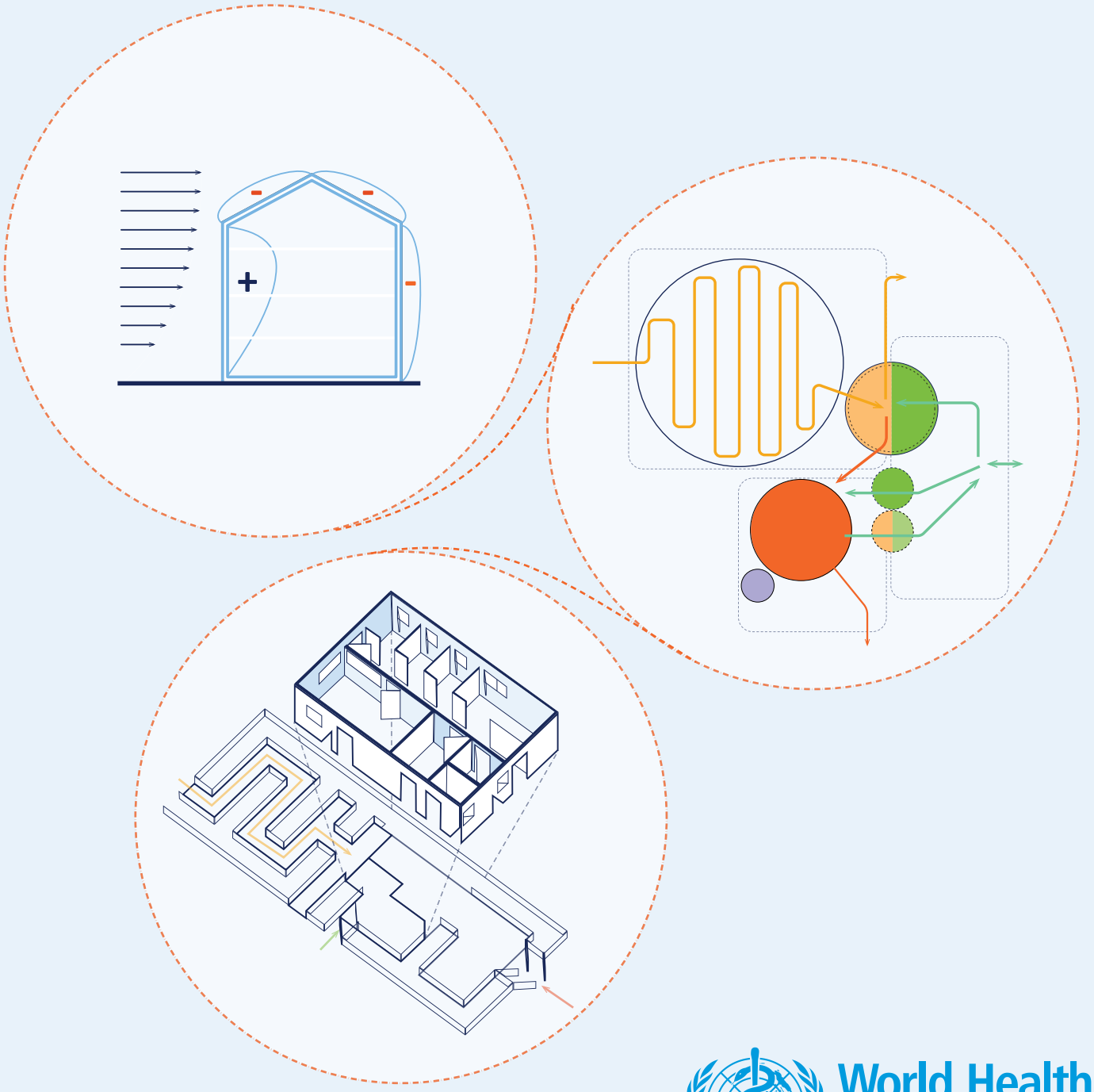
Practical manual to design, set up and manage severe acute respiratory infections facilities



World Health Organization

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This publication is the update of the document published in 2020 entitled "*Severe acute respiratory infections treatment centre: practical manual to set up and manage a SARI treatment centre and a SARI screening facility in health care facilities*".

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Contents

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The WHO/HQ/WHE Health & Technical Logistic team led the work of this publication drafting the contents, coordinating the Technical Advisory Group meetings and the documents reviews, ensuring the WHO procedure was respected. The groups of external experts and the WHO secretariat have contributed as part of the Technical Advisory Group. The members have participated to regