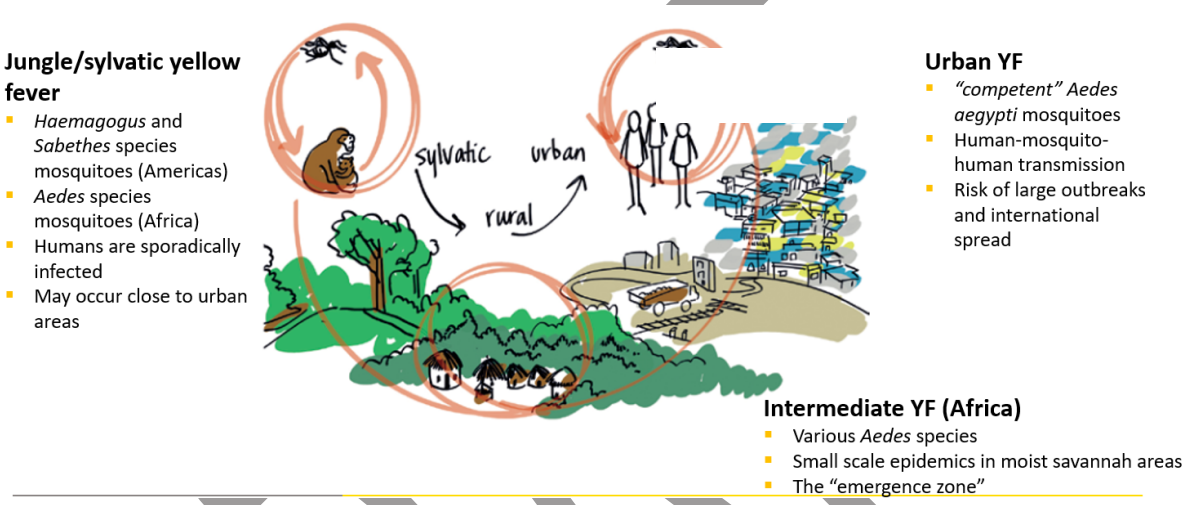
Urban transmission of YFV

The emergence of YFV in an urban environment involves both the introduction of the virus and the presence of competent vectors. The virus can be introduced by a viraemic human infected through the bite of an infected sylvatic or savanna vectors. In the environmental context of forest patches close to housing, such as in peri-urban areas in endemic areas,

humans can get infected without traveling to forest or rural areas. Introduction of the YFV in an urban area could also be due to the accidental transportation of infected mosquitoes.

Fig. 2 illustrates the the three transmission cycles of the YFV, which primarily circulates between wild infected mosquitoes and non-human primates. The intermediate cycle, called "savanna cycle" in Africa is found in zones between forest and savanna where the virus can be transmitted from non-human primates to other vectors biting humans or from humans to humans via various semi-domestic and peri-domestic mosquitoes.

Figure 2. Yellow fever (YF) transmission cycles (source: World Health Organization. (2024). Eliminate yellow fever epidemics (EYE) strategy country toolkit. World Health Organization. https://iris.who.int/handle/10665/379980)



The transmission of YFV in and near urban centres in South America is complex due to 1) urban expansion encroaching on nature, 2) the fact that some sylvatic YFV vectors such as *Haemagogus leucocelaenus* occur in periurban areas *(15,18)*, and 3) the presence of non-human primates in peri-urban areas close to metropolitan areas and in urban areas under sylvatic influence (i.e. forest patches with non-human primates (NHP) and vectors close to habitats) in Brazil *(19)*. Increased interactions between humans and infected mosquito vectors raise the risk of YFV transmission. The complexity of YF outbreaks that occurred in Brazil in densely population areas close to a sylvatic environment is summarized in Box 1.

Box 1: YF outbreak in São Paulo, 2016–2019

Between 2016 and 2019, Brazil experienced a YF outbreak that spread to high-density population areas where the virus had not circulated for almost 80 years, affecting the Atlantic Forest biome (de Abreu et al., 2019) and resulting in autochthonous human cases and epizootics in São Paulo, the most populous state in the country (Cunha et al., 2019a; Hill et al., 2020; Rezende et al., 2018). During that period, the virus spread among mosquito vectors and non-human primates and reached municipalities with low vaccination coverage or no vaccination recommendations (Lacerda et al., 2021; Cunha et al., 2019b). The state confirmed 648 human cases (230 deaths; 35.5% case fatality rate) and 843 epizootics (Lacerda et al., 2021). Analyses on phylogeographic and geopositioning using complete genomic sequences from 36 patients with YF, from December 2017 to April 2018, indicated that the virus moved through the peri-urban area of São Paulo without detectable transmission (Cunha et al., 2019b). This pattern was also observed through molecular and epidemiological analyses of samples collected in 2017 from other states affected by YF (Espírito Santo, Minas Gerais and Rio de Janeiro). In these areas, there was no evidence of a transmission cycle only involving only humans and urban vectors. The rural origin of cases, the predominance of affected adult males, and the absence of molecular evidence of urban transmission cycle suggest a predominantly sylvatic transmission of the virus. Furthermore, the presence of two distinct clades circulating simultaneously in humans and non-human primates indicates multiple sylvatic transmission cycles (Moreira-Soto et al., 2018). Entomological surveys confirmed virus transmission by sylvatic vectors during the YF outbreak. Thousands of mosquitoes from dozens of species were collected in municipalities across five Brazilian states (Bahia, Espírito Santo, Minas Gerais, Rio de Janeiro, and São Paulo) and tested for YFV. After the

virus began circulating, nine mosquito species were detected as positive, with *Haemagogus janthinomys* and *Haemagogus leucocelaenus* implicated as the primary vectors due to their wide distribution, abundance, and high infection rates (de Abreu et al., 2019; Cunha et al., 2019b; Pinheiro et al., 2019; Cruz et al., 2023; Stanzani et al., 2023). Other species appeared to play a secondary or localized role; however, there was no documented transmission by *Ae. albopictus* or *Ae. aegypti*, though *Ae. albopictus* was found in many affected municipalities, with significant niche overlap with sylvatic vectors (de Abreu et al., 2019).

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Factors driving or impacting on urban transmission cycle

Displacement of populations due to many drivers such as desire for better income and better amenities, conflict or natural disasters from climate change, as well as rapid rural–urban migration in many parts of the world has resulted in unmanaged and unplanned urbanization encroaching on nature. Moreover, with inadequate access to potable water and poor environmental sanitation, an increase of man-made larval habitats is related to proliferation of *Ae. aegypti*, vector of several pathogens. Infected *Ae. aegypti* mosquitoes can also pass on the virus to their eggs through transovarial (or vertical) transmission, happening however at a much lower rate than infection through blood feeding. Frequent travel by workers between forests or peri-urban areas with ongoing disease transmission and urban centres significantly increases the risk of initiating an urban transmission cycle. This risk is particularly high in areas where *Ae. aegypti* mosquitoes are present and where preventive measures or effective control strategies are lacking (Fig. 3).

The invasion and establishment of another mosquito species, *Aedes albopictus,* competent for YFV in laboratory experiments is raising concerns *(20)*. However, the implication of this species in urban transmission of YFV has never been reported. It was hypothesized that *Ae. albopictus* could also act as a bridge vector between urban and sylvatic YF transmission cycles, but again no evidence was ever found. Although it is uncertain how significant *Ae. albopictus* might be in YF transmission, its ability to adapt to new environments, its zoophilic feeding habit, and competence to amplify YFV enhance the need for further studies to better

understand if this species has or does not have a role in YFV transmission. Other arboviral disease transmission cycles also make the surveillance of this species important.

Figure 3. Increased risk of urban YF outbreaks with international spread
Source: Eliminate yellow fever epidemics (EYE) strategy country toolkit. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/379980, accessed 3 September 2025)

Knowledge of the incubation periods and viraemia helps to understand transmission dynamics of urban YF and response scenarios. It is mainly during initial, or acute, phase of infection that patients are viraemic (infected by a quantity of viral particles capable of infecting mosquitoes through a blood feeding). Viraemic humans are infectious to mosquitoes shortly before fever through first 3–5 days of illness (Fig. 4). This means that most patients with jaundice, which appears in a minority of patients after a phase of remission, are no longer infectious to mosquitoes. When jaundice arises, usually there is no (or very little) intact virus circulating in the blood though viral RNA might be detected by reverse transcription polymerase chain reaction (RT-PCR) testing.

In the hypothetical scenario where a single viraemic person with YF arrives in an urban area and is immediately bitten by a female *Ae.aegypti*, it would take an average of 15 days before another symptomatic case generated by that initial viraemic individual might be detected in the location, assuming the secondary case develops symptoms. This period is based on the sum of the mean Extrinsic Incubation Period (EIP) of ~10 days (EIP is the time between the bite when the mosquito acquires the virus from a viraemic person and when it becomes capable of transmitting the virus to another person through another bite) and the mean intrinsic incubation period of ~4.3 days in the patient (i.e. the time between the mosquito bite and the onset of illness in a person) (Fig. 4 and Table 1). It must be noted that EIP depends on the species and the temperature, and an infected mosquito can transmit the virus for the remainder of its lifespan *(21)*.

Figure 4. Timeline of YFV transmission (adapted from: Johansson MA, Arana-Vizcarrondo N, Biggerstaff BJ, Staples JE. Incubation periods of Yellow fever virus. Am J Trop Med Hyg. 2010 Jul;83(1):183-8)

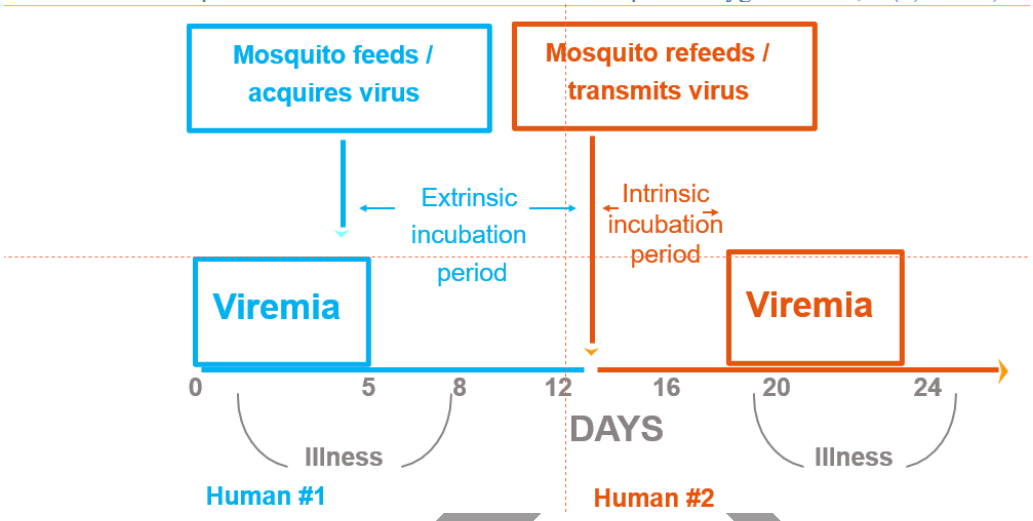
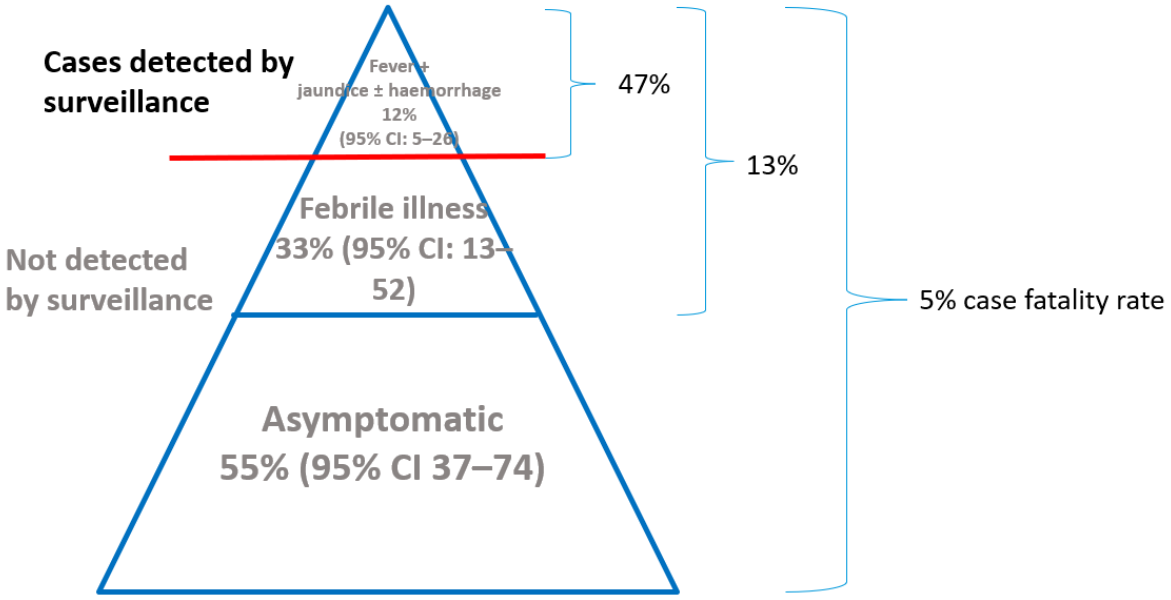


Table 1: Yellow fever virus intrinsic and extrinsic incubation periods
Source: Johansson MA, Arana-Vizcarrondo N, Biggerstaff BJ, Staples JE. Incubation periods of Yellow fever virus. Am J Trop Med Hyg. 2010 Jul;83(1):183-8.

▪ Incubation period for humans is median 4.3 days (95% CI: 2–9)
▪ Viraemic humans are infectious to mosquitoes shortly before fever through first 3–5 days of illness
▪ Extrinsic incubation period in *Ae. aegypti* is median of about 10 days (95% CI: 2–37) at 25°C ▪ It is shorter when warmer; 9 days at 27°C
▪ Once infected, mosquitoes remain so for life

Mayn infected people develop asymptomatic, subclinical, and mild forms of the disease, which are difficult to diagnose clinically. Symptoms observed in mild and moderate forms can be mistaken with those found in other infectious diseases common in endemic areas such as malaria, viral hepatitis, leptospirosis, dengue *(22,23)*. YF is more likely to be diagnosed when disease is severe showing jaundice +/- haemorrhagic signs. This means that even with a well performing surveillance system covering both public and private health facilities, cases imported in urban areas may be overlooked: for every severe case of YF (with failure of organs and haemorrages), there are several other mild cases and asymptomatic infections (Fig.5). The problem is that asymptomatic individuals can be viremic and thus capable of transmitting the virus to naïve mosquitoes *(24)*.

Figure 5. Clinical presentation of yellow fever ratio in the Americas (adapted from Johansson MA, Vasconcelos PF, Staples JE. The whole iceberg: estimating the incidence of yellow fever virus infection from the number of severe cases. Trans R Soc Trop Med Hyg. 2014 Aug;108(8):482–7).



Differences between urban and non-urban YF

Urban YF cases and outbreaks resulting from an urban transmission cycle is of particular public health importance because the virus can spread rapidly both in time and place *(25)*. Table 2 summarizes the differences between urban and non-urban YF transmission. *Ae. aegypti* mosquitoes transmit the virus to humans, resulting in large epidemics in heavily populated areas with high mosquito density and lack of immunity (vaccination). Moreover, the proximity of airports increases the risk of exporting YF through viraemic travellers. In urban settings, control measures are more difficult to implement due to difficulties in assessing target populations and high mobility of the population. Because of the risks of YF large outbreaks in urban environment, it is strongly required to tailor detection of YFV and/or YF disease and response plans to urban settings.

Table 2. Differences between non-urban YF and urban transmission that may elicit different preparedness and response

	NON URBAN	URBAN
Outbreak pattern and scale	Isolated sylvatic cases and outbreaks from intermediate transmission (Africa) Large outbreaks are unusual (e.g. Brazil 2016–2019)	Rare event: requires an infected person being bitten by *Ae. aegypti* often (but not necessarily) after travel from endemic to urban area (or from a city with an urban outbreak). Imported infected mosquito eggs could also potentially result in introduction and transmission of YFV in urban areas.
Burden of disease	Typically low number of cases and deaths (in absolute numbers)	Risk of explosive outbreak with potential high morbidity and mortality, great burden on and disruption of public health system
Virus circulation	**YFV** circulates between non-human primates and sylvatic mosquitoes in sylvatic areas (or areas under sylvatic influence)	No circulation of YFV unless infected human case (or infected mosquitoes or eggs) is introduced into an area with urban vectors
Healthcare involvement	The public sector may be a major source of care for patients with severe YF	Both public and private sectors will be a source of care for patients with severe YF; a significant increase in Intensive Care Unit admissions is expected.
Vector control feasibility	Vector control is not feasible in forest areas. It can be implemented only on the fringes of the forest-village areas.	Vector control and source reduction are needed for prevention and response, including assessing susceptibility to the insecticide used and social mobilisation.
Vaccination challenges	Challenges for vaccinating hard-to-reach populations in rural areas with	Challenges for organizing a reactive vaccination campaign in urban settings due to people not being

	sparse housing in both routine and reactive vaccination.	available (e.g. working) or able to access (e.g. underserved) vaccination sites
Vaccine supply risk	Low risk of vaccine shortage	High risk of vaccine shortage
Risk of international spread		High risk of international spread because of more connectivity (e.g. air travel or roads) and larger population movement

Alignment with health emergency preparedness in urban settings

Cities and urban settings are complex environments with unique vulnerabilities that must be considered in health emergencies preparedness. This is primarily due to the higher density of population, built-up infrastructure, contextual laws and cultures, the high diversity of population groups with social, ethnic, political, linguistic, religious and income differences, and the dynamics with high mobility and rapidly shifting power relationships. An unprepared urban setting is more vulnerable to the catastrophic effects of health emergencies, and can exacerbate the spread of diseases such as YF. Urban settings often serve as the frontline for response efforts making their preparedness crucial for effective disease control. Countries that invest in contextualized health emergency preparedness at the urban level will be better equipped to respond to public health threats, locally, nationally, and internationally (Urban Preparedness | Strategic Partnership for Health Security and Emergency Preparedness (SPH) Portal).

At the World Health Assembly (WHA) in 2022, WHO Member States adopted WHA Resolution 75.7 on strengthening health emergency preparedness and response in cities and urban settings. This resolution requests WHO to incorporate the specific vulnerabilities of urban settings into its ongoing work on health emergencies. This guidance supports the implementation of WHA 75.7 resolution by supporting countries to tackle YF in urban settings.

Since health emergency risk management functions are similar across different health hazards, it is not always relevant to develop a separate global response mechanisms for each hazard. Instead, an urban YF contingency plan can be integrated, for example, as an annex in a comprehensive health emergency preparedness plan for urban settings. WHO guidance and tools on urban health preparedness propose possible actions and approaches that can be adapted to different local contexts.

The WHO Framework for Stregthening Health emergency Preapredness in Cities and Urban Settings aims to provide an overview of the key areas that national and subnational authorities should focus on to strengthen health emergency preparedness at the urban level. It also guides the development of policies and capacity building activities at both the national and sub-national levels based on priority risks and existing gaps. This handbook focuses on key areas for national and local authorities to prioritize in health emergency preparedness in urban settings. It is supported by an operational guidance for national and local authorities, providing actionable approaches across these key areas to strengthen urban preparedness. Taking into account these key areas is essential in building a foundation for improved YF risk management in cities and urban settings.

Framework for strengthening health emergency preparedness in cities and urban settings, Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/348351, accessed 14 August 2024).

Strengthening health emergency preparedness in cities and urban settings: guidance for national and local authorities, Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/351721, accessed 7 May 2024).

National instructions for urban YF risk management can be further integrated into national climate resilience strategies, recognizing effectively YF as a climate-sensitive disease.

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3 General approach for managing urban YF risk

As the risk of YF epidemics varies between countries, preparedness efforts need to be tailored accordingly. In 2016, specific criteria were applied to classify at-risk countries in Africa and Latin America into three categories based on the risk of outbreak: high-risk, moderate-risk, and potential-risk (Fig.6 and Fig.7) *(1)*. Countries and territories neighbouring or located in a geographic area with high-risk and moderate-risk areas and had reports of recent or current outbreaks of *Ae. aegypti*-transmitted viral diseases, such as dengue, were characterized as having "potential for YFV transmission". In this document, moderate-risk and potential-risk countries are grouped together because of the absence on ongoing transmission of YFV in both groups. Notably, this characterization excludes countries from other geographical areas that have never reported YFV transmission, despite some of them remaining at risk of YF introduction through international travel, as exemplified by the exportation of cases to China in 2016. However, evidence indicates that the mere presence of the urban vector *Ae. aegypti* is insufficient to initiate a YF transmission cycle, as additional ecological and epidemiological factors are required.

Figure 6. Yellow fever risk classification by country in Africa

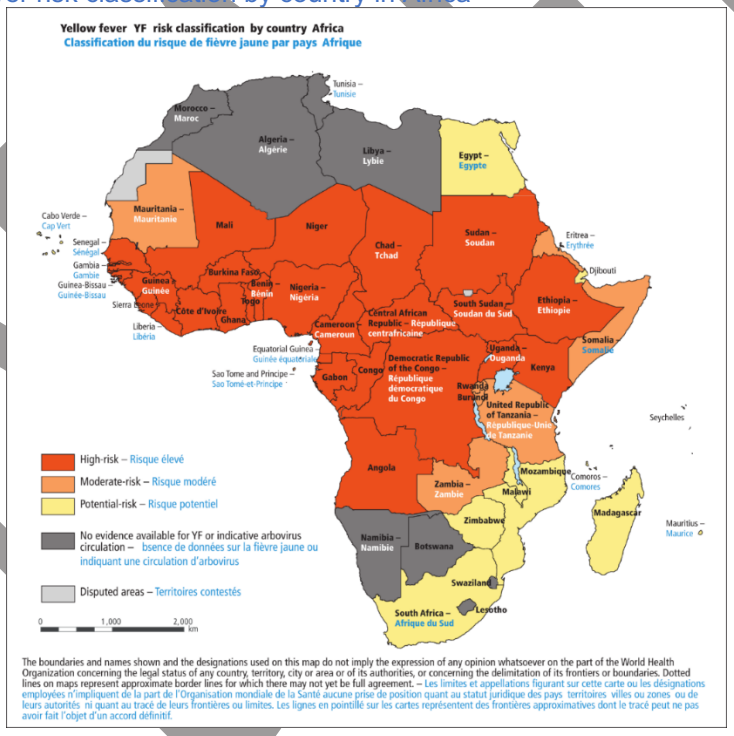
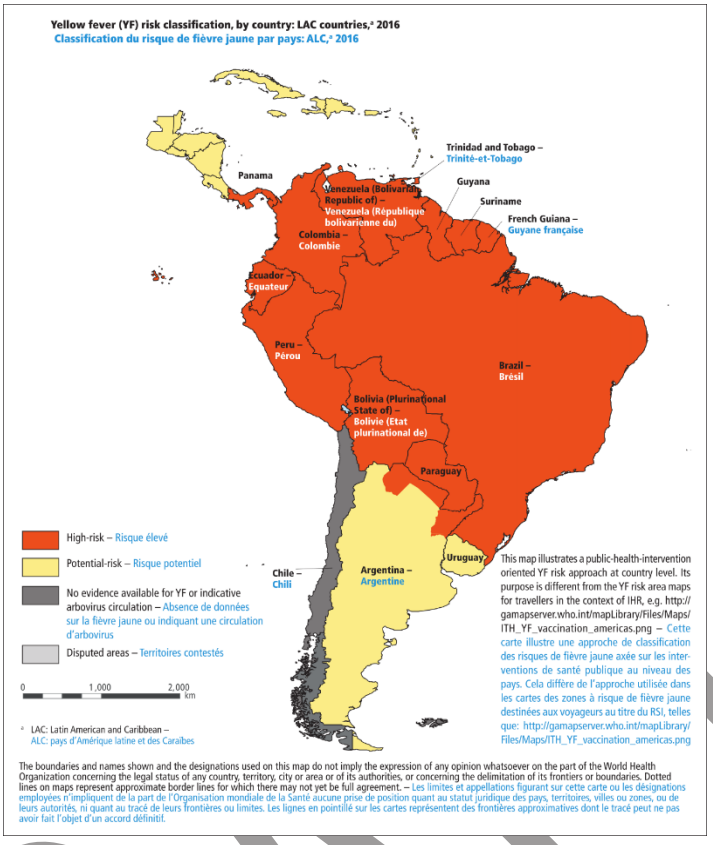


Figure 7. Yellow fever risk classification by country in Latin America and the Caribbean



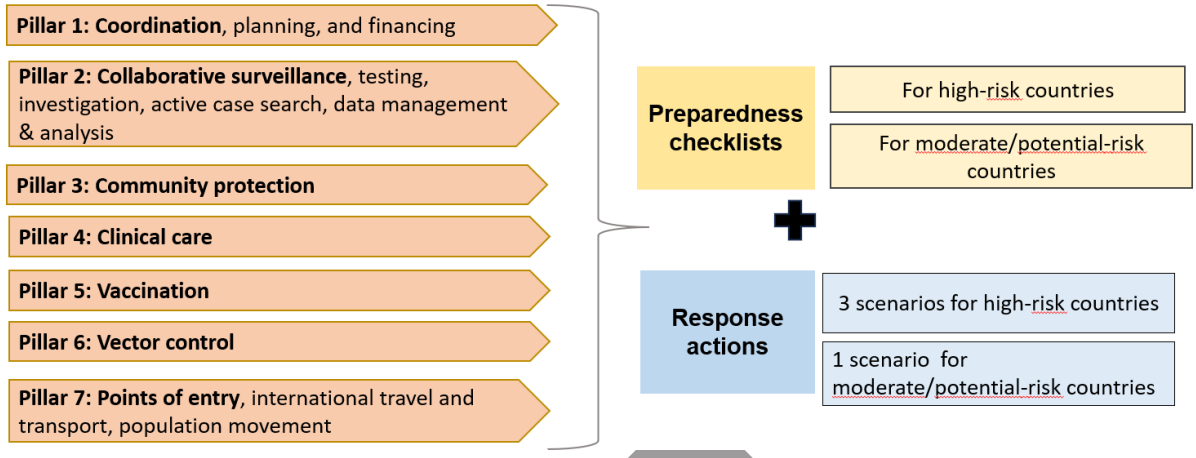
In the high-risk countries, urban transmission can happen if the virus is introduced into urban areas from sylvatic zones. These countries typically have national vaccination policies in place to protect their population and often, YF vaccination is part of their routine child immunization. In contrast, moderate or potential risk countries currently have no YF circulation. Their populations are generally immunologically naïve. Transmission could occur if the virus is introduced where a competent mosquito vector is present. As a result, a single case of YF in these countries would trigger an immediate alert.

The operational planning for urban YF handbook includes action checklists with recommended activities under seven pillars (Figure 8). These were adapted from the core health emergency components that guide the operational system of WHO's strategic framework for Health Emergency Prevention, Preparedness, Response, and Resilience (HEPR) based on field experience and country needs *(2)*. For each of the seven pillars that guide YF preparedness and response, key reference documents are listed and key challenges identified. Approaches and actions must be adapted to the contexts and the cities in countries. Actions under each pillar are categorized into two steps that form the basis for urban resilience: preparedness and response.

Preparedness action lists are developed under each pillar and tailored to risk level to account for key differences between high-risk countries and moderate/potential-risk countries.

Response action lists are developed under each pillar according to four scenarios, one for moderate/potential-risk countries and three for high-risk countries (Fig. 8).

Figure 8. Preparedness and response actions under each pillar tailored to country risk classification



Response measures are defined for four scenarios:

To effectively tailor urban YF guidance across settings, four scenarios were defined by the steering committee based on the endemicity of YFV and the expected level of population protection, assuming a well functioning surveillance system is used to inform interventions :

Scenario 1: likely imported case of YF in an unprotected (unvaccinated) population in an urban area with presence of *Ae. aegypti* in a country with a moderate or potential risk of YF (EYE Strategy classification).

- ➔ This corresponds to the detection of one presumptive case of YF with a travel history to a high-risk area within 2–10 days before the onset of symptoms, and returning to a moderate/potential-risk country in an urban area with presence of *Ae. aegypti* and with a very low population immunity (vaccination in travellers only).

Scenario 2: likely imported case of YF in an urban area with presence of *Ae. aegypti* in a high-risk country (vaccination required) (EYE Strategy classification).

- ➔ This corresponds to the detection of one presumptive case of YF with a travel history to a non-urban area (sylvatic, rural or peri-urban) within 2–10 days before the onset of symptoms and returning to an urban area with presence of *Ae. aegypti*.

Scenario 3: more than 1 confirmed case of YF with epidemiological evidence of urban transmission in a high-risk country (vaccination required) (EYE Strategy classification).

- ➔ This corresponds to the detection of several presumptive cases (2 or more) of YF without travel history to a non-urban area and no exposure to sylvatic vectors within 2–10 days before the onset of symptoms, living in an urban area with presence of *Ae. aegypti* of a high-risk country.

Scenario 4: Evidence of YF viral circulation (YF confirmed cases and/or confirmation of a YF epizootic and/or virus confirmation of YF infected mosquitoes) in forest patches surrounding an urban area with presence of *Ae. aegypti* in a high-risk country (vaccination required).

Immunological protection of a population against urban YF epidemics is possible through vaccination when the coverage of the YF vaccine is above a certain threshold and thus adequate to limit the number of cases.
Populations in moderate and potential risk countries have low vaccination coverage as YF vaccine is not part of the routine immunization. Introduction of the YFV in cities and urban areas in moderate-risk and potential-risk countries could thus generate larger epidemics than in high-risk countries with high vaccination coverage.

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4 Key knowledge and tools per pillar

This section provides background information per thematic area, for all risk categories and scenarios.

Pillar 1: Coordination and planning

- The coordination, planning, financing, and monitoring for YF urban outbreak response should align with broader urban health emergency coordination mechanisms. Effective health emergency preparedness relies on governance and financing which are not unique to YF. Specific mechanisms for city-level preparedness should be detailed in a national health emergency plan.
- Multi-partner mechanisms at both national and city level are essential to maximize resource availability and efficient allocation. Existing capacities and mechanisms targeting other *aedes* borne diseases can be leveraged. City-level authorities should establish a platform for multisectoral dialogue with local actors for preparedness and response, facilitating coordination between national and local governance. Key players include actors across the seven pillars. Main activities to be coordinated relate to surveillance and field investigation (epidemiological and entomological), vaccination, vector control, communication, community engagement, control at border points. For example, sharing of datasets on vaccination coverage of urban populations, human mobility, and detailed maps of vector presence or suitability can contribute to the identification of areas at the greatest risk of infection *(1)*.
- As YF is a zoonotic disease, it is crucial to adopt a multisectoral One Health approach to prepare for and respond to urban outbreaks in both Africa and Latin America. In Latin America, surveillance of YF epizootics is essential for early detection and prevention of YF in humans.
- Collaboration between entomological and epidemiological teams is crucial for understanding disease transmission and targeting interventions.
- The capacity to be operationally ready for and respond to an urban YF epidemic should be evaluated at national and subnational levels, linked with existing urban health emergency response mechanisms. Countries are encouraged to use quantitative and qualitative monitoring and evaluation to inform the response. They should ensure the capacity to collect, analyze and act on various types of data, including social, environmental, biological (e.g. vector and vector control), and behavioural evidence (related to vector control and vaccination uptake). Collaboration with academic and research institutions may be necessary.

Yellow fever: investigation of yellow fever epidemics in Africa : field guide. Geneva: World Health Organization; 2008 (https://iris.who.int/handle/10665/69874, accessed July 29, 2024)

- The International Health Regulations (IHR) States Parties Self-Assessment Annual Reporting Tool (SPAR) consists of 35 indicators for the 15 IHR capacities needed to detect, assess, notify, report and respond to public health risks and acute events of domestic and international concern. This annual assessment supports States Parties to fulfill their obligation for a set of minimum core capacities for surveillance and response to public health risks.

IHR States Parties Self-Assessment Annual Reporting Tool or SPAR

Pillar 2: Collaborative surveillance, testing, epidemiological and entomological investigations, active case search, data management and analysis

- Timely, real-time epidemiologigcal surveillance, field investigation and active case search are essential to detect and respond to urban YF effectively.
- As many cases of YF are asymptomatic or have non-specific mild clinical signs, the first imported case in an urban area is likely to be misdiagnosed and overlooked. This is true also in areas with a suboptimal surveillance system. Rumour surveillance, increase in febrile cases and tracking frequent human movement helps to map the most affected and at risk areas.
- For quicker case detection, individuals with fever and absence of a more likely clinical explanation and who have stayed in an area with confirmed YFV circulation should be tested for YFV infection, as jaundice appears late in the course of disease. Identification of a YF case during the viraemic phase allows for prompt supportive care and vector control. Use of personal protection measures can limit transmission of YFV to mosquitoes.
- **Case-based surveillance** with laboratory testing of all suspect cases and rapid confirmatory testing if indicated is essential to detect YFV introduction in an urban area where the *Ae.aegypti*. mosquito is present.
- In high-risk countries, during urban outbreaks, a **more sensitive case definition** is used to detect non-severe YF cases, which are more likely to be viraemic. Identification of patients with acute fever when malaria/dengue infections are excluded (in malaria/dengue-endemic areas) allows for earlier detection and could improve YF care and control *(2)*.
- **YF testing** should be included in a syndromic surveillance system for *Aedes*-borne arboviral diseases. In moderate and potential risk countries (where there is no reported indigeneous transmission of YF), a very sensitive syndromic surveillance system is needed to detect YF cases.

Yellow fever: vaccine preventable diseases surveillance standards. Geneva: World Health Organization; 2020 (https://www.who.int/publications/m/item/vaccine-preventable-diseases-surveillance-standards-yellow-fever, accessed 12 November 2024).

Yellow fever: investigation of yellow fever epidemics in Africa: field guide. World Health Organization; 2008 (https://iris.who.int/handle/10665/69874, accessed 3 June 2024).

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WHO Regional Office for the Eastern Mediterranean. Establishing syndromic surveillance and event-based surveillance systems for zika, dengue and other arboviral diseases. Geneva: World Health Organization; 2020 (https://iris.who.int/handle/10665/334166, accessed 13 December 2024).

Global strategy on comprehensive vaccine-preventable disease surveillance. Geneva: World Health Organization; 2020 (https://www.who.int/publications/m/item/global-strategy-for-comprehensive-vaccine-preventable-disease-(vpd)-surveillance, accessed 12 November 2024).

- Efforts are required to ensure optimal **laboratory testing capacity** for confirmation of all suspected cases of YF. Detection of YF viral RNA by real-time or quantitative RT-PCR (RT-qPCR) from tissue and eventually serum specimens and detection of YFV-specific IgM antibodies from serum specimens are standard methods that are used in the diagnosis process of YF. YF laboratory testing algorithms have been developed for outbreak and non-outbreak settings.

Laboratory manual for yellow fever. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/375814, accessed 22 May 2024).

Operational guidance on the use of yellow fever assays in the context of surveillance. Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/375150, accessed 3 June 2024).

- In an urban setting, the **use of RT-qPCR** should be prioritized to diagnose cases early in their clinical course and to make a definite diagnosis, particularly if vaccine history is unknown (because serology does not differentiate between antibodies formed against a natural YFV infection or against vaccination). It also confers the benefit of the implementation of protection measures against mosquito bites during the viraemic phase. However, when a large number of suspected cases and exposed persons must be tested, a huge demand on the existing laboratory capacity is expected (automats, reagents, workforce,…) and this pressure requires anticipation.
- In recent vaccinees, developing classical symptoms of YF infection, targeted sequencing or use of discriminatory RT-qPCR can differentiate between infections with wild-type YF and the vaccine virus strain.
- **Genomic sequencing** of YFV strains can be useful to help trace transmission pathways and origin of outbreaks, understand transmission dynamics, and for monitoring of viral evolution. However, sequencing results do not impact case classification or outbreak identification and response.
- Efficient **sample shipment** from health facility to national lab (and to a regional reference laboratory for confirmatory testing as necessary) is key for early case confirmation. In the WHO region of Africa, WHO has been supporting three regional reference laboratories with confirmatory testing capacity. This includes support for shipment of samples from national to regional referral laboratories (In Africa: Institut Pasteur Dakar, Centre Pasteur du Cameroon, Uganda Virus Research Institute). In the WHO region of the Americas, The Pan American Health Organization (PAHO) has supported the implementation of molecular detection at the National Publich Health laboratories or National Institutes of Health in all countries considered endemic for YF. Additionnally, PAHO has been supporting the National laboratory networks to strengthen transport of samples from remote areas to National reference laboratories. Decentralization of the diagnosis to strategic areas in endemic countries has been also recommended as strategy to facilitate early detection.

Yellow fever outbreak toolbox, updated March 2024. (accessed 3 June 2024).

- A single autochthonous confirmed case of YF in an urban area is indicative of an outbreak. More than one case in an area previously without YF is defined as a large or disruptive outbreak (IA2030).
- **Rapid notification** of a suspect case of YF by the health facility to the health authorities is important as one confirmed case in a population with low level of protection is sufficient to declare an outbreak. Rapid detection and diagnosis of YF is crucial in moderate and potential risk countries not only to prevent further transmission, but also to prevent YFV transmission to a non-immune population. This can be challenging as clinicians may not be familiar with YF diagnosis.The IHR 2005 require that all countries have the ability to detect, assess, report, and respond to public health events. YF is a notifiable disease under the IHR. Countries are required to report confirmed cases to WHO within 24 hours if the event meets at least two of the four criteria outlined in Annex 2 of the IHR(2005). These criteria include: (1) a significant risk of international spread, (2) a serious public health impact, (3) an unusual or unexpected nature of the event, and (4) a risk of international travel or trade restrictions. In the case of urban YF, these criteria are likely to be met, triggering the obligation to notify WHO.

WHO Guidance for the use of Annex 2: Microsoft Word - Revised Annex 2 Guidance_Final.doc (who.int), (accessed 14 May 2024).

- Through **active surveillance**, additional cases can be detected through targeted outreach in a perimeter of 150 to 200 metres around the house of the case and eventually in areas frequented during viraemic phase.

Yellow fever: vaccine preventable diseases surveillance standards. World Health Organization, Regional Office for Africa; 2020 (https://www.afro.who.int/publications/integrated-disease-surveillance-and-response-african-region-guide-establishing-0#, accessed 14 May 2024).

Defining collaborative surveillance: a core concept for strengthening the global architecture for health emergency preparedness, response, and resilience (HEPR). Geneva: World Health Organization, 2023 (https://iris.who.int/handle/10665/367927, accessed 26 July 2024)

- **Community-based surveillance** offers the advantage of improving early detection during the vireamic phase and empowers communities to play an essential role in their own health security.

Integrated disease surveillance and response in the African Region: a guide for establishing community based surveillance. World Health Organization, Regional Office for Africa; 2014 (https://www.afro.who.int/publications/integrated-disease-surveillance-and-response-african-region-guide-establishing-0#, accessed 14 May 2024).

- In urban settings, it is particularly important to be able to distinguish spillover sylvatic infection from local urban transmission. An **urban transmission cycle** would be confirmed if there is a significant association between human cases and the presence of infected mosquitoes in the urban setting. Annex 2 proposes steps to confirm urban transmission of YFV. Epidemiological, spatial and genomic approaches can help characterize YF transmission.

Yellow fever: rapid field entomological assessment during yellow fever outbreaks in Africa: handbook: methodological field approaches for scientists with a basic background in entomology. World Health Organization; 2022 (https://iris.who.int/handle/10665/112785, accessed 7 May 2024).

- **Geographic Information System (GIS) platforms** enchance surveillance in urban areas by mapping human cases and mosquito across time and space. Geolocation of a case's residence and visited places as well as of mosquito presence enables risk mapping and hotspot identification, which are necessary to understand the epidemiology and implement response actions.
- The use of Go.Data or other compatible tools facilitates data collection in the field. Ways to guarantee that the privacy of patients is respected should be included in the preparation phase.
- Preventing or limiting urban transmission of YFV is dependent on the control of mosquito vectors and the reduction of bites. **Entomological surveillance** needs to be implemented in urban areas on a continuous basis to detect the presence of *Ae. aegypti*, evaluate its dispersion, and limit its density to protect the population. This early warning system is key to detect early the virus. Surveillance of *Ae. Aegypti* is based on the following since more than 50 years:
    - Monitoring of adult density.
    - Three larval indices:
        - house index (HI) (percentage of houses infested with larvae and/or pupae),
        - container index (CI) (percentage of water-holding containers infested with larvae or pupae),
        - breteau index (BI) (number of positive containers per 100 houses inspected).

  However, the relationships between these indicators and the disease are not straightforward. The thresholds are varying according to the situations and contexts and none of them is relevant for estimating the force of the disease transmission. Nevertheless, these indicators are still used because no other indicator is available and they can monitor the presence of the vector and the efficiency of the vector control measures.
- Countries are advised to adopt an integrated vector management approach that addresses all vector-borne diseases and focuses on integration of entomological surveillance into human surveillance systems for early detection of arboviral diseases. This approach requires cross sector preparation and coordination. In many African countries, vector control divisions within Ministries of Health (MoHs) are limited to the malaria vector control division, which does not deal with *Aedes* mosquitoes. Entomological surveillance of *Aedes* mosquitoes is used for operational (and research) purposes to determine changes in geographical distribution, for monitoring and evaluating control programmes, for obtaining relative measurements of the vector population over time, and for facilitating appropriate and timely decisions regarding interventions. There are several methods for monitoring vectors (mostly *Ae. aegypti*) of arboviral diseases. However, the selection and use of a method requires a clear understanding of the surveillance objectives, the availability of skills and resources, and in some instances, the threat of transmission.

- **An entomological field investigation** should be conducted around probable and confirmed YF cases to :
    - identify mosquito species (crucial to determine the type of transmission of YFV);
    - collect and calculate larval, pupal and adult indices, (pupal and adult risk indices such as mean number of females per trap/day are better indicators than larval indices);
    - use collected data to facilitate implementation of appropriate vector control measures;

- assess and monitor insecticide susceptibility of the vectors;
- detect YFV in potential vectors (*Ae. aegypti* in urban settings);

- The **entomological investigation** must be performed in collaboration with other disciplines such as virology, epidemiology and/or environmental surveillance, in order to enable flows of information and exchange of material for proper and timely diagnosis.

Yellow fever: rapid field entomological assessment during yellow fever outbreaks in Africa: handbook: methodological field approaches for scientists with a basic background in entomology. World Health Organization; 2022 (https://iris.who.int/handle/10665/112785, accessed 7 May 2024).

World Health Organization & UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. Global vector control response 2017-2030. World Health Organization; 2017 (https://iris.who.int/handle/10665/259205, accessed 3 September 2025).

Multisectoral approach to the prevention and control of vector-borne diseases: a conceptual framework. Geneva: World Health Organization; 2022 (https://iris.who.int/handle/10665/331861, accessed 19 February 2025).

World Health Organization Regional Office for the Eastern Mediterranean. Establishing syndromic surveillance and event-based surveillance systems for zika, dengue and other arboviral diseases. World Health Organization Regional Office for the Eastern Mediterranean; 2020 (https://iris.who.int/handle/10665/334166, accessed 3 September 2025).

Defining collaborative surveillance: a core concept for strengthening the global architecture for health emergency preparedness, response, and resilience (HEPR). Geneva: World Health Organization; 2023 (https://iris.who.int/handle/10665/367927, accessed 3 September 2025).

- In South America, non-human primates **epizootic surveillance** is implemented and critical to alert public health authorities to the possibility of future human infections with YFV, and to provide an indicator of spatiotemporal disease spread. The identification of epizootics provides an early warning of viral circulation that can help prevent YF human cases.
- **Online training on YF surveillance and investigation** of outbreak are available through the OpenWHO platform:

The fundamentals of yellow fever disease, surveillance and laboratory (openwho.org)

Investigation and management of a yellow fever outbreak | OpenWHO

Pillar 3: Community protection and community engagement

- Well managed, timely and proactive risk communication and community engagement contribute to:

a) improving community surveillance of suspected YF cases,

b) increasing uptake of vaccination,

c) improving case management outcome (early self-referral),

d) implementing vector control measures – such as searching for and eliminating mosquito breeding sites) – both routinely and in response to an outbreak, particularly before vaccination is carried out and immunity becomes effective,

e) improving epizootic surveillance.

- All public health challenges, including YF epidemics, have **a behavioural and social components.** Understanding and addressing the social and behavioural aspects of an epidemic can lead to more effective and sustainable community protection efforts. It can help identify and address factors hindering communities from adopting protective behaviours.
- **Community engagement** is essential to strengthen resilience of people, to building trust with affected populations, designing people-centred interventions and ensuring multisectoral understanding of vulnerabilities and underserved populations. Allocation of financial resources to implement their local community engagement plans will reinforce their trust and resilience.
- To effectively mobilize communities in YF, communication must be timely, credible, and community-centered. Empowering communities through active participation and engaging, evidence-based **risk communication** helps reinforce their knowledge and encourages local actions to reduce YF transmission.Communication strategies should be inclusive, gender-sensitive, and culturally appropriate to ensure intervention acceptability. Special attention must be given to vulnerable groups – such as those with occupational exposure, poor living conditions, or limited access to vaccination – whild also addressing misinformation and disinformtion, particularly in urban areas prone to “infodemics”.
- Health care workers play a key role in communicating risk to the population. This applies to both formal and informal health workers including the private sector, community volunteers, professional associations, etc. They are trusted messengers in the community and can help counteract any misinformation during outbreaks.

Risk communication and community engagement readiness and response toolkit: yellow fever. Geneva: World Health Organization, 2024 (https://iris.who.int/handle/10665/376259, accessed 13 May 2024).

Communication and social mobilization in yellow fever mass vaccination campaigns: 10 points from field experience. Geneva: World Health Organization; 2015 (https://iris.who.int/handle/10665/156053, accessed 3 September 2025).

Hive, a digital space for health emergency preparedness and response powered by communities: HIVE (who.int).

Managing yellow fever epidemics. Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/329432 , accessed 29 July, 2024).

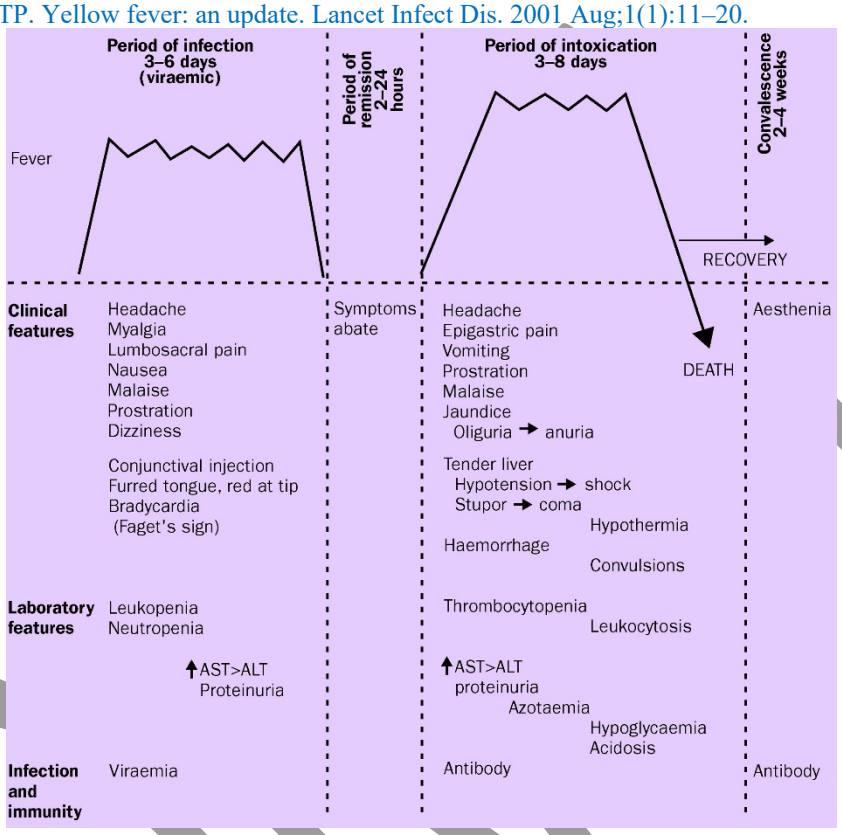
Pillar 4: Clinical care

Effective clinical care for patients with YF involves early detection, timely referral, intensive management of severe cases, and IPC measures. Ensuring equitable access to care and preparing for potential outbreaks are essential components of this strategy.

Many individuals with YF infection are asymptomatic or mildly unwell, usually requiring minimal clinical intervention. However, some develop severe disease characterized by jaundice, bleeding, coagulopathy, multi-organ failure and death *(3)*. The case fatality rate (CFR) for severe YF is high, ranging from 31% to 47% *(4)*. Managing severe YF, particularly cases leading to liver failure, is challenging and necessitates intensive invasive supportive therapies, including access to intensive care units (ICU) and critical care. Fig. 12 shows the clinical and laboraty features of YF disease.

Figure 12: Stages of yellow fever infection, showing the major clinical and laboratory features of the disease.

Source: Monath TP. Yellow fever: an update. Lancet Infect Dis. 2001 Aug;1(1):11–20.



- **Early detection and referral**:
  - Early case detection and high-quality clinical care in both public and private clinics are crucial.
  - Triage and early referral of severe cases to hospitals with ICUs can reduce mortality and morbidity.
  - An efficient referral system requires establishing clear referral criteria and pathways for suspected and confirmed cases.
  - Effective communication channels between different levels of the referal system should be established.
  - Transportation services and adequate, affordable inpatient facilitites should be provided.
  - Social protection approaches should be implemented to support marginalized and poor urban communities.
- **Clinical management:**
  - Health care workers should be trained to identify clinical presentations of YF.
  - Prompt diagnosis is essential, especially in outbreak settings, where patients with fever and jaundice or just fever should be identified in all primary health care (PHC) facilities, including the private sector.

- Blood samples should be taken and quickly shipped to laboratories with YF testing capacity (National YF laboratory), and be tested for other infectious diseases as appropriate.
- While awaiting laboratory results, supportive treatment should commence immediately, as there is no licensed antiviral for YFV. Rapid implementation of supportive care may decrease mortality *(5,6)*.
- Standard Operating Procedures for referral of samples to national and international laboratories for confirmatory testing should be established and disseminated to health and laboratory professionals at all levels.
- Refer to 2025 WHO Clinical management guidelines for arboviral diseases for recommendations on the use of intravenous N-acetylcysteine for liver failure, monoclonal immunoglobulin and sofosbuvir.

World Health Organization. (2025). WHO guidelines for clinical management of arboviral diseases: dengue, chikungunya, Zika and yellow fever. World Health Organization. https://iris.who.int/handle/10665/381804. (accessed 27 August 2025).

Pan American Health Organization. Clinical Management of Yellow Fever in the Region of the Americas. Experiences and Recommendations for Health Services. Washington, D.C.: PAHO; 2023, URI https://iris.paho.org/handle/10665.2/57318 (accessed 10 July 2024).

- **Private sector involvement**:
  - Special initiatives are needed to promote appropriate testing and case management in the private sector.
  - Where available, use laboratories with capacity for YF testing for haematology, liver and renal function tests.
- Health care facilities should implement **infection prevention and control (IPC)** strategies, which for YF include:
  - vector control within and around the health care facility to decrease adult mosquitoes,
  - protecting patients from mosquito bites using bed nets and instructing non-hospitalized patients to use protective clothing, insect repellents and bed nets,
  - YF vaccination of health care workers.
- **Equitable access to health care**:
  - To ensure universal health coverage, special initiatives need to be developed for vulnerable and marginalized populations in urban informal settlements.
  - Social and behaviour change communication materials tailored to these groups to encourage health care-seeking behaviour should be developed.
- **Surge planning**:
  - Countries at risk of major urban YF outbreaks should ensure surge planning to enable rapid scale-up of case management services if needed. During a YF outbreak, it is crucial to closely monitor ICU bed occupancy. In Brazil, the median ICU length of stay for patients was observed to be 6 days, with an ICU admission rate of 46% *(7)*.
  - Safeguarding the delivery of essential non-YF health services is essential during large-scale urban outbreaks.

Pillar 5: Vaccination

- Vaccination is the main method to prevent and control YF epidemics. The vaccine is a live attenuated vaccined termed “17D”. As the protection provided by the YF vaccine is

life-long, vaccination should be seen as a long-term investment in high-risk (endemic) countries.

- Vaccination helps to protect local population and travellers and reduce international spread by minimizing risk of importation of YFV in non-endemic territories.
- The EYE Strategy recommends high-risk countries to conduct **national preventive mass vaccination campaigns** to protect populations and to reduce the risk of outbreaks. **Vaccine coverages** greater than 80%, with a 60-80% security threshold, are necessary to interrupt autochthonous transmission (human-mosquito-human) of YFV within a community and ensure that sporadic unvaccinated cases do not generate secondary cases *(8)*.
- A **reactive vaccination campaign** is a control measure of an outbreak that aims to vaccinate a large number of people within a short timeframe to create a herd immunity. This reduces the possibility of transmission of the virus. During a reactive vaccination campaign, a dose of YF vaccine should be administered to everyone aged 9 months and older; it is not recommended for people aged over 60 years.

Eliminate yellow fever epidemics (EYE) strategy country toolkit. Geneva:World Health Organization; 2024 (https://iris.who.int/handle/10665/379980, accessed 3 September 2025).

- **Determining the scale of a reactive vaccination campaign** :
  The scale of a reactive vaccination campaign should be guided by two key factors:
  1. Population immunity: In a naïve population or with very low vaccination coverage (e.g. 20% or less), a non selective vaccination campaign can be considered targeting all eligible population. In a population with moderate coverage but less than optimum (80%), a selective vaccination campaign can be considered if operationally feasible (ie. Feasibility to identify non vaccinated individuals). This may involved door to door vaccination.
  2. Understanding the behaviours and movement patterns of at-risk groups to effectively target vaccination efforts.
     The risk of YF transmission is determined by the presence of confirmed YF cases and the presence of the vector.
- During a reactive vaccination campaign, a **phased-approach** can be undertaken whereby the family and neighbours are vaccinated during the first phase, followed by the population in the area(s) of residence of the reported case(s) in a second phase.
- **There are unique challenges faced in urban settings** to ensure equitable vaccination coverage and which require careful planning. Challenges include the presence of vulnerable populations such as street children and displaced /migrant populations, mobile workers, gated communities, high-rise buildings, and inflexible employment arrangements limiting access of health services during regular opening hours and unavailability of expanded working hours or days for vaccination services. It is recommended to use the toolkit developed by UNICEF and partners to better locate, identify, characterize and serve the urban disadvantaged in a coordinated fashion.

Urban Immunization Toolkit. New York: United Nations Children's Fund; September 2018. https://clearinghouse.unicef.org/

- From an operational standpoint, an effective and timely reactive vaccination campaign in an urban context depends on:
  - inclusive planning and coordination with city health authorities,

- community and private sector (private health facilities, pharmacies and private companies) engagement to support vaccine uptake and promote vaccine equity,
- microplanning and plan for vaccines to be co-delivered with other health services,
- effective targetting of and access to vulnerable populations (e.g. migrants, mobile workers, and people living in slums) in collaboration with non-state and local actors.

- Administration of **fractional YF vaccine** dose (one-fifth of a full dose) can be used as part of an emergency response to an outbreak if there is a shortage of full-dose YF vaccine that exceeds the capacity of the global stockpile *(9)*.
- A global **stockpile of YF vaccine** is available at all times for outbreak response.The International Coordinating Group (ICG) on Vaccine Provision is a mechanism that manages and coordinates the provision of this emergency vaccine supply to countries during outbreaks. Countries are expected to implement a reactive vaccination campaign within 10 days after receiving the vaccines. In high-risk countries where YF vaccine is part of the child routine immunization schedule, vaccines from the Expanded Programme on Immunization (EPI) stock can be used for the first phase(s) of the reactive vaccination campaign and replenished through the ICG mechanism.

See WHO webpage: International Coordinating Group (ICG) on Vaccine Provision (who.int) (accessed 21 may 2024).

ICG request forms. See WHO webpage: Yellow fever vaccines stockpiles (who.int), (accessed 21 may 2024).

- **Mathematical modelling** can inform outbreak response vaccination in several ways, including informing vaccine response strategy through risk mapping. Key challenges include modelling at the appropriate geographic scale in urban settings, accounting for human mobility patterns that influence exposure, and limitations due to the quality and availability of surveillance data.

Shankar M, Hartner AM, Arnold CRK, Gayawan E, Kang H, Kim JH, et al. How mathematical modelling can inform outbreak response vaccination. BMC Infect Dis. 2024;24(1):1371.

Pillar 6: Vector control & urban environment improvements

- A sustainable, long-term solution to prevent YF transmission in urban areas lies in **modifying the urban environment** to eliminate breeding habitats of the *Aedes aegypti* mosquito, the primary vector of the disease in the urban outbreaks. This approach addresses the root cause of transmission by reducing mosquito populations through environmental management and urban planning. Effective urban modifications include: improved waste management, water storage practice, dranaige system maintenance, and urban design.
- **Entomological surveillance** performed on a routine basis is part of vector control. It helps improve timeliness of vector control decisions and their effectiveness to prevent arboviral disease (see Pillar 2). If longitudinal entomological surveillance is in place, data collected on different stages can help to monitor vector populations and anticipate increase of densities.
- Severe YF cases presenting with fever and jaundice only represent a small proportion of infected and infectious cases. So in urban settings of high-risk countries, the first urban

imported case is likely to be missed unless s/he seeks care. The first case is also likely to be unreported in areas where surveillance system is suboptimal. In these contexts, a **preemptive strategy** approach is best for vector control, particularly in domestic settings (urban and rural) where *Ae. aegypti* is present. Reducing *Ae. aegypti* populations reduces the risk for a YF outbreak should the virus be introduced and it will contribute to the suppression of other *Aedes*-transmitted viruses; e.g., dengue, Zika, and chikungunya.

- When a preemptive approach is not possible, **reactive strategies** will need to be applied. Timely and effective vector control measures in urban areas can help reduce transmission of YFV by killing infected mosquitoes and reducing vector density, although there is no evidence of the efficiency of the reactive vector control measures. The aim is to rapidly interrupt transmission of the virus among the human population until vaccination takes effect. In moderate and potential risk countries (where there is no active YF circulation), vector control measures implemented after the detection of a viraemic imported YF case aims to reduce the risk of autochtonous circulation of YFV.
- Early in the outbreak, vector control should be directed to households in the community where the infected person lives. Other **key settings for vector intervention** are where human-vector contact can occur, such as, transport hubs, schools, or gathering places. With an increasing number of YF cases, the vector control strategy needs to account for the likelihood of infection of the mosquito population on a larger scale beyond the neighourhoods of confirmed YF cases.
- Targeting *Ae. aegypti*, which is also the principal vector of dengue, Zika, and chikungunya viruses, requires an **integrated and intersectoral approach** that involves multiple partners within and outside the health sector, and particularly strong involvement of the community for all aspects of management. Vector control can be enhanced by educating and empowering communities to identify, empty, remove or treat mosquito aquatic habitats in and around their homes (see Pillar 3).
- The **selection of combined vector control methods** needs to be appropriate to the local setting and include innovative techniques as recommended by WHO. Findings from the field entomological investigation and from routine entomological surveillance guide the choice of vector control measures (see Pillar 2). Ritchie et al. (2021) provide a detailed guide for the development of an effective insecticide-based *Ae. aegypti* control program, which addresses immature and adult mosquitoes. Reference to WHO guidance documents will provide information on best practice for application of novel interventions as they become available.
- Vector control efforts need to target both adult and immature (larvae and pupae) mosquitoes. The main approach relies on source reduction by eliminating container habitats where aquatic stages of mosquitoes develop, and reducing human-mosquito contact: i.e., screening windows and doors, repellents, etc.

Ritchie SA, Devine GJ, Vazquez-Prokopec G, Lenhart AE, Manrique-Saide P, Scott TW. Insecticide-based approaches for dengue vector control. In: *Innovative Strategies for Vector Control*. eds: Koenraadt CMJ and Takken W. Wageningen, the Netherlands: Wageningen Academic Publishers; 2021: 59-89.

Global vector control response: progress in planning and implementation. Geneva: World Health Organization; 2020 (https://iris.who.int/handle/10665/336658. accessed 21 January 2025).

WHO (2014). Yellow fever: rapid field entomological assessment during yellow fever outbreaks in Africa: handbook: methodological field approaches for scientists with a basic background in entomology. World Health Organization; 2022 (https://iris.who.int/handle/10665/112785, accessed 7 May 2024).

Manual para aplicar rociado residual intradomiciliario en zonas urbanas para el control de Ae. aegypti. Washington, D.C.: Organización Panamericana de la Salud; 2019 (https://iris.paho.org/handle/10665.2/51638, accessed 20 September 2024)

World Health Organization & UNICEF/UNDP/World Bank/WHO Special Programme for Research and Training in Tropical Diseases. Global vector control response 2017-2030. Geneva: World Health Organization; 2017 (https://iris.who.int/handle/10665/259205. accessed 14 May 2024).

Global Vector Hub, a directory on courses of medical entomology: Global Vector Hub - Menu (accessed 2 October 2025)

Massive Open Online Course on multisectoral approaches for prevention and control of vector-borne diseases: https://vbd-environment-mooc.org/ (accessed 2 October 2025)

Pillar 7: Points of entry, international travel and transport, population movement

- Cities and urban settings often serve as subnational, national, and international transport hubs, with major points of entry and exit (e.g., airports, seaports, ground crossings), increasing risk of importation and exportation of disease in case of an urban YF outbreak. Understanding mobility dynamics is important in urban YF preparedness both to prevent introduction of YFV at entry and its spread abroad at point of exit.
- To prevent international spread, it is essential that the **International Health Regulations (2005) (IHR)** are applied. IHR provide a framework for countries in handling public health events and emergencies that have the potential to cross borders. Comprehensive implementation of the IHR aims at preventing international spread of YF. Cities and urban settings are increasingly at the forefront of effectively operationalizing many of these requirements and are important elements of national plans and efforts towards IHR implementation. Therefore, strengthening health emergency preparedness in cities and urban settings is an important prerequisite for all countries to effectively strengthen capacities under their commitments to the IHR (2005).
- YF is specifically designated under IHR as **proof of vaccination** may be required by national authorities for travellers as a condition of entry into an area.
    - *Vaccination against YF may be required of any traveller leaving an area (point of exit) where the Organization has determined that a risk of YF transmission is present.*
    - *A State Party, in whose territory vectors of YF are present, may require a traveller from an area (point of entry) where the Organization has determined that a risk of YF transmission is present, who is unable to produce a valid certificate of vaccination against YF to be quarantined until the certificate becomes valid, or until a period of not more than 6 days, from the date of last possible exposure to infection, has elapsed, whichever occurs first.*
- In 2014, an amendment to the IHR (2005) stipulates that the period of protection from an approved vaccine against infection with YF is life-long.

World Health Organization. (2016). International Health Regulations (2005), 3rd ed. World Health Organization. (https://iris.who.int/handle/10665/246107 accessed 21 May 2024).

- The IHR States Parties self-assessment annual reporting tool (SPAR) is intended to support States Parties to fulfil their obligations to report to the World Health Assembly on the implementation of the Regulations. The tool provides a roadmap for assessing the capacity of a country to respond to health threats, based on the IHR core capacity requirements. It also facilitates the identification of gaps including those of YF vaccination at points of entry.

World Health Organization. (2021). International Health Regulations (2005): state party self-assessment annual reporting tool, 2nd ed. World Health Organization. https://iris.who.int/handle/10665/350218 accessed 30 May 2024).

- Specific strategies are required for **informal border crossing** with the aim to protect migrant and seasonal workers and prevent international spread of YF. However, there is presently insufficient evidence for or against syndromic entry and exit screening of travellers at ground crossings *(10).*

International Health Regulations (2005), 3rd ed. Geneva: World Health Organization; 2016 (https://iris.who.int/handle/10665/246107 accessed 21 May 2024).

National IHR focal points [website]. Geneva: World Health Organization; 2023 (https://www.who.int/teams/ihr/national-focal-points, accessed 5 June 2024)

- Specific guidance on vector surveillance and control at points of entry and onboard conveyances developed for dengue is useful for YF.

Vector surveillance and control at points of entry and onboard conveyances: meeting report, 19 and 21 November and 10-11 December 2024. Geneva: World Health Organization; 2025. https://iris.who.int/server/api/core/bitstreams/800f2c27-f839-48f1-938b-5d93d72c6158/content. Licence: CC BY-NC-SA 3.0 IGO; (accessed 7 October 2025)

Effectiveness of disinsection of conveyances to prevent or reduce the spread of mosquito vectors via international travel: evidence reviews. Geneva: World Health Organization; 2024. https://doi. org/10.2471/ B09173. Licence: CC BY-NC-SA 3.0 IGO. (accessed 7 October 2025)

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10. Syndromic entry and exit screening for epidemic-prone diseases of travellers at ground crossings: evidence review and a call for research. Geneva: World Health Organization; 2024 (https://iris.who.int/handle/10665/376764 accessed 6 June 2024).

5 High-risk countries: preparedness and response action lists

Pillar 1 Preparedness list: Coordination and planning

Pillar 1 Preparedness list for high-risk countries

STEP 1 : Situation analysis

- ☐ Review history of urban outbreaks of other *Aedes*-borne diseases (dengue, chikungunya, Zika) in the country.
- ☐ List/map *Ae. aegypti*-endemic urban areas and neighbouring forest areas; analyse data on local *Ae. aegypti* resistance to insecticide and indices.
- ☐ Review EPI data on YF vaccination coverage in children in mosquito-endemic major urban centres.
- ☐ Coordinate sharing of diverse datasets to establish which areas are at the greatest risk of infection. Datasets include findings from the most recent YF immunity gap analysis, detailed maps of vector suitability, and information on size and mobility of human populations.
- ☐ Map/estimate vulnerable and hard to reach populations (under-served populations, zero-dose communities, etc.) in major urban centres with presence of *Ae. aegypti*.
- ☐ Review existing national technical guidance on YF (EYE strategy implementation plan, YF surveillance, national YF response plan, etc.).
- ☐ Review existing national/subnational health emergency plans (urban preparedness, viral haemorragic fever (VHF) plan, integrated vector management plan, etc.) and agree on how to integrate the urban YF national operational guidance.
  Various types of plans exist: (i) National Action Plan for Health Security (NAPHS), (ii) Hazard Preparedness Plans, and if countries have a specific hazard that they have interest in, they develop a (iii) Hazard Specific Contingency Plan (HSCP), which can be annexed to the main hazard preparedness plan.
  Several options exist such as (non-exhaustive): a stand-alone contingency plan for urban YF, a YF-specific annex to a multi-hazard plan, a chapter/section in an existing national plan for YF outbreak detection and response or in a national preparedness plan to respond to VHF. Additionally, national instructions for YF risk management can be integrated into the national climate resiliency plan, recognizing YF as a climate-sensitive disease.

- ☐ If YF surveillance and outbreak response falls under EPI prerogatives, establish links with emergency response division of MoH to clarify roles in outbreak detection and response.
- ☐ Identify state and non-state actors from all relevant fields (e.g. public health, laboratory, clinical care, communication, vector control) that could be involved in preparedness and outbreak response. List their contacts (telephone number and e-mail addresss; data should be institutional given the possible turnover of the professionals involved).
  Examples include:

- *Departments of MoH leading emergency preparedness & response, surveillance, vector control division,*
- *vaccination programme,*
- *emergency operation centre,*
- *national laboratory,*
- *national public health institute,*
- *IHR focal point,*
- *One Health focal point,*
- *and local health authorities involved in urban planning and environment;*
- *UN Agencies including WHO, United Nations Development Programme (UNDP), Office of the United Nations High Commissioner for Refugees (UNHCR), United Nations Office for the Coordination of Humanitarian Affairs (OCHA), United Nations Children's Fund (UNICEF), United Nations Population Fund (UNFPA), World Food Programme (WFP) and UNHabitat*
- *International non-Governmental Organizations (NGOs) such as Doctors without borders (MSF), Red cross, major bilateral or multilateral partners, Regional Organisations: West African Health Organisation, ECOWAS Regional Center for Surveillance*
- *Academics and research institutions*
- *Civil society: professional corps (Physician, nurses, pharmacists, etc.), community representatives, civil society organizations (CSO)*

☐ Leverage the competencies of the National Steering Committee for Integrated Vector Management or the Vector Control Working Group to coordinate vector control activities. Liaise with vector control division of MoH and perform a vector control needs assessment.

☐ Ensure intercluster/intersectoral communication channels between actors involved in YF response are defined in the preparedness and response plan (e.g. communication between surveillance epidemiologists and entomologists in charge of activating vector control measures).

☐ Assess actions required for preparedness under each of the seven pillars.

☐ Take steps to mitigate and prevent a disproportionate impact in future urban YF outbreaks based on inequality dimensions, including gender, age, migration status, vulnerable populations, among others.

Addressing sex and gender in epidemic-prone infectious diseases. Geneva: World Health Organization; 2007 (https://iris.who.int/handle/10665/43644, accessed 7 May 2024).

☐ Adapt the proposed general decision algorithms (scenarios 2,3, and 4 in Annex 3)

STEP 2: Prioritize (identify & cost priority actions & gaps)

☐ Prioritize cities and urban areas for preparedness/operational readiness based on size and population vaccine coverage, and closeness /access to high risk areas; priority should be given to major urban centres with low population protection and presence of *Aedes*-species mosquitoes.

☐ Based on the list of identified preparedness actions, select priority ones under each of the seven pillars against existing plan and available funds.

☐ Identify critical gaps and resource requirements.

STEP 3: Mobilize (mobilize resources & assign responsibilities)

☐ Identify sources of funding, domestic and international, and inform them of funding gaps.

- ☐ Develop funding proposals.
- ☐ Identify and assign responsibilities for implementing entities and delivery partners.
- ☐ Inform relevant actors of preparedness plan through recurrent meeting platform and existing networks.

Pillar 2 Preparedness list: Collaborative surveillance, testing, epidemiological and entomological investigations, active case search, data management and analysis

Pillar 2 Preparedness in high-risk countries

- ☐ Develop national and local response plan for several scenarios: a) likely imported case, b) single or multiple cases of YF without exposure to endemic area, c) evidence of YF viral circulation in a peri-urban are or an urban area endemic for *Ae. aegypti* with forest patches (Latin America) (see examples of decision algorithms in annex 3).

Surveillance of human cases

- ☐ Ensure effective communication between entities in charge of surveillance (national immunization programme or nation public health institute) and emergency response lead to facilitate exchange of information on epidemiological situation and vaccination coverage.
- ☐ Ensure WHO surveillance-related capacity indicator C5 is at level ≥3 (SPAR tool).
- ☐ Ensure that a YF case classification committee is set up for serological confirmation of YF cases.
- ☐ Use national YF case definition and YF standardized case notification form based on WHO recommendations.
    - Travel history data are important in distinguishing imported vs locally transmitted infections.
    - Vaccination history is crucial to interpret serological results.
- ☐ Assess if case-based surveillance of YF disease with associated tools is implemented in a standardized manner in priority cities and urban centres from all points of data collection of the public and private sectors at the levels of:
    - secondary and tertiary care hospitals,
    - first level health services.
- ☐ Assess reporting network (data collection method and forms, data flow, reporting procedures) and timeliness of notification (time from case detection to notification form reaching decision-maker).
- ☐ Map underserved vulnerable and high risk groups and their access to health services including inpatient services.
- ☐ Assess level of involvement of community in surveillance of YF especially in underserved urban communities (in link with pillar 3).
- ☐ Develop an action plan to strengthen epidemiological surveillance by filling identified gaps to:

- strengthen capacity at level of PHC and at hospital level to detect YF and notify to health authorities within 24 hours,
- strengthen capacity at community level to self-report febrile jaundice and active case search,
- strengthen YF case notification by all health facilities, public and private.

☐ Disseminate the surveillance protocols to the municipal health services network.

Testing

☐ Ensure capacity for blood sampling at point of care: equipment and standard operating procedures (SoPs).
☐ Ensure capacity for sample shipment from health facility to laboratory with capacity to conduct YF testing (at least serology): equipment and SoPs.
☐ Develop national testing algorithms for YF based on WHO recommendations.
☐ Map laboratories with testing capacity for YF and other arboviruses (serological and PCR testing).
☐ Identify which laboratory is the nominated National YF testing laboratory and assess type of detection assay they can provide (e.g. PCR, IgM, other, etc.).
☐ Identify, if relevant, the Regional Reference Laboratory to enable serology confirmatory testing.
☐ Assess availability and procure reagents and consumables including triple-packaging.
☐ Assess laboratory capacity to absorb high demand for testing (surge plan?)
☐ Prepare SoPs for sample management and for sample shipment from health facility to national laboratory and, if relevant, to international laboratory through EYE.ops (Africa).
☐ Train lab personnel in YF diagnostics in all YF testing laboratories.

Investigation

☐ Define composition of investigation team and their terms of reference.
☐ Check existence of/update SoPs (content, process, roles) for field investigation, both epidemiological and entomological.
☐ Check existence of template for conducting the field investigation and for reporting findings.
☐ Check if following key items are part of the investigation protocol: household visit, active case search, household survey on vaccination coverage, entomological assessment.

Active case search

☐ Review/develop instructions/tool for active search in health facilities in area/district of each confirmed case and in neighbouring households 1) to identify clinically suspect cases to be referred for testing and 2) to identify non-vaccinated individuals to be vaccinated or referred for vaccination in nearest health facility.
☐ Prepare list of contact phone numbers of hospitals in urban areas that will be reached to obtain further information on YF suspect cases.

Entomological surveillance and investigation

☐ Assess functional status of routine entomological surveillance programme in cities.
☐ Review available routine entomological surveillance data, studies, and mapping of *Ae. aegypti* distribution in urban areas.
☐ Check capacity for conducting field entomological assessment in priority cities/urban areas and link up with vector control division of MoH or equivalent or

national malaria programme. Experts working on arboviral diseases and their vectors can also be found in local universities and research institutes.

- ☐ Adapt national instructions for field entomological investigation for urban setting and outbreak context (e.g. during an outbreak, field entomological investigations may not be needed for each new YF case in neighbourhoods/districts with recent entomological data).
- ☐ Develop a template investigation protocol.
- ☐ Establish framework of agreement with MoH designated entomologist focal point (entomology department, malaria national programme, etc.) for information sharing and joint assessments.

Non-human primate epizootics surveillance (Americas)

- ☐ Assess functional status of epizootics surveillance in forest areas close to urban centres.
- ☐ Assess capacity of epizootics surveillance system to report data in timely manner and disseminate data to local health authorities.
- ☐ Develop an action plan to strengthen existing NHP epizootics surveillance by filling identified gaps (Latin America).

Data management & analysis

- ☐ Check existence of SoPs describing process, roles and responsibilities at each level on the following: case notification form for YF and information flow from health facility to admin 1 to admin 2 to national level & data management.
- ☐ Check that case investigation form is in place at facility-level with staff trained on how to complete it thoroughly and where to refer the specimen to and how in a timely manner.
- ☐ Check if data generated from notification and investigation is used for decision-making.
- ☐ Assess level of digitization of surveillance data and processes.
- ☐ Assess capacity for data visualization including map production.

Pillar 3 Preparedness list: Community protection

Pillar 3 Preparedness in high-risk countries

Communication and coordination:

- ☐ Identify key actors:
  - Spokesperson with primary responsibility and authority for public communication about an outbreak.
  - Experts to support communication efforts during outbreak response (e.g. public affairs specialists, risk communication experts, digital/social media experts, social scientists).
- ☐ Engage community leaders and groups to ensure both community inclusion and consistency of communication approaches:

- trusted community groups and influencers (e.g. doctors, community leaders, religious leaders, health workers, community volunteers, unions),
- local groups (e.g. women's and youth groups, business groups, traditional healers).

☐ Map risk communication and community engagement (RCCE) capacities in priority urban settings.

☐ Ensure co-creation of interventions namely in development and implementation of contextualized plans in a coordinated manner that specifically targets key stakeholders and partners such as the International Federation of Red Cross and Red Crescent Societies (IFRC), UNICEF and WHO.

Develop communication materials:

☐ Data collection and analysis:
- Review studies/reports to understand behaviours related to vaccination and vector control, considering psychological, social, gender, cultural and environmental drivers. These will inform development/review of inclusive and community-centred YF strategies in urban centres.
- Utilize mapping and study findings to identify marginalized and at-risk populations.
- If feasible and needed, conduct studies to identify gaps in knowledge, attitudes and practices as regards YF through multi-source approaches before developing communication plan (surveys, analysis of existing YF investigation reports, qualitative or quantitative behavioural studies, etc.). Priority topics include knowledge on when to seek health care, knowledge on personal protection measures, perception and acceptability of YF vaccination by health workers and the general population, and knowledge and acceptability of vector control measures (e.g. destruction of breeding sites and insecticide spraying).

☐ Develop key RCCE products (procedures, plans, guidance, training materials, etc) including evidence-based messages tailored for all sub-population groups (e.g. groups most exposed to mosquito bites, underserved populations, individuals working in or close to forests). Messaging should be culturally appropriate and should address key community concerns such as:
- information on YF and protection,
- alert messages,
- messages for empowerment: messages on the do(s) and don't(s) in case of fever and jaundice,
- message on why, where, when and how to get vaccinated,
- develop Q&A, including on the adverse events following vaccination, and frequently update it and share it with communities.

Community mapping and engagement:

☐ Conduct mapping of communities such as marginalized and high-risk urban populations.

☐ Engage with community leaders from the identified population groups.

☐ Develop a monitoring and evaluation monitoring and evaluation framework with smart key performance indicators and document lessons learned and best practices.

Engaging the community for the reactive vaccination campaign:

☐ Conduct a survey on vaccination perception and acceptability

☐ Design and distribute a social mobilization and engagement strategy plan and information awareness programme (including advocacy, communications, social

mobilization, risk and safety communications, community engagement, and training) to support acceptance for YF vaccines, taking into account cultural and historic issues that may influence vaccine hesitancy.
- ☐ Develop key messages and materials for public communications and advocacy.

Pillar 4 Preparedness list: Clinical care

Pillar 4 Preparedness in high-risk countries

- ☐ Map secondary-level care facilitites and health facilities with ICU. YF case management could be optimized by designating one YF specialized unit.
- ☐ Put in place procedures and criteria for screening, admission, and referral of severe cases to specialist units from first level facilities (public and private). This will enable provision of centralized critical care and YF management services. Disseminate this referral pathway, including testing procedures, to all PHC facilities.
    - Check availability of ambulance for referral of severe cases.
    - Check capacity of first level facilitities to provide basic emergency care for severe cases before referral.
    - Check capacity for critical care units to manage severe cases of YF.
    - Ensure that the cost of diagnosis and treatment for patients with suspected and confirmed YF is free of charge.
    - Display pictorial charts (job-aids) of symptoms of YF in all PHC facilities for easy recognition of symptoms.

- ☐ Develop or update and adapt national clinical protocol for YF case management with package of care specific for each level of care, based on most recent WHO guidelines on clinical management of arboviral diseases.
- ☐ Consider engaging in research for the use of monoclonal antibodies or sofosbuvir (Use under the Monitored Emergency Use of Unregistered and Investigational Interventions [MEURI]).
- ☐ Prepare support material for clinicians on YF case management:
    - Prepare information and training plan for hospital health workers of services likely to encounter patients with YF (emergency room, critical care, paediatrics); training should include recognition of clinical features of YF, including taking in-depth history to understand possible transmission of the infection.
    - Disseminate job aids and standardized patient care form for patients with YF to facilitate retrospective cohort study on clinical and biological evolution.
    - Disseminate national clinical protocol to medical schools, health professional health networks, and all health facilities.
- ☐ Refer to WHO's standardized list of essential drugs, equipment and supplies needed for YF case management
    - Ensure availability of Rapid Diagnostic Test for malaria (where relevant) and other arboviruses to consider in the differential diagnosis.
    - Ensure availability of bednets in hospitals.
    - Establish a supply chain management system.

- Estimate quantities of supplies needed from forecasting/projection based on spectrum of disease severity (mild-severe).
- Engage blood bank(s) on making available blood products for patients.
- Stock intravenous fluids, drugs and consumables.
- Standardise critical care capacities (ICU) to include dialysis services, blood transfusion services and effective monitoring of patients.

☐ Ensure YF vaccination status is checked for all out and in patients of hospitals as well as for health workers.
☐ Plan for re organization of health services and surge scenarios by defining strategies to rapidly increase bed capacity (e.g. re-purposing wards) and increasing health worker staffing levels (link with urban health emergency planning).
☐ Consider participating in the WHO global clinical network knowledge exchange platform to aid in the clinical characterization of YF, address challenges and share best practices in clinical care, and foster global collaboration (*optional based on country capacity*).
☐ Engage with communities, ensure the provision of key messages on YF and promote early self-referral to health facilities (see Pillar 2).
☐ Develop monitoring tools for core indicators (CFR, number of in-patients with minimal set of characteristics).

Pillar 5 Preparedness list: Vaccination

Pillar 5 Preparedness in high-risk countries

Prevention:
☐ Strengthening efforts to achieve routine childhood immunization coverage >95% should also target underserved communities in cities and urban areas.
☐ Conduct immunity gap analysis/assess vaccination coverage in priority cities and urban areas at least every 5 years and implement catch-up and targeted interventions as needed.
☐ Conduct a rootcause analysis of YF vaccination gaps in districts with high immunity gaps to inform EPI strengthening plans. Measuring the gap between the first dose of measles-mumps-rubella vaccine (MMR1) and YF vaccine coverage can help identify barriers to accessing YF vaccination in childhood programme. A low coverage for YF vaccine without a gap with MMR1 could reflect broad deficiencies in the EPI programme rather than a specific issues with YF vaccination.
☐ Maintain a high vaccination coverage in urban areas, especially in areas most infested by *Ae. aegypti* and close to forest patches or forests following country risk prioritization.

Reactive vaccination campaign:
☐ Learn about the process to request access to ICG yellow fever vaccine global stockpile (if relevant for the country). Information can be obtained from the WHO regional office:

- download and read the ICG guidelines to understand the application procedure,
- download ICG request form and associated annexes.

☐ Identify/set up the committee at MoH that will decide on the need to implement a reactive vaccination campaign, fill and submit the ICG request (*request should be submitted within 7 days after confirmation of the outbreak*):

☐ Ensure regulatory preparedness (*the reactive vaccination campaign should be implemented within 10 days after receiving the vaccines*).

- Ensure an expedited import approval from appropriate authorities.
- Identify the requirements and documents needed to release YF vaccines at airport customs.
- Set up expedited funds release from WHO country office to national health and city health authorities.

☐ Review and address specific training requirements of the involved staff for vaccination and reporting adverse events.

☐ Ensure vaccination of workers with occupational exposure to YF, all health personnel, and laboratory workers through policy and access to free vaccine (occupational health service).

☐ Review cold chain equipment, logistics and infrastructure in urban areas and in major entry points.

☐ The approach to vaccinate the population should be adapted to the local context to meet the needs of the urban communities. The optimal vaccination approach (selective versus non-selective) depends on various factors such as the estimated current population's coverage rate and availability of vaccination records. As each context is unique, the most effective strategy needs to be determined through an evaluation of these factors rather than by cost considerations or vaccines supplies.

☐ Selective vaccination (i.e. checking vaccination status and vaccinating only unvaccinated individuals) could be conducted in individuals aged <15 years as the card retention is higher in this age group; a non-selective approach (i.e. all individuals offered vaccination) could be adopted in areas with low vaccination coverage).

☐ Agree on urban-specific vaccination strategy to target specific groups (underserved populations as well as mobile workers);

- plan on how to identify populations who may be excluded or not covered by the public health system (e.g. migrants and refugees, stigmatized populations).
- Identify existing health services in the private sector that could be leveraged for vaccine delivery.

Engage community (see Pillar 3)

Pillar 6 Preparedness list: Vector control

Pillar 6 Preparedness checklist for high-risk countries
Key actors and coordination:

- ☐ Identify entomological experts either at MoH (e.g. vector control division, national malaria programme, arboviral diseases division, neglected tropical diseases division) or in research and academic institutes.
- ☐ Leverage the competencies of the National Steering Committee for integrated vector management (IVM) or the Vector Control Working Group to coordinate vector control activities.
- ☐ Map partners in major urban areas who could be involved in implementing *Aedes* vector control measures and testing new techniques.
- ☐ List and describe role of local actors in charge of their implementation, city/local authorities in charge of their supervision.

- ☐ Check availability of mapping of *Ae. aegypti* in urban areas and their main breeding sites (see Pillar 2).
- ☐ Develop a plan for an IVM and related standard operating procedures for the level of urban municipalities.
- ☐ Update or develop national policy, guidelines and SoPs on vector surveillance and control strategy and measures (including type of insecticide products for control of *Aedes* mosquitoes and how to use them) for *Aedes*-transmitted arboviral diseases (e.g. dengue):
    - Develop a decision algorithm for an imported suspect case of YF and for YF case resulting from local (urban) transmission (examples in Annex 3) that define when to implement vector control measures.
    - Airports and sea ports should be kept free from the breeding of insect vectors over an area extending at least 400 m around their perimeters *(1)*.
- ☐ Develop a plan to protect users and health care personnel of hospitals against mosquito bites.

- ☐ Check in-country availability and supply of adulticides and larvicides for vector control that are pre-qualified by the Prequalification Team/Vector Control Product Assessment of WHO. Check availability of equipment and vehicles.
- ☐ Analyze existing data on resistance to insecticides used in public health in *Aedes* populations in risk areas. If updated data is not available, conduct insecticide susceptibility studies. As part of routine vector control activities, the effectiveness of insecticide treatments should be monitored at a few sentinel sites to assess the density of *Ae. aegypti* before and after spraying. Mosquito resistance to the molecules used should also be monitored.
- ☐ Vector control measures targeting *Ae. aegypti* in urban areas should be implemented on routine basis to keep infestation rate low. Infestation rate should be kept very low in urban neighbourhoods, especially close to forest patches. Insecticide resistance, vector behaviour (indoor and outdoor biting) and biting time should be monitored.

Training:

- ☐ Train health workers and community health workers for identification and destruction of *Aedes* larval habitats (see Pillar 3).
- ☐ Train community leaders as future trainers in each district on larval source reduction methods. (see Pillar 3).

1 Present status of yellow fever: memorandum from a PAHO meeting. Bull World Health Organ. 1986;64(4):511-24.

Pillar 7 Preparedness list: Points of entry, international travel and transport, population movement

Pillar 7 Preparedness list for high-risk countries

IHR compliance States Parties self-assessment annual reporting tool

- ☐ The national IHR focal point should assess the requirements for compliance to IHR, especially the verification of YF vaccination at exit and entry. Identify and address the gaps:
    - All designated Points of Entry should be implementing routine core capacities with an all-hazard and multisectoral approach integrated into the national surveillance system: C11.1 indicator should be at Level 4.
- ☐ Include YF whenever a simulation exercise to test the point of entry contingency plan is conducted.
- ☐ MoH entity in charge of YF surveillance and outbreak response to establish links with national IHR focal point and WHO IHR contact point.
- ☐ Map/update points of entry in or close to cities and priority urban areas.
- ☐ Communicate to travellers information about YF-related entry and exit requirements.
- ☐ Set up YF vaccination centres or referral pathway to vaccination centres from points of entry. Availability of YF vaccination at the point of entry helps with compliance by travellers.
- ☐ Train entry post workers on the protective immunity (e.g. need for individuals who are vaccinated to continue to avoid mosquito bites until the vaccine is likely able to provide protection around 10 days post vaccination) and potential side-effects of YF vaccine.
- ☐ Plan for permanent building/strengthening capacities of health staff at/in charge of-points of entry.
- ☐ As part of regular cross-border collaboration, which could be facilitated by IHR national focal points or any relevant authority, build international partnerships and collaboration and harmonize surveillance procedures at points of entry with neighbouring countries.
- ☐ Identify/map mobile populations such as migrant and seasonal workers from neighbouring countries (points of entry and informal border crossing).
- ☐ Develop strategy and plan to check vaccination status/vaccinate incoming and outgoing mobile population groups in cities and urban areas.
- ☐ Map transport hubs in cities and urban areas.
- ☐ Establish programmes to eliminate *Ae. aegypti* a minimum distance of 400 metres from those areas of point of entry facilities that are used for operations involving travellers, conveyances, containers, cargo and postal parcels.

Response action lists for high-risk countries

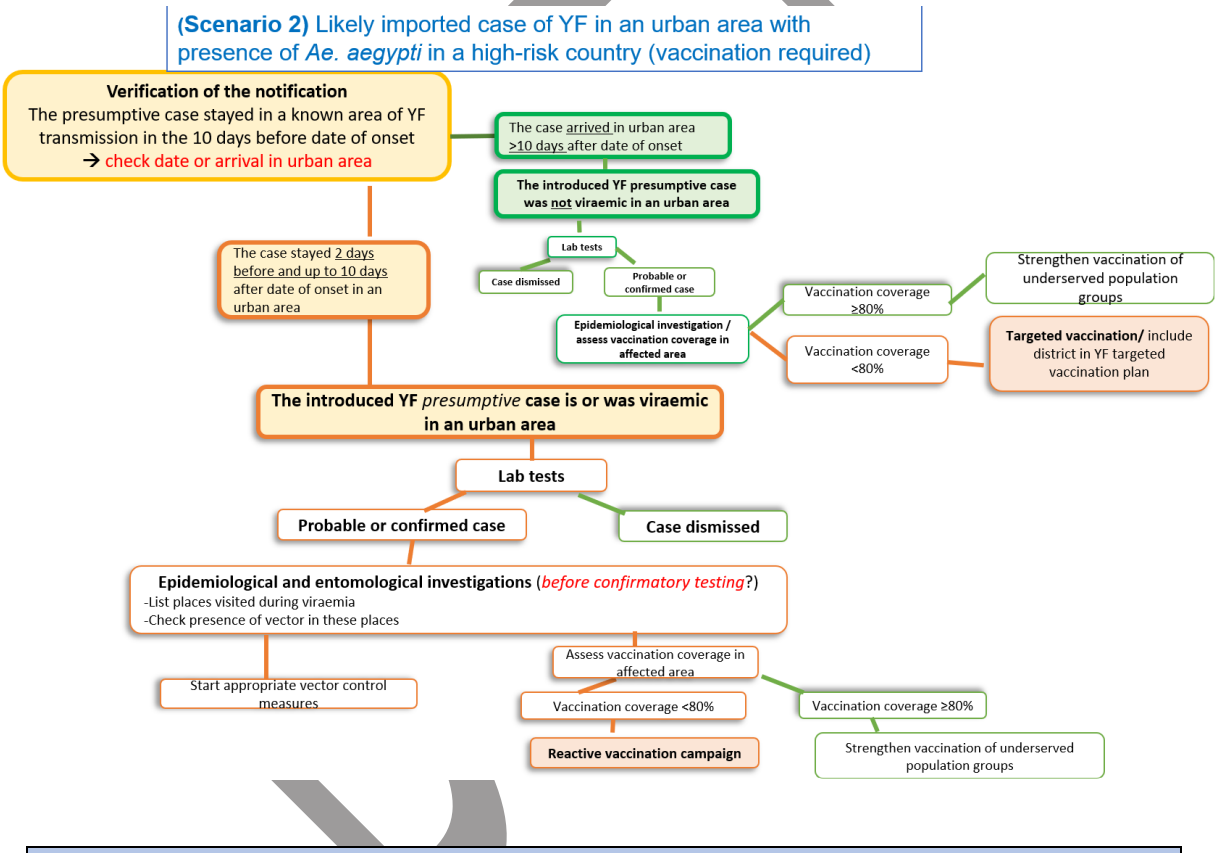
Decisional flowcharts are proposed for three scenarios (numbers 2–4) in high-risk countries; these should be adapted to local context.

Response actions listed below are grouped by thematic area (pillar).

Scenario 2: Response

Scenario 2: *likely* imported case of YF in an urban area with presence of *Ae. aegypti* in a high-risk country (EYE Strategy classification) (i.e. general population vaccinated)

➔ Detection of one confirmed case of YF with travel history to sylvatic environment (rural or peri-urban) within 2–10 days before the onset of symptoms in an urban area with presence of *Ae. aegypti* in a high-risk country.



Pillar 1 Response actions: Coordination and planning
Scenarios 2, 3 and 4

- ☐ Assess the need to activate emergency operation centre or equivalent based on criteria defined in urban YF preparedness plan.
- ☐ Contact WHO and ICG for information and support if needed.
- ☐ Activate rapid response team (multidisciplinary team) with expertise in surveillance, laboratory, case management, RCCE, vaccination, vector control specifialists, local/city health department among the core team, IHR focal point, partners for outbreak response, with defined roles and responsibilities.
- ☐ Establish links between the national and local urban government levels.
- ☐ Local urban government/urban health department should include and engage with the local community to ensure their support and involvement in communication and vector control.

- ☐ Define place where responders can meet and frequency of touch points. Suggested frequencies of meetings to decide on response measures, follow, and assess effective implementation of control measures for each of the pillars:
    - daily meetings for the response/coordination team during the acute phase,
    - weekly meetings when the outbreak is being controlled or reduced,
    - biweekly meetings with technical and financial partners,
    - regular meetings with civil society, laboratories, private sector, community-based organizations and associations, etc.
- ☐ Decide on how to share information between responders (Microsoft SharePoint, telephone numbers, generic email).
- ☐ Share with all responders actions points from meetings and epidemiological situation updates.
- ☐ WHO recommends that within 3 months after the official declaration of the end of the outbreak, an after-action review is conducted with the stakeholders who were involved in the response. Key objectives include the analysis of gaps and/or contributing factors noted during the implementation of the response as well as lessons learned.

Guidance for after action review (AAR). Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/311537, accessed 22 May 2024).

Pillar 2 Response actions: Collaborative surveillance

Scenario 2

- ☐ Notify cases to WHO under the IHR(2005), if situation fulfils criteria (use Annex 2 of IHR(2005)).
- ☐ Carry out a field epidemiological investigation at the home of the patient following WHO or national instructions; this should include an active search for cases and a household survey of vaccination coverage.
- ☐ Map the case (GIS), including places where case statyed during viraemia (usually occurs during the initial febrile phase and lasts for up to five days).
- ☐ Inform all stakeholders (e.g. health facilities, laboratories, local health authorities) on case definition, testing procedure and information flow.
- ☐ Strengthen human case surveillance in the affected and expanded areas by sharing surveillance protocol, data forms, and operating procedures to the network of health facilities, laboratories, and local health authorities. Inform them of the YF case(s) detected.
- ☐ Consider conducting a retrospective analysis of surveillance data from relevant urban area for indications of YF outbreak.
- ☐ From community health records, check for other suspect cases of YF.
- ☐ Inform clinicians on laboratory involved in the testing of cases and provide clear instructions about sampling.
- ☐ Perform viral genomic analysis in humans and in mosquitoes to help identify the origin of the outbreak, determine the type of transmission and reconstruct the history of viral diffusion (can be done at reference regional laboratory).
- ☐ Carry out an entomological investigation around house of index case AND at the location of probable infection of human cases based on the epidemiological investigation, the history of travel (exposure to risk situations) and the clinical and epidemiological history of the patient.

Pillar 3 Response actions: Community protection

Scenarios 2, 3, and 4

Early, transparent and understandable communication on the event establishes lines of dialogue with affected populations and stakeholders. It builds trust in the response. This communication must have facts and information and also include messages that acknowledges and responds to people's concerns and fears.

- ☐ Authorities, experts and response teams must quickly relay information on the nature of the event and the protective measures that people can take :
    - Use social and behavioural insights and data collected during the preparedness phase to inform communications and behavioural interventions that target specific prevention and protection behaviours and their barriers. Focus should be put on understanding and targeting vulnerable and marginalized groups.
    - Utilize the most appropriate communication channels, previously identified in the preparedness phase (e.g. mass media including television, radio, newspapers and internet can be used; social media; community radio; leaflets and posters). Social mobilizers and frontline responders can relay information.
    - Encourage community engagement through two-way, face-to-face communication via community leaders, religious figures and community health workers.
    - Predeveloped messages can be adapted to current situation and needs. Communication must propose practical actions people can take: vaccination (where, when), when and where to seek medical treatment, protection against mosquito bites, and larval source management (practical actions that can be taken at home).

- ☐ It is important to continuously evaluate strategies and interventions in specific contexts. Evaluation can generate useful data and insights to refine and contextualize a strategy or intervention for greater health impact. Evaluation should be documented and shared to build evidence.
- ☐ Frequent and evolving communication will keep people updated on the situation and actions taken, and will help deliver effectively advice on protective behaviours that populations can adopt.
- ☐ Communication on YF transmission, protection, health care-seeking, and larval source management can also be integrated in home visits conducted as part of the epidemiological and entomological investigations.
- ☐ Disease outbreaks are often accompanied by the presence of false rumours and misinformation. Responders need to have ways to listen to such misinformation and correct examples of it in appropriate ways without delay.
- ☐ House-to-house mobilization actions will be required the day before insecticide spraying activities to sensitize the community to the importance of the activity.

Pillar 4 Response actions: Clinical care

Scenarios 2, 3, and 4

- ☐ Ensure guidance on clinical management of arboviral diseases is in line with latest WHO recommendations and is made available to clinicians handling the patient(s) with YF.
- ☐ Disseminate printed job aids and SoPs for case detection.

- ☐ Ensure screening and triage are operational in health facilities of affected areas to prioritize care for patients with severe YF.
- ☐ Inform peripheral health facilities, from public and private sectors, of hospital referral criteria (presence of febrile jaundice).
- ☐ Ensure transportation is available for transfer of patients with severe YF to hospitals.
- ☐ Communicate to all health facilities, from public and private sectors, the name of the YF referral treatment centre(s) for severe YF. Special initiatives are needed to promote appropriate case management in the private sector, including use of recommended testing algorithm and accredited laboratories for confirmatory testing.
- ☐ Check that core variables on in-patients are captured and transmitted at pre-defined frequency to health authorities to enable follow up of in-patient case counts and calculation of case fatality rate.
- ☐ Apply infection prevention and control (IPC) measures:
    - Vaccination: YF vaccination should be provided to health workers not previously vaccinated.
    - Vector control (see Pillar 6): protect patient with YF from further exposure to mosquitoes by asking patient to stay indoors and/or under a mosquito net (especially during the day) for up to 5 days after the onset of fever. Health facilities should provide insecticide-impregnated mosquito nets for patients. Vector control measures around health facilities aim at reducing *Ae. aegypti* population and keeping density very low. Isolation: patients with YF do not require to be isolated.
    - Standard precautions: when caring for patients with YF, health workers should adhere to standard IPC precautions recommended for all patients. The use of additional transmission-based precautions are not necessary once YF is confirmed since the mode of transmission is vector-borne.
- ☐ Contact WHO for use of monoclonal antibodies and/or sofosbuvir in the context of a controlled research trial.
- ☐ Consider use of standardized YF case management form to improve clinical characterization of YF.
- ☐ Check that inpatient facilities are equipped with sufficient supplies for the management of severe illness and bed nets.
- ☐ Special initiatives to to facilitate free access to care for marginalized populations in urban informal settlements should be implemented.
- ☐ Social and behaviour change communication materials tailored to reach marginalized populations in urban informal settlements can be used to encourage health care-seeking behaviour (see Pillar 3).

Pillar 5 Response actions: Vaccination

Scenarios 2 and 3

- ☐ Estimate the **vaccination coverage** of the population in the area considered to be at risk of YFV transmission, based on presence of YF cases and presence and density of vector. This includes evaluating previous vaccinational coverage from routine immunization and past mass vaccination campaigns as well as conducting a household survey to estimate the vaccination coverage in both children and adults.Compile data from most recent routine immunization coverage rate, coverage rate of past vaccination campaigns (reactive, EPI catch up, targeted,

preventive mass vaccination campaign), findings from subnational immunity gap analysis, household survey of vaccination coverage targeting both children and adults near the residence of the YF case(s).

- ☐ If the vaccination coverage is suboptimal (<80%), a reactive vaccination campaign should be conducted within 10 days after receiving the vaccines.
- ☐ **Plan the vaccination strategy** by:
- ☐ Considering the most appropriate methods for the context :
    - selective vaccination
    - mobile and fixed points
    - closed population strategies
    - door-to-door campaigns, etc
- ☐ Identifying the most effective approach for reaching remote or vulnerable populations.
- ☐ A two-phased approach may be adopted: first, a limited reactive campaign using (EPI) vaccines available in-country for routine immunization around the (imported or first) case, followed by a more carefully prepared campaign targeting the population in affected district/neighbourhood.
- ☐ If there are constraints on the number of vaccine doses available, consider use of fractional doses according to Strategic Advisory Group of Experts (SAGE) recommendations.
- ☐ To inform vaccine priorisation decisions, areas at the greatest risk of infection need to be identified. Human mobility and vector suitability are two key factors accounting for the spatial spread of YF.
- ☐ **Determine target population** for reactive vaccination campaign based on which areas are at the greatest risk of infection. Vaccination should target individuals aged 9 months and older up to 59 years in districts/municipalities with infected vectors. Include specific population groups that would require special vaccination strategies such as transient workers, mobile populations, individuals living in poor urban settlements/slum areas, and other vulnerable populations. Understanding the behaviours and movement patterns of at-risk groups to effectively target vaccination efforts.
- ☐ Develop a **vaccination operational plan** with specific strategies to reach vulnerable and other special populations.
- ☐ Determine **material and human resources** and develop a budget to cover operational costs.
- ☐ **Estimate vaccine requirements** and necessary supplies by:
- ☐ Calculating the number of syringes, cold chain equipment, and protective materials needed,
- ☐ Ensuring adequate stockpiling and distribution.
- ☐ To access the emergency **YF vaccine global stockpile** managed by the ICG on vaccine provision, the country should fill and submit an ICG request form for YF vaccine, annexes and other required documents as per the checklist in the request form to the ICG Secretariat (WHO Geneva). It is highly recommended that the country submits the request to the ICG secretariat within 7 days after confirmation of the outbreak. The ICG secretariat at WHO then circulates this request to the members (IFRC, MSF, UNICEF and WHO) for review and assessment within 1 day after receiving the country request.
- ☐ Establish strong **coordination** mechanisms by:
    - ensuring clear communication flow between national, state, and local levels,

- allocating responsibilities and resources for the successful execution of the campaign,
- managing resources effectively to ensure the campaign's success.

☐ Enhance and strengthen surveillance of events potentially attributable to vaccination or immunization (AEFI) to guarantee proper reporting, investigation, causality assessment, and classification of cases suspected to AEFI.

☐ Gavi-supported countries can request funds to cover the operational costs of a campaign (as determined under Gavi policy for vaccine in consultation with all stakeholders/partners).

☐ Communities living near border areas of the affected urban area should be informed of ongoing YFV transmission and ensured protection through vaccination if the vaccination coverage is <80%.

☐ Conduct an active search for unvaccinated individuals and carry out focal vaccination, and/or refer them to the appropriate health unit and expand the vaccination outreach area, based on the location of probable infection and new suspected events detected.

☐ Conduct **post-vaccination campaign coverage survey** to determine vaccine coverage, with data assessed by sex and age groups and special populations.

Pillar 6 Response actions: Vector control

Scenario 2

☐ Representative of the vector control division or equivalent at city and national levels should be included in the multisectoral team emergency response team (see Pillar 1).

☐ Patient can be contacted to confirm the accuracy of the addresses received.
- Conduct a home visit for focal treatment and health education on YF transmission and protection.
- If entomological data are available in the area of concern (e.g. from resting adult traps), it can be used to clarify the presence of vectors and included in the ICG if applicable.
- If the reported case is within an active transmission focus, data on previous control actions can be integrated into the mapping.

☐ All suspect YF cases should be advised to prevent mosquito bites before laboratory confirmation.

☐ Vector control measures should start during the field entomological investigation around the first YF urban case (see Pillar 2) following national guidelines for vector control. If the presence of the vector is confirmed, the field entomology agents physically eliminate as many productive breeding sites as possible, ideally on both public and private land, within the perimeter of the investigation.

☐ If adulticide treatment proves necessary, field agents carry out an information campaign in the area to be treated, distributing leaflets and posters specifying the date and time of treatment, as well as instructions for limiting exposure to insecticide products (see Pillar 3).

☐ Emergency action to reduce significantly the population of *Ae. aegypti* and protect patients against bites should be taken in the environment of the hospitalized case or in their neighbourhood if treated as outpatient (see Pillar 4).

- ☐ Actions should be taken to significantly reduce *Ae. aegypti* population in the municipality where the transmission likely occurred as indicated in national instructions informed by relevant WHO guidance on vector control.

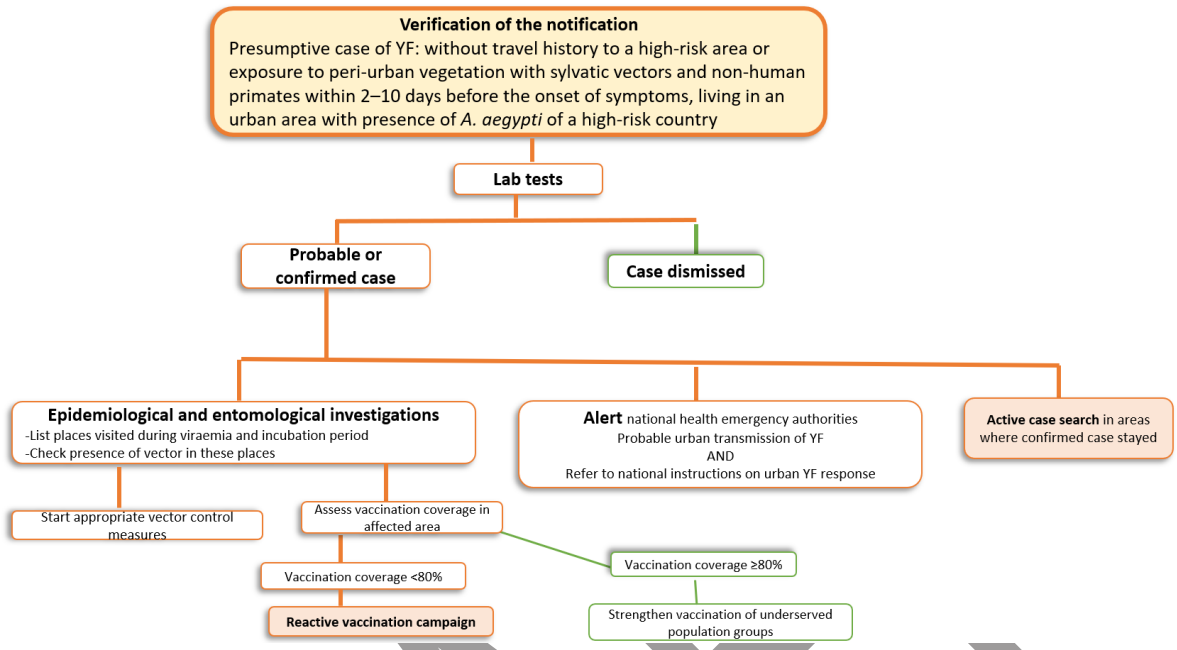
Pillar 7 Response actions: Points of entry
Scenario 2

- ☐ Apply the IHR Decision Algorithm (Annex 2) to decide if notification to WHO is required. If criteria are not fulfilled for a notification under IHR annex 2, it is nevertheless recommended to consult WHO country office (article 8) and pursue the risk assessment of the situation as the situation evolves.
- ☐ IHR implementation should be enhancened: all urban points of entry, airports and ports and land border crossing points near urban area, should check for proof of the international certificate of vaccination for all travellers and visitors entering and leaving the urban area. This approach can be challenging in areas with no clear landborder demarcation. Options need to be discussed locally.
    - Priority should be given to airports and ports, followed by busiest landborder crossing points taking into account feasibily and local context.
    - Health authorities should inform authorities of neighbouring country of YF epidemiological situation to increase their level of alert.
    - Communities living near border area should be informed of ongoing YF transmission and ensured protection through vaccination (see Pillar 5).
- ☐ Communication material on risk of YF and protection measures should be available at all urban transport hubs (see Pillar 3). YF vaccination service should be set up in major international entry points of city/urban area for non vaccinated travellers. Another option is effective referral to vaccination service.
- ☐ Identify incoming/outgoing mobile population groups that would require vaccination. In case of humanitarian emergencies leading to population displacement, unprotected internally displaced populations and refugees should be vaccinated.

Scenario 3: Response

Scenario 3: ≥1 confirmed case of YF with epidemiological evidence of urban transmission in a high-risk country (EYE Strategy classification) (i.e. vaccinated population).
→ Detection of ≥1 confirmed case of YF without travel history to a high-risk area or exposure to peri-urban vegetation with sylvatic vectors and non-human primates within 2–10 days before the onset of fever, living in an urban area with presence of *Ae. aegypti in* a high-risk country.

(Scenario 3) More than 1 confirmed case of YF with epidemiological evidence of urban transmission in a high-risk country (vaccination required)



For Pillars 1, 3, and 4 See Scenario 2)

Pillar 2 Response actions: Collaborative surveillance

Scenario 3

- ☐ Notify cases to WHO, under the IHR(2005), if situation fulfils criteria (see Annex 2 of IHR(2005)).
- ☐ Carry out a field epidemiological investigation at home of the patient following WHO or national instructions; this should include an active search for cases and a household survey of vaccination coverage.
- ☐ Decide on the relevance of an entomological investigation at the location of a new probable infection, based on availability of existing data (i.e. if other YF cases were investigated in same locality, then additional data may not be needed).
- ☐ Ensure that all stakeholders (e.g. health facilities, laboratories, local health authorities) are informed on case definition, testing procedure and information flow.
- ☐ Establish frequent and regular case classification calls with surveillance officers and national laboratory.
- ☐ Strengthen human case surveillance in the affected and expanded areas by sharing surveillance protocol, data forms, and operating procedures to the network of health facilities, laboratories, and local health authorities. Inform them of the YF case(s) detected.
- ☐ Perform viral genomic analysis in humans and in mosquitoes to help identify the origin of the outbreak, determine the type of transmission and reconstruct the history of viral diffusion (can be done at reference regional laboratory).
- ☐ Conduct a retrospective analysis of surveillance data from relevant urban area for indications of YF outbreak:
- ☐ Calculate CFR for in-patients with jaundice and compare with CFR from other districts/municipalities or previous periods of time.

- ☐ From community health records, check for other suspect cases of YF.
- ☐ Broaden the definition if suspect case to increase detection of non severe cases of YF most likely to be viraemic, through PCR testing. Jaundice should not be required for testing for YF in urban YF outbreak.
- ☐ Inform clinicians on laboratory involved in the testing of cases and provide clear instructions about sampling.
- ☐ Facilitate rapid case investigation and active surveillance (case finding) by mobile teams in affected communities and health care facilities.
- ☐ Enter core data for all suspect YF cases in spreadsheet or other software, including vaccination history and travel history; ensure data quality and data completeness.
- ☐ Maintain the line list of cases with key variables updated on weekly basis
- ☐ Monitor the course of the epidemic and outcome interventions.
    - Draw epidemic curve on weekly basis.
    - Analyse data on weekly basis at minimum: sex and age disaggregated data, incidence per area of residence, profession of cases.
    - Calculate CFR and disaggregated per age group and sex
    - Map all confirmed cases with Global Positioning System (GPS) coordinates showing transport hubs and areas with vegetation.
    - Perform weekly epidemiological situation analysis including an evaluation of the risks of YF spread, and provide updated epidemiological curve and mapping of cases and deaths using GIS to all responders.
- ☐ Mobilize relevant partners for surveillance identified during preparedness phase.
- ☐ Carry out a field entomological investigation at the location of probable infection of human cases based on the epidemiological investigation, the history of movements and the clinical history of the patient (to define when patient was viraemic). Entomological investigations are conducted for new human cases until sufficient information is available to understand the transmission cycle and guide the appropriate vector measures. When the number of sites is too high and it is impossible to investigate them all, they can be prioritized by the entomologist field experts according to the duration of presence, the time of exposure, and the abundance of vectors in the different sectors visited.

Pillar 6 Response actions: Vector control
Scenario 3

- ☐ Representative of the vector control division or equivalent at city and national levels should be included in the multisectoral team emergency response team (see Pillar 1).
- ☐ Refer to national decision algorithm (see examples in Annex 3).
    - Define the scope of the intervention according to the scenario (isolated case, grouped cases in single or multiple districts/municipalities); contact the patient or family members to confirm the accuracy of the addresses received.
    - Map provisionally area of concern, integrating environmental data as available to be able to identify the presence of vectors.
    - If entomological data are available in the area concerned (e.g. from resting adult traps), these data can be used to initiate the assessment of vector presence.
    - If the reported case is within an active transmission focus, data on previous control actions can be integrated into the mapping.

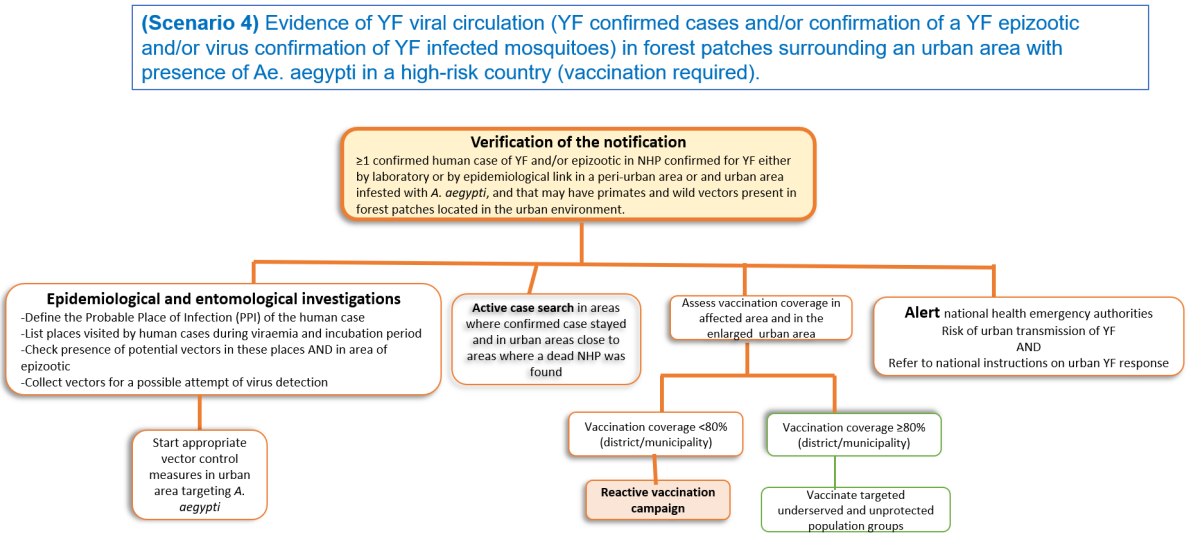
- ☐ All suspect YF cases should be advised to prevent mosquito bites before laboratory confirmation.
- ☐ Home visits conducted for epidemiological investigations can be used to disseminate information on actions to eliminate breeding sites.
- ☐ Vector control measures should start during the field entomological investigation around the first YF urban case (see Pillar 2) following national guidelines for vector control. If the presence of the vector is confirmed, the field entomology agents physically eliminate as many productive breeding sites as possible, ideally on both public and private land, within the perimeter of the investigation.
- ☐ If adulticide treatment proves necessary, field agents carry out an information campaign in the area to be treated, distributing leaflets and posters specifying the date and time of treatment, as well as instructions for limiting exposure to insecticide products (see Pillar 3).
- ☐ Emergency action to reduce significantly population of *Ae. aegypti* and protect patients against bites should be taken in the environment of hospitalized cases (see Pillar 4).
- ☐ Actions should be taken to reduce infestation rate of *Ae. aegypti* in the peri-domestic environments as indicated in national instructions informed by relevant WHO guidance on vector control.
- ☐ The effectiveness of insecticide treatments should be monitored at a few sentinel sites to assess the density of *Ae. aegypti* before and after spraying. Mosquito resistance to the molecules used should also be monitored.

Pillar 7 Response actions: Points of entry
Scenario 3

- ☐ Apply the IHR Decision Algorithm (Annex 2) to decide if notification to WHO is required. If criteria are not fulfilled for a notification under IHR annex 2, it is nevertheless recommended to consult WHO country office (article 8) and pursue the risk assessment of the situation as the situation evolves.
- ☐ IHR implementation should be strengthened: all urban points of entry, airports and ports and land border crossing points near urban area, should check for proof of the international certificate of vaccination for all travellers and visitors entering and leaving the urban area. This can be challenging in areas with no clear landborder demarcation. Options needs to be discussed locally.
    - Priority should be given to airports and ports, followed by busiest landborder crossing points taking into account feasibily and local context.
    - Health authorities should inform authorities of neighbouring country of YF epidemiological situation to increase their level of alert.
    - Communities living near border area should be informed of ongoing YF transmission and ensured protection through vaccination (see Pillar 5).
- ☐ Communication material on risk of YF and protection measures should be available at all urban transport hubs (see Pillar 3). YF vaccination service should be set up in major international entry points of city/urban area for non vaccinated travellers. Other option is effective referral to vaccination service.
- ☐ Identify incoming/outgoing mobile population groups that would require vaccination. In case of humanitarian emergencies leading to population displacement, unprotected internally displaced populations and refugees should be vaccinated.

Scenario 4: Response

Scenario 4: Evidence of YF viral circulation (YF confirmed case and/or confirmation of an epizootic of YF) in an urban area with forest patches and presence of *Ae. aegypti* in a high-risk country (EYE Strategy classification) (i.e. vaccinated population).



For Pillars 1, 3, and 4: see Scenario 2

Pillar 2 Response actions: Collaborative surveillance

Scenario 4

- ☐ Conduct a retrospective analysis of surveillance data from relevant urban area for indications of YF outbreak:
- ☐ From community health records, check for other suspect cases of YF.
- ☐ Integrate analysis of human, animal, and vector suitability data to better understand transmission dynamics and identify high-risk zones. This analysis should include vaccination coverage data of populations at risk of contact with infected mosquitoes.
- ☐ Perform viral genomic analysis in humans and mosquitoes to help identify the origin of the outbreak, determine the type of transmission and reconstruct the history of viral diffusion (can be done at reference regional laboratory).

Pillar 5 Response actions: Vaccination

Scenario 4

- ☐ Estimate the vaccination coverage of the population in the area considered to be at risk based on location of YF case and/ or place of epizootic.
- ☐ Determine target population for reactive vaccination campaign. YF vaccination should target individuals aged 9 months and older up to 59 years in pre-epidemic context (confirmed epizootic), in outbreak-affected districts as well as neighbouring areas at risk.
- ☐ Develop vaccination operational plan with specific strategies to reach vulnerable and other special populations; determine required material and human resources and develop a budget to cover operational costs.

- ☐ Plan the vaccination strategy by:
    - Considering the most appropriate methods for the context (e.g. selective vaccination, mobile and fixed points, closed population strategies, door-to-door campaigns).
    - Identifying the most effective approach for reaching remote or vulnerable populations. Understanding the behaviours and movement patterns of at-risk groups to effectively target vaccination efforts.
    - A two-phased approach may be adopted: first, a limited reactive campaign using (EPI) vaccines available in-country for routine immunization around the (imported or first) case, followed by a more carefully prepared campaign targeting the population in affected district/neighbourhood.
    - Considering the eventual use of fractional doses according to SAGE recommendations.
- ☐ The country should implement the reactive vaccination campaign within 10 days after receiving the vaccines.
- ☐ Establish strong coordination mechanisms by:
    - ensuring clear communication flow between national, state, and local levels,
    - allocating responsibilities and resources for the successful execution of the campaign,
    - managing resources effectively to ensure the campaign's success.
- ☐ Enhance and strengthen surveillance of AEFIs to guarantee proper reporting, investigation, causality assessment, and classification of cases suspected to AEFI.
- ☐ Estimate vaccine requirements and necessary supplies by:
    - calculating the number of syringes, cold chain equipment and protective materials needed,
    - ensuring adequate stockpiling and distribution.
- ☐ Conduct an active search for unvaccinated individuals and carry out focal vaccination, and/or refer them to the appropriate health unit and expand the vaccination outreach area, based on the location of probable infection and new suspected events detected.
- ☐ Conduct a post-vaccination campaign coverage survey to determine vaccine coverage, with disaggregated data by sex and age groups and special populations.

Pillar 6 Response actions: Vector control
Scenario 4

- ☐ Representative of the Vector Control Division or equivalent at city and national levels should be included in the multisectoral team emergency response team (see Pillar 1).
- ☐ Refer to national decision algorithm (see examples in Annex 3).
    - Define the scope of the intervention according to the scenario (isolated case, grouped cases in single or multiple districts/municipalities); contact the patient or family members to confirm the accuracy of the addresses received.
    - Map provisionally area of concern, integrating environmental data as available to be able to identify the presence of vectors.
    - If the reported case is within an active transmission focus, data on previous control actions can be integrated into the mapping.

- ☐ Home visits conducted for epidemiological investigations can be used to disseminate information on actions to eliminate breeding sites (see Pillar 3).
- ☐ Vector control measures should start during the field entomological investigation around the first YF urban case (see Pillar 2) following national guidelines for vector control. If the presence of the vector is confirmed, the field entomology agents physically eliminate as many productive breeding sites as possible, ideally on both public and private land, within the perimeter of the investigation.
- ☐ If adulticide treatment proves necessary, field agents carry out an information campaign in the area to be treated, distributing leaflets and posters specifying the date and time of treatment, as well as instructions for limiting exposure to insecticide products (see Pillar 3).
- ☐ Emergency action to reduce significantly population of *Ae. aegypti* and protect patients against bites should be taken in the environment of hospitalized cases (see Pillar 4).
- ☐ Actions should be taken to reduce infestation rate of *Ae. aegypti* in priority in urban areas close to forest patches and in areas where cases were detected as indicated in national instructions informed by relevant WHO guidance on vector control.
- ☐ The effectiveness of insecticide treatments should be monitored at a few sentinel sites to assess the density of *Ae. aegypti* before and after spraying. Mosquito resistance to the molecules used should also be monitored.

Pillar 7 Response actions: Points of entry
Scenario 4

- ☐ Apply the IHR Decision Algorithm (Annex 2) to decide if notification to WHO is required. If criteria are not fulfilled for a notification under IHR annex 2, it is nevertheless recommended to consult WHO country office (article 8) and pursue the risk assessment of the situation as the situation evolves.
- ☐ IHR implementation should be strengthened: all urban points of entry, airports and ports and land border crossing points near urban area should check for proof of the international certificate of vaccination for all travellers and visitors entering and leaving the urban area. This approach can be challenging in areas with no clear landborder demarcation. Options need to be discussed locally.
    - Priority should be given to airports and ports, followed by busiest landborder crossing points taking into account feasibily and local context.
    - Health authorities should inform authorities of neighbouring country of YF epidemiological situation to increase their level of alert.
    - Communities living near border area should be informed of ongoing YF transmission and ensured protection through vaccination (see Pillar 5).
- ☐ Communication material on risk of YF and protection measures should be available at all urban transport hubs (Pillar 3). YF vaccination service should be set up in major international entry points of city/urban area for non vaccinated travellers. Another option is effective referral to vaccination service.

6 Moderate and potential risk countries: preparedness and response action lists

Pillar 1 Preparedness list: Coordination and planning

Pillar 1 Preparedness list for moderate/potential-risk countries

STEP 1: **Situation analysis**

- ☐ Review literature on modelling studies, arboviral disease seroprevalence or other risk assessments relevant for country.
- ☐ Review history of urban outbreaks of other *Aedes*-borne diseases (dengue, chikungunya, Zika) in the country.
- ☐ Liase with vector control authority and assess vector control needs.
- ☐ List/map mosquito-endemic urban areas with most recent population figures
- ☐ Inquire about migration and travel pattern from/to high-risk countries/areas and main ports of entry.
- ☐ Assess actions required for preparedness for each of the seven pillars.
- ☐ Check if SPAR benchmark C7.1 (Planning for health emergencies) is at level ≥3.
- ☐ Adapt the proposed decision algorithm to national and regional context (Annex 3: scenario 1).
- ☐ Map experts and partners that can be involved in YF preparedness and response across all seven pillars.

STEP 2: Prioritize

- ☐ Prioritize cities and urban areas for preparedness/operational readiness based on size and presence of vector.
- ☐ Map priority actions under each of the seven pillars against existing plan and available funds.
- ☐ Identify critical gaps and resource requirements.

STEP 3: Mobilize, coordinate and train

- ☐ Raise awareness: inform key experts and partners identified for preparedness of the risk of YF introduction and potential consequences.
- ☐ Develop proposals and identify souces of funding to cover gaps in preparedness efforts.
- ☐ Organize trainings.
- ☐ Set up intersectoral coordination mechanism.

Pillar 2 Preparedness list: Collaborative surveillance, testing, epidemiological and entomological investigations, active case search, data management and analysis

Pillar 2 Preparedness list for moderate/potential-risk countries

- ☐ Identify a laboratory with YF testing/confirmatory testing capacity, either a national laboratory or a regional reference laboratory. Contact the WHO country/regional office for further guidance. Develop clear sample management SoP based on WHO guidance.
- ☐ Ensure WHO surveillance-related benchmarks 10.1 (Early warning surveillance system), 10.2 (Event verification and investigation system) and 10.3 (Surveillance data and information systematically analysed and shared to inform decision making for action) for strengthening health emergency capacities are at level ≥3.
- ☐ Check if SPAR tool benchmark C5.1 (Early warning surveillance function) is at level ≥3; hospitals should be able to report events and/or data.
- ☐ Assess if information on YF clinical presentation and diagnosis is available for clinicians of referral hospitals most likely to manage returning travellers (e.g. YF factsheet on clinical presentation and differential diagnosis posted on MoH website).
- ☐ Assess that information on YF if provided to departing and returning travellers to/from high-risk areas for YF, and that travellers are encouraged to seek health care in reference centres if ill on return.
- ☐ Organize a consultation with surveillance officers and clinicians to agree to best approach to detect an eventual imported case of YF (rare event not to be missed) and definitions for suspect and confirmed cases. Adaptations of existing surveillance systems to be considered include:
    - Raising the index of suspicion for YF among clinicians most likely to encounter severe YF cases (e.g. hospitals near airports and in areas bordering a high-risk country) by actively informing them of YF disease (clinical presentation, transmission, local epidemiology).
    - YF testing of all suspect cases of viral haemorrhagic fever with exposure to endemic area.
    - YF testing of all cases of acute febrile jaundice with fatal outcome with exposure to endemic area.
    - YF testing in syndromic surveillance system of *Aedes*-borne diseases when there is exposure to endemic area.
    - Include febrile jaundice with fatal outcome in community-based surveillance and investigate all increased number of febrile jaundice.
    - Develop a YF notification form with a standardized case definition and integrate YF in the national notifiable disease list.
- ☐ Assess if hospital clinicians in sentinel sites (where severe cases of YF are likely to be hospitalized) have access to the YF notification form.
- ☐ Assess if hospital clinicians in sentinel sites are trained in recognizing *Aedes*-borne arboviral diseases clinical presentation.
- ☐ Assess if communication pathway exists between MoH surveillance unit and hospital clinicians to be able to rapidly inform them of an eventual YF epidemic in a neighbouring country or of an increased risk of YF case (e.g. in geographical areas bordering a high-risk country).

- ☐ Assess reporting network (data collection method, data flow, reporting procedures) and timeliness of notification (time from case detection to notification form reaching decision-maker).
- ☐ Check that laboratory algorithms are available for testing and guidance for clinicians on which laboratory tests to request if *Aedes*-borne arboviral disease is suspected.
    - Considering the documented antibody cross-reactivity among flaviviruses, check if YF is included in the testing algorithm for other flaviviruses endemic in the country.
    - Assess if YF is included in the clinical decision tree of other arboviral diseases (dengue, Zika, chikungunya) endemic in the country if relying on a syndromic case definition for arboviral diseases.

WHO Regional Office for the Eastern Mediterranean. Establishing syndromic surveillance and event-based surveillance systems for zika, dengue and other arboviral diseases. Geneva: World Health Organization; 2020(accessed https://iris.who.int/handle/10665/334166, accessed 3 September 2025).

- ☐ Map national laboratories with capacity to perform serology testing for YFV IgM and/or RT-PCR. Identify WHO regional reference laboratory or the nearest recognized laboratory able to perform these tests. Contact the WHO country/regional office for further guidance if needed.
- ☐ Define referral pathway for confirmatory testing if necessary.
- ☐ Develop SoPs for laboratories with YF testing capacity.
- ☐ Assess capacity for field investigation and active case search.
- ☐ Prepare mechanisms to deploy large capacity testing in anticipation of urban outbreak.
- ☐ Develop national and local response plan (SoPs) for the scenario of a likely imported case of YF in an unprotected population in a mosquito-endemic urban area (see example of decision algorithms for Scenario 1 in annex 3).

Pillar 3 Preparedness list: Community protection

Pillar 3 Preparedness list for moderate /potential risk countries

- ☐ Check if SPAR benchmark C10.1 (RCCE system for emergencies) is at level ≥3.
- ☐ Check if SPAR benchmark C10.2 (Risk communication) is at level ≥3.
- ☐ Check if SPAR benchmark C10.3 (Community engagement) is at level ≥3.
- ☐ Conduct mapping of community leaders, networks, marginalized and at-risk populations to engage with culturally appropriate messages using relevant channels and community networks/incluencers in urban districts.
- ☐ Gather information/conduct studies to identify gaps in knowledge, attitudes and practices as regards YF through multi-source approaches before developing communication plan (surveys, analysis of existing YF investigation reports, qualitative or quantitative behavioural studies, etc). Priority topics include knowledge on when to seek health care, knowledge on personal protection measures,

perception and acceptability of YF vaccination by health workers and general population, and knowledge and acceptability of vector control measures (destruction of breeding sites and insecticide spraying).

- ☐ Develop/contextualize key RCCE products (SoPs, guidance, training materials, etc.). Develop and test evidence-based messages with communities to fill the gap and respond to the missing knowledge. Tailor messaging for all sub-population groups (e.g. groups most exposed to mosquito bites, underserved populations, individuals working in or close to forests). Messaging should be culturally appropriate and address key community concerns such as :
  - information on YF and protection,
  - alert messages,
  - messages for empowerment: messages on the do(s) and don't(s) in case of fever and jaundice,
  - message on why, where, when and how to get vaccinated,
  - develop Q&A, including on the adverse events following vaccination, and frequently update it and share it with communities.

Pillar 4 Preparedness list : Clinical care

Pillar 4 Preparedness list for moderate/potential-risk countries

- ☐ Develop or update and adapt national clinical protocol for YF case management with package of care specific for each level of care, based on most recent WHO guidelines on clinical management of arboviral diseases.
  - Disseminate national clinical protocol/standard operating procedures to all health facilities, public and private.
- ☐ Display pictorial charts (job-aids) of symptoms of YF in all PHC facilities for easy recognition of symptoms.
- ☐ Map secondary level care facilitites and health facilities with ICUs.
- ☐ Establish a referral pathway for screening, triage, and admission, including criteria and processes which are integrated with testing procedures.
- ☐ Put in place procedures and criteria for referral to specialist units for severe cases from first level facilities (public and private). This will enable provision of centralized critical care and YF management services. Disseminate this referral algorithm to all PHC facilities.
  - Check availability of ambulance for referral of severe cases.
  - Check capacity of first level facilitities to provide basic emergency care for severe cases before referral.
  - Check capacity for critical care units to manage severe cases of YF.
- ☐ Ensure availability of diagnostic capacity and related materials.
- ☐ Ensure that the cost of diagnosis and treatment for patients with suspected and confirmed YF is free of charge.
- ☐ Ensure availability of bednets in hospitals.
- ☐ Ensure YF vaccination status is checked for all out and in patients of hospitals as well as for health workers.
- ☐ Ensure availability of RDT for malaria (where relevant) and other arboviruses to consider in the differential diagnosis.
- ☐ Engage with communities, ensure the provision of key messages on YF and promote early self-referral to health facilities (see Pillar 2).

- ☐ Plan for reorganization of health services and surge scenarios by defining strategies to rapidly increase bed capacity (e.g. re-purposing wards) and increasing health worker staffing levels (link with urban health emergency planning).
- ☐ Consider participating in the WHO global clinical network knowledge exchange platform to aid in the clinical characterization of YF, address challenges and share best practices in clinical care, and foster global collaboration (*optional based on country capacity*). Alternatively, participation in cohort studies to describe at least the epidemic and estimate its severity is recommended where available.
- ☐ Consider engaging in research for the use of monoclonal antibodies or sofosbuvir (Use under the MEURI).
- ☐ Develop monitoring tools for core indicators (CFR, number of in-patients with minimal set of characteristics).

Pillar 5 Preparedness list: Vaccination

Pillar 5 Preparedness list for moderate/potential-risk countries

- ☐ Learn about the process to request access to International Coordinating Group (ICG) YF vaccine stocks (if relevant for the country):
  - Download and read the ICG guidelines to understand the application procedure,
  - Download ICG request form and associated annexes.

  Information can be obtained from the WHO regional office.
- ☐ Identify/set up the committee at MoH that will decide on the need to implement a reactive vaccination campaign, fill and submit the ICG request (*request should be submitted within 7 days after confirmation of the outbreak*).
- ☐ Agree on urban-specific vaccination strategy to target specific groups (underserved populations as well as mobile workers); plan on how to identify and include populations who may be excluded or not covered by the public health system (e.g. migrants and refugees, stigmatized populations). Identify existing health services in the private sector that could be leveraged for vaccine delivery.
- ☐ Ensure regulatory preparedness (*the reactive vaccination campaign should be implemented within 10 days after receiving the vaccines*):
  - ensure an expedited import approval from appropriate authorities,
  - identify the requirements and documents needed to release YF vaccines at airport customs,
  - set up expedited funds release from WHO country office to national health and city health authorities.
- ☐ Prepare the supply chain from primary to service delivery level, train health care workers and operational managers for delivering vaccine, recording and reporting.

Pillar 6 Preparedness list: Vector control

Pillar 6 Preparedness list for moderate/potential-risk countries

- ☐ Check availability of mapping of *Ae. aegypti* in urban areas and their main breeding sites (see Pillar 2).
- ☐ Review or assess level of resistance of *Ae. aegypti* to adulticides and larvicides.
- ☐ Vector control measures targeting *Ae. aegypti* in urban areas should be implemented on routine basis to keep infestation rate low. Infestation rate should be kept very low in urban neighbourhoods close to forest patches.
- ☐ Update/develop national policy, guidelines and SoPs on vector surveillance and control strategy and measures (including type of insecticide products for control of *Aedes* mosquitoes and how to use them) for *Aedes*-transmitted arboviral diseases (e.g. dengue), listing and describing role of local actors in charge of their implementation, city/local authorities in charge of their supervision.
- ☐ Check in-country availability and supply of adulticides and larvicides for vector control that are pre-qualified by the Prequalification Team/ Vector Control Product Assessment of WHO. Check availability of equipment and vehicles.
- ☐ Analyze existing data on resistance to insecticides used in public health in *Aedes* populations in risk areas; if updated data is not available, conduct insecticide susceptibility studies.
- ☐ Train community leaders as future trainers in each district on larval source reduction methods and biolarvicides application (benefits for all *Aedes*-transmitted arboviruses).
- ☐ Develop a decision algorithm for an imported suspect case of YF (example in Annex 3) that defines when to implement targeted vector control measures.
- ☐ Develop/update standard operating procedures for vector control measures.
- ☐ Map partners in major urban areas who could be involved in implementing *Aedes* vector control measures.
- ☐ Airports and sea ports should be kept free from the breeding of insect vectors over an area extending at least 400 m around their perimeters *(1)*.

1 Present status of yellow fever: memorandum from a PAHO meeting. Bull World Health Organ. 1986;64(4):511-24.

Pillar 7 Preparedness list: Points of entry, international travel and transport, population movement

Pillar 7 Preparedness list for moderate/potential-risk countries

- ☐ Assess if all designated points of entry are implementing routine core capacities with an all-hazard and multisectoral approach integrated into the national surveillance system": C11.1 indicator is at Level 4 (IHR SPAR).
- ☐ Assess if proof of vaccination against YF is requested at all points of entry for incoming travellers from endemic countries (EYE high risk countries). This is to prevent entry of a person potentially with YF viraemia.
- ☐ Assess if ship sanitation inspection is performed in ports as per IHR(2005) regulations.
- ☐ IHR focal point should be familiarized with Annex 2 of IHR(2005) and ready to notify to WHO a probable or confirmed case of YF. WHO should be informed of a suspect case of YF.

☐ Establish programmes to eliminate *Aedes aegypti* a minimum distance of 400 metres from those areas of point of entry facilities that are used for operations involving travellers, conveyances, containers, cargo and postal parcels.

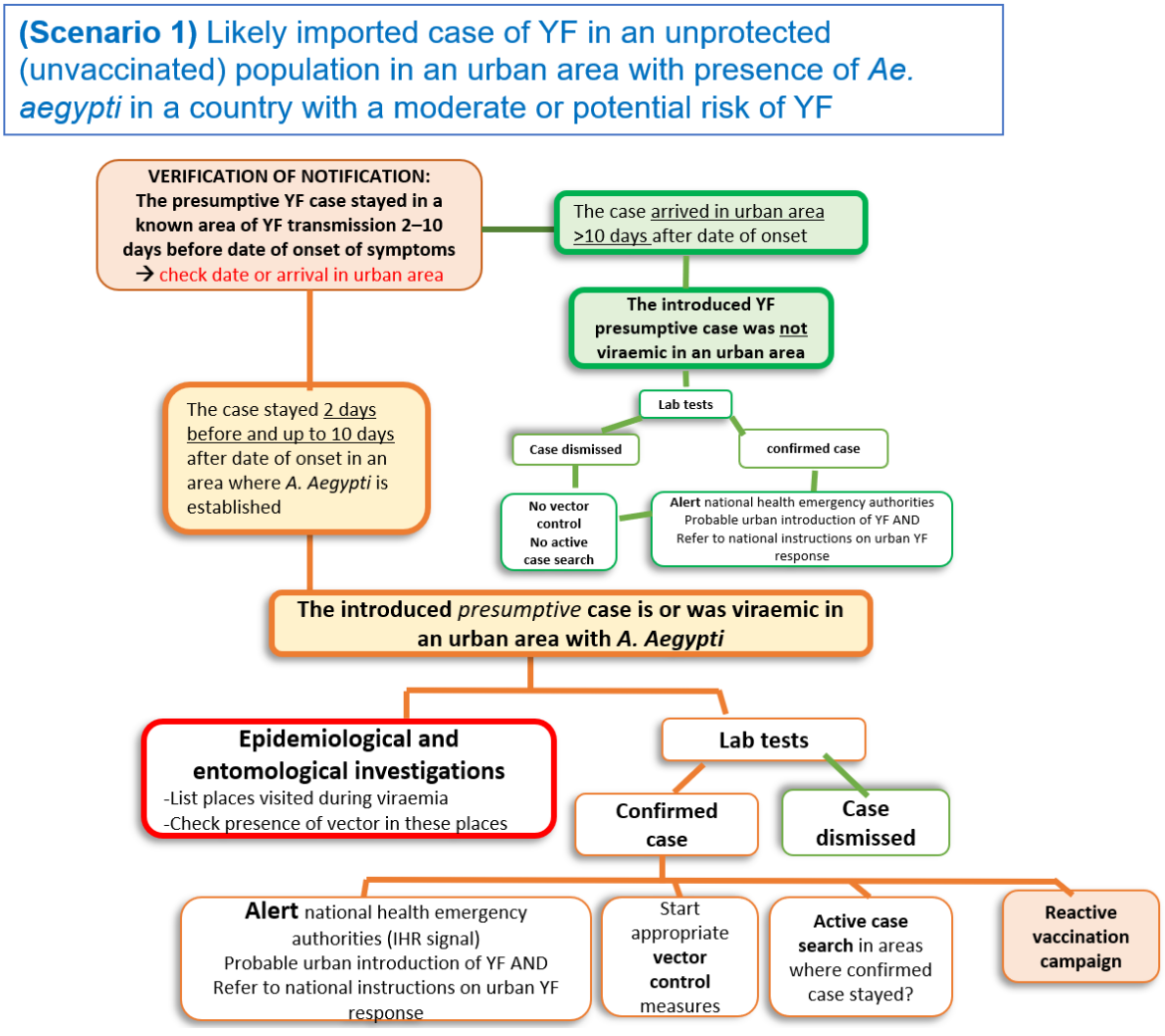
Response action lists for moderate and potential risk countries

A decisional flowchart is proposed for moderate and potential risk countries (scenario n°1) that should be adapted to local context.

Scenario 1: Response

Scenario 1: *likely* imported case of YF in an unprotected population (unvaccinated) in an urban area with presence of *Ae. aegypti (in moderate and potential risk countries- EYE Strategy classification)*

→ Detection of one presumptive case of YF with travel history to an endemic area within 2–10 days before the onset of symptoms in a population with very low population immunity (vaccination in travellers only) in an urban area with presence of *Ae. aegypti*



Pillar 1 Response actions: Coordination and planning

Scenario 1

- ☐ Refer to decision algorithm (adaptation of Scenario 1) (see Annex 3) to help with situation analysis and decision on priority control measures.
- ☐ Establish links between the national and local urban government levels.
- ☐ Local urban government/urban health department should include and engage with the local community to ensure their support and involvement in communication and vector control.
- ☐ Assess the need to activate emergency operation centre or equivalent based on criteria defined in urban YF preparedness plan and epidemiological assessment of YF situation (evaluation of the risk of YF spreading).
- ☐ Contact WHO and ICG for information and support if reactive vaccination campaign is envisaged.
- ☐ Activate rapid response team (multidisciplinary team) including surveillance, case management, RCCE, vaccination, vector control specifialists, local/city health department among the core team, IHR focal point, partners for outbreak response, with defined roles and responsabilitites a per the response plan that include communication plan with detailed information dissemination process.
- ☐ Define place where responders can meet and frequency of touch points. Suggested frequencies of meetings to decide, follow, and assess effective implementation of control measures for each of the pillars are:
    - Daily meetings for the response/coordination team during the acute phase,
    - Weekly meetings when the outbreak is being controlled or reduced,
    - Biweekly meetings with technical and financial partners,
    - Regular meetings with civil society, laboratories, private sector, community-based organizations and associations, etc.

- ☐ Decide on how to share information between responders (Microsoft SharePoint, telephone numbers, generic email).
- ☐ Share with all responders actions points from meetings and epidemiological situation updates.
- ☐ WHO recommends that within 3 months after the official declaration of the end of the outbreak, an after-action review is conducted with the stakeholders who were involved in the response. Key objectives include the analysis of gaps and/or contributing factors noted during the implementation of the response as well as lessons learned.

Guidance for after action review (AAR). Geneva: World Health Organization; 2019 (https://iris.who.int/handle/10665/311537, accessed 22 May 2024).

Pillar 2 Response actions: Collaborative surveillance

Scenario 1

- ☐ Refer to national decision algorithm (see examples in Annex 3).
- ☐ Notify YF case(s) to WHO, according to Annex 2 of of the IHR(2005).
- ☐ Carry out a field epidemiological investigation at home of the patient following WHO or national instructions; this should include an active search for cases and a household survey of vaccination coverage.
- ☐ In coordination with the health sector, carry out an entomological investigation at the location of probable infection based on the epidemiological investigation, the

history of movements, and the clinical history of the patient. Field agents visit the various sites identified. The first stage of the entomological investigation aims to assess the presence of the vector in the perimeter concerned (larvae or adults).

- ☐ Strengthen case surveillance by informing all key stakeholders (e.g. laboratories, local health authorities, hospital-based clinicians [infectious disease, ICU] and clinicians in sentinel health facilities) on case definition, testing procedure and information flow, as well as on the epidemiological situation.
- ☐ Inform hospital-based clinicians in emergency services and ICU of YF case definition, testing algorithm, and epidemiological situation. Clinicians most likely to encounter potential other YF cases should be informed of in order to increase their index of suspicion.
- ☐ Inform clinicians on laboratory involved in the testing of cases and provide clear instructions about sampling.
- ☐ Intensify surveillance strategies for human cases in the affected and expanded areas by sharing surveillance protocol, forms, and procedure to the network of health facilities and informing them of the YF case(s) detected.
- ☐ Perform viral genomic monitoring in humans and in mosquitoes to help determine the origin of the outbreak, the type of transmission and to reconstruct the history of viral diffusion (can be done at reference regional laboratory).
- ☐ Ensure that capacity testing (if done in the country) is sufficient to face the outbreak and/or transport packaging is sufficient (for international shipment).
- ☐ Start active case search in areas where confirmed case stayed in first 2 weeks after symptom onset.
- ☐ Share with key stakeholders a weekly epidemiological bulletin with key indicators (daily updates may be useful at the beginning of the outbreak).
- ☐ Prepare to monitor the evolution of the outbreak using key indicators:
    - Number of suspect, probable and confirmed cases per geographical area,
    - Number of hospitalizations and duration of hospitalizations,
    - Number of deaths in hospitalized patients,
    - Number of death certificates mentioning YF,
    - CFR.

Pillar 3 Response actions: Community protection
Scenario 1

- ☐ Responders, experts and authorities must quickly assess and understand the behaviours, fears, concerns, perceptions and views of those affected, and tailor their interventions and messages to address such concerns. This approach requires the use of social and behavioural science and community engagement expertise and methods.
- ☐ Use social and behavioural insights and data to inform communications and behavioural interventions that target specific prevention and protection behaviours and their barriers. Focus should be put on understanding and targeting vulnerable and marginalized groups.
- ☐ It is important to continuously evaluate strategies and interventions in specific contexts. Evaluation can generate useful data and insights to refine and

contextualize a strategy or intervention for greater health impact. Evaluation should be documented and shared to build evidence.

- ☐ Authorities, experts and response teams must quickly relay information on the nature of the event and the protective measures that people can take. Mass media including television, radio, newspapers and internet can be used, as well as social media; community radio; leaflets and posters. Social mobilizers and frontline responders can relay information. Encourage community engagement as well as face-to-face communication via trusted interlocutors such as community leaders, religious figures and community health workers.
- ☐ Predeveloped messages can be adapted to current situation and needs.
- ☐ Early, transparent and understandable communication on the event establishes lines of dialogue with affected populations and stakeholders. It builds trust in the response. This communication must have facts and information and also include messages that acknowledges and responds to people's concerns and fears.
- ☐ Frequent and evolving communication will keep people updated on the situation and what is being doing, and will help deliver effectively advice on protective behaviours that populations can adopt. Communication must propose practical actions people can take: vaccination (where, when), when and where to seek medical treatment, protection against mosquito bites, and larval source management (practical actions that can be taken at home).
- ☐ Communication on YF transmission, protection, health care seeking, and larval source management can be integrated in home visits conducted as part of the epidemiological and entomological investigations.
- ☐ Disease outbreaks are often accompanied by the presence of false rumours and misinformation. Responders need to have ways to listen to such misinformation and correct examples of it in appropriate ways without delay.
- ☐ House-to-house mobilization actions will be required the day before insecticide spraying activities to sensitize the community to the importance of the activity.

Pillar 4 Response actions: Clinical care

Scenario 1

- ☐ Ensure update guidance on clinical management of arboviral diseases is made available to clinicians handling the patient(s) with YF.
- ☐ Key messagings on detection of cases should be extracted from the guidelines to use as job aids and SOPs in facilities.
- ☐ Search for other potential cases in the area of residence of the imported case.
- ☐ Apply infection prevention and control (IPC) measures:
    - Vaccination: YF vaccination should be provided to health workers not previously vaccinated.
    - Vector control (See Pillar 6): protect patient with YF from further exposure to mosquitoes by asking patient to stay indoors and/or under a mosquito net (especially during the day) for up to 5 days after the onset of fever. Health facilities should provide insecticide-impregnated mosquito nets for patients. Vector control measures around health facilities aim at reducing *Ae. aegypti* population and keeping density very low.
    - Isolation: patients with YF do not require to be isolated.

- Standard precautions: when caring for patients with YF, health workers should adhere to standard IPC precautions recommended for all patients. The use of additional transmission-based precautions are not necessary once YF is confirmed since the mode of transmission is vector-borne.

☐ In patients presenting with symptoms, collect blood samples and send to the laboratory with YF capacity for laboratory diagnosis. If result is positive, inform relevant authorities (See Pillar 2).

Pillar 5 Response actions: Vaccination
Scenario 1

☐ Determine target population for reactive vaccination campaign. Vaccination should target individuals aged 9 months and older up to 59 years in priority around the imported YF case and other localities with presence of *Ae. aegypti* where the patient stayed during the viraemic phase.

☐ **Plan the vaccination strategy**:
- Consider the most appropriate methods for the context (e.g., mobile and fixed points, door-to-door campaigns),
- Consid the eventual use of fractional doses according to SAGE recommendations,
- Develop vaccination operational plan, determine material and human resources and develop a budget to cover operational costs.

☐ **Establish strong coordination mechanisms**:
- Ensure clear communication flow between national, state, and local levels,
- Allocate responsibilities and resources for the successful execution of the campaign,
- Manage resources effectively to ensure the campaign's success.

☐ **Enhance and strengthen surveillance of AEFIs** to guarantee proper reporting, investigation, causality assessment, and classification of cases suspected to AEFI.

☐ **Estimate vaccine requirements** and necessary supplies by:

☐ Calculating the number of syringes, cold chain equipment, and protective materials needed,

☐ Ensuring adequate stockpiling and distribution.

☐ Gavi-supported countries can request funds to cover the operational costs of a campaign (as determined under Gavi policy for vaccine in consultation with all stakeholders/partners.

☐ To access the emergency YF vaccine stockpile managed by the International Coordinating Group (ICG) on vaccine provision, the country should submit fill and submit an ICG request form for YF vaccine, annexes and other required documents as per the checklist in the request form to the ICG Secretariat (WHO Geneva). It is highly recommended that the country submits the request to the ICG secretariat within 7 days after confirmation of the outbreak. The ICG secretariat at WHO then circulates this request to the members (IFRC, MSF, UNICEF, and WHO) for review and assessment within 1 day after receiving the country request.

☐ The country should implement the reactive vaccination campaign within 10 days after receiving the vaccines.

- ☐ Communities living near the border areas of the affected urban area should be informed of ongoing YF transmission and ensured protection through vaccination if the vaccination coverage is <80%.
- ☐ Conduct an active search for unvaccinated individuals and carry out focal vaccination, and/or refer them to the appropriate health unit and expand the vaccination outreach area, based on the location of probable infection and new suspected events detected.
- ☐ Conduct post-vaccination campaign coverage survey to determine vaccine coverage, with disaggregated data by sex and age groups and special populations.

Pillar 6 Response actions: Vector control
Scenario 1

- ☐ Representative of the Vector control division or equivalent at city and national levels should be included in the multisectoral team emergency response team (see Pillar 1).
- ☐ Refer to national decision algorithm (see examples in Annex 3). The first step is to define the scope of the intervention according to the scenario, here isolated case. Patient can be contacted to confirm the accuracy of the addresses received. Once a perimeter has been defined, provisional mapping is carried out, integrating environmental data available.
- ☐ If entomological data is available in the area concerned (e.g. from resting adult traps), it can be used to initiate actions to confirm the presence of vectors.
- ☐ If the reported case is within an active transmission focus, data on previous control actions can be integrated into the mapping.
- ☐ Conduct a home visit for focal treatment and health education on YF transmission and protection.
- ☐ Vector control measures should start during the field entomological investigation around the first YF urban case (see Pillar 2) following national guidelines for vector control. If the presence of the vector is confirmed, the field entomology teams physically eliminate as many productive breeding sites as possible, ideally on both public and private land,within the perimeter of the investigation. District-level community-based source reduction is critical.
- ☐ If adulticide treatment proves necessary, field agents carry out an information campaign in the area to be treated, distributing leaflets and posters specifying the date and time of treatment, as well as instructions for limiting exposure to insecticide products (see Pillar 3)
- ☐ Emergency action to reduce significantly population of *Ae. aegypti* and protect patients against bites should be taken in the environment of hospitalized cases. (see Pillar 4)
    - Vector control activities which could include residual or spatial application of insecticide may be needed in the household of the imported case and immediate vicinity, as well as other settings where the imported case stayed during the viraemic period.
    - Use of bednets.

Pillar 7 Response actions: Points of entry
Scenario 1

- ☐ IHR implementation should be strengthened with emphasis on point on entry requirements, with proof of the international certificate of vaccination by all travellers and visitors coming from high-risk countries, including the country of probable contamination of the imported case.
- ☐ Apply the IHR Decision Algorithm (Annex 2): notification of confirmed YF case in this context justifies notification to WHO. Even if notification under IHR annex 2 is not required, WHO country office should be informed. Moreover, risk assessment of the situation needs to be pursued as the situation evolves.
- ☐ In link to the national surveillance system, implement health surveillance at ports, airports, and borders for travellers coming from the country of probable contamination of the imported case.

Annexes

Annex 2 Steps to confirm urban transmission cycle of yellow fever

Several criteria can be considered to confirm the presence of urban transmission cycle:

- Lack of travel to enzootic/epizootic areas for at least 3 weeks prior to disease onset
- Secondary transmission by *Aedes aegypti* within the community after detection of an index case
- Widespread *Ae. aegypti* infestation
- Yellow fever (YF) virus isolation from *Ae. aegypti*

To confirm the urban transmission cycle of YFV, which involves transmission through infected *Ae. aegypti* mosquitoes, the following actions are typically undertaken:

Epidemiological investigation:

- Case identification: Conduct active case search, identify and confirm human cases of YF through clinical diagnosis and laboratory testing (e.g. serology for IgM antibodies, PCR for viral RNA).
- Investigate travel history in confirmed cases.
- Case mapping: Map the locations of confirmed cases to identify clusters and potential transmission hotspots.

Entomological investigation:

- Breeding site identification: Identify and map breeding sites of *Ae. aegypti* mosquitoes in the affected urban areas.
- Mosquito collection: Collect *Ae. aegypti* mosquitoes from areas with confirmed human cases using traps and other collection methods.
- Virus detection in mosquitoes: Test the collected mosquitoes for YFV using techniques like PCR to detect viral RNA.

Data analysis and confirmation:

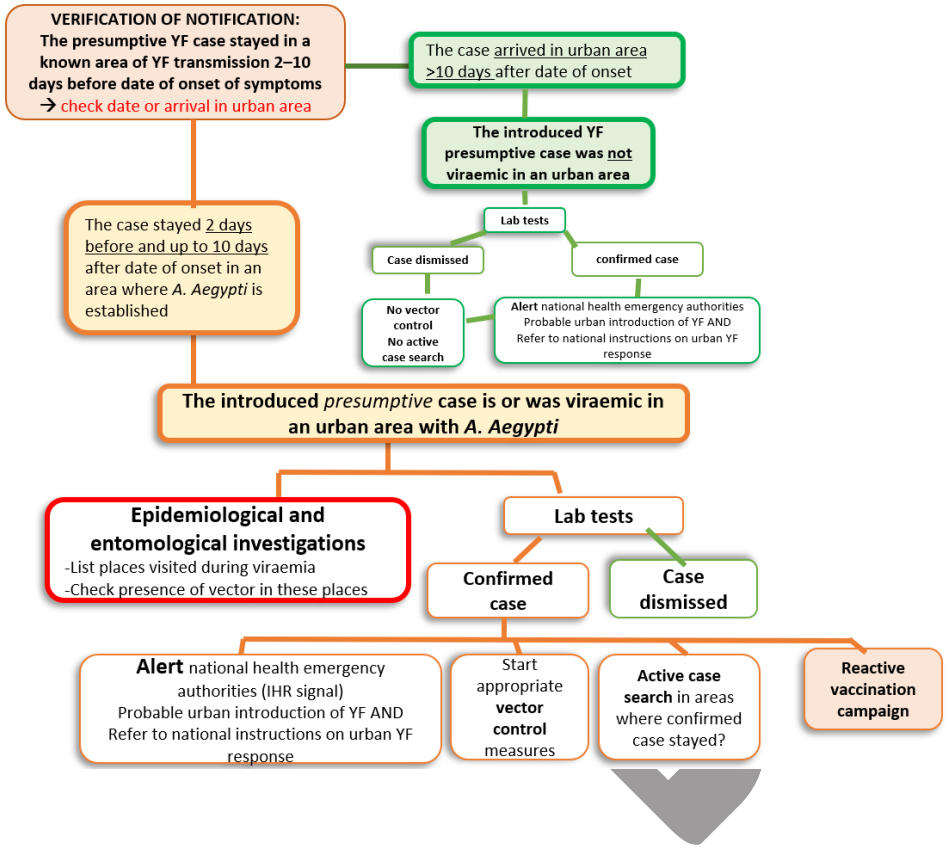
- Analyze case distribution per time, place, likely place of infection (imported/locally infected).
- Confirmation of urban cycle: confirm the urban transmission cycle if the following criteria are present:
  From epidemiological investigation:
  - Lack of travel to enzootic/epizootic areas for at least 3 weeks prior to disease onset
  - Secondary transmission by *Ae. aegypti* within the community after detection of an index case

  From entomological investigation:
  - Widespread *Ae. aegypti* infestation
  - YFV isolation from *Ae. aegypti*

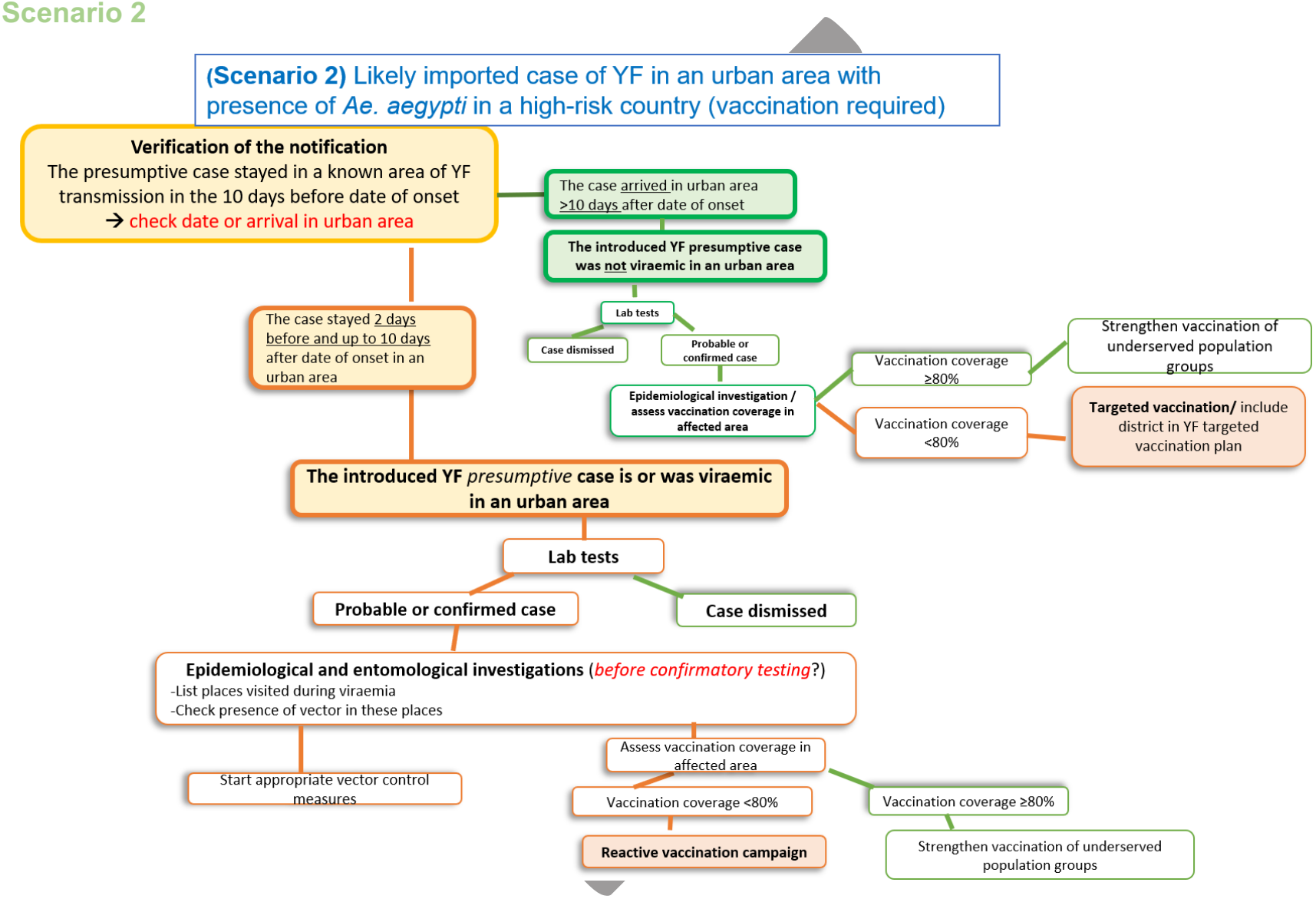
Annex 3 Examples of decision algorithms for urban yellow fever

Scenario 1

(Scenario 1) Likely imported case of YF in an unprotected (unvaccinated) population in an urban area with presence of *Ae. aegypti* in a country with a moderate or potential risk of YF

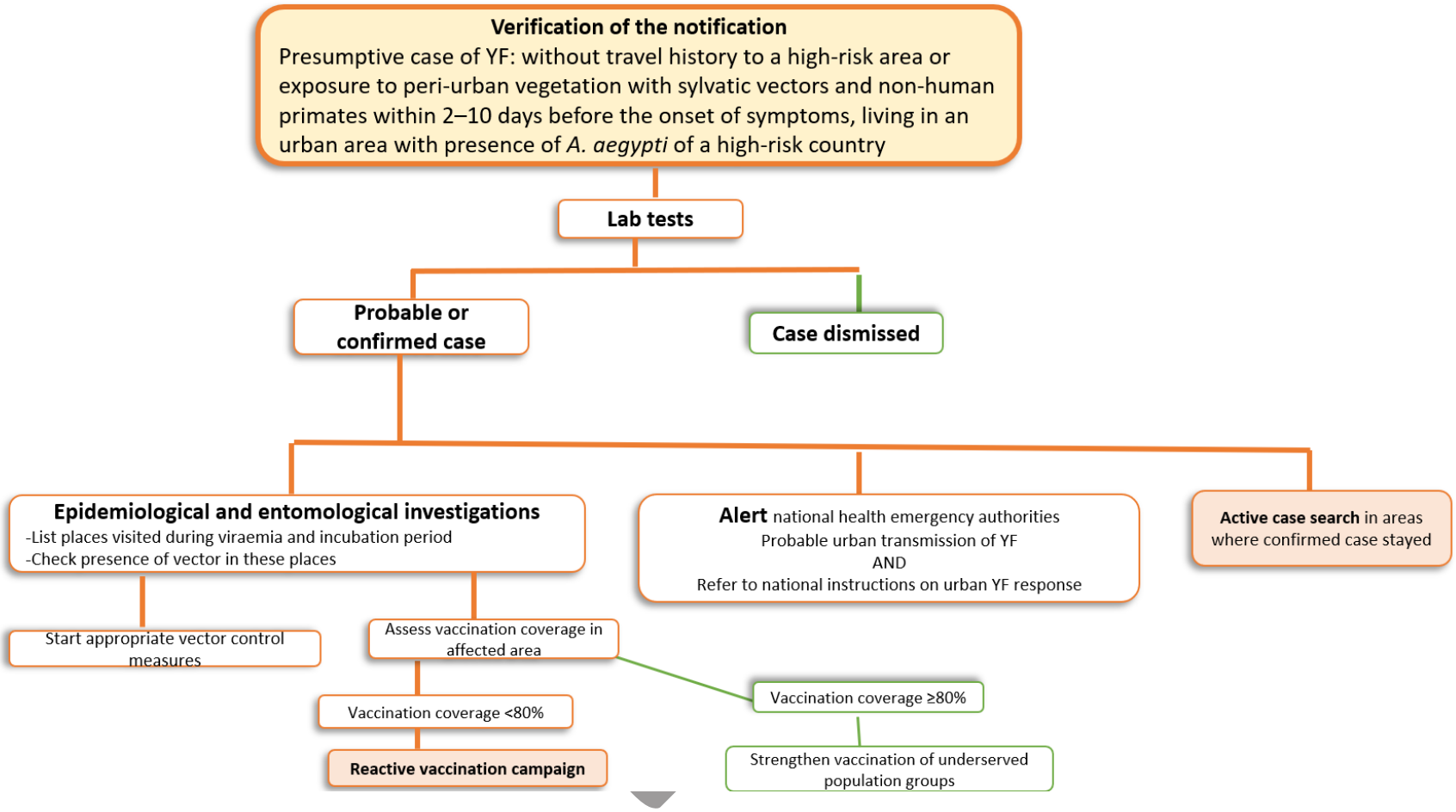


Scenario 2


(Scenario 2) Likely imported case of YF in an urban area with presence of Ae. aegypti in a high-risk country (vaccination required)
Verification of the notification
The presumptive case stayed in a known area of YF transmission in the 10 days before date of onset
→ check date or arrival in urban area
The case arrived in urban area >10 days after date of onset
The introduced YF presumptive case was not viraemic in an urban area
Lab tests
Case dismissed
Probable or confirmed case
Epidemiological investigation / assess vaccination coverage in affected area
Vaccination coverage ≥80%
Strengthen vaccination of underserved population groups
Vaccination coverage <80%
Targeted vaccination/ include district in YF targeted vaccination plan
The case stayed 2 days before and up to 10 days after date of onset in an urban area
The introduced YF presumptive case is or was viraemic in an urban area
Lab tests
Probable or confirmed case
Case dismissed
Epidemiological and entomological investigations (before confirmatory testing?)
-List places visited during viraemia
-Check presence of vector in these places
Start appropriate vector control measures
Assess vaccination coverage in affected area
Vaccination coverage <80%
Reactive vaccination campaign
Vaccination coverage ≥80%
Strengthen vaccination of underserved population groups

Scenario 3

(Scenario 3) More than 1 confirmed case of YF with epidemiological evidence of urban transmission in a high-risk country (vaccination required)



Scenario 4

(Scenario 4) Evidence of YF viral circulation (YF confirmed cases and/or confirmation of a YF epizootic and/or virus confirmation of YF infected mosquitoes) in forest patches surrounding an urban area with presence of Ae. aegypti in a high-risk country (vaccination required).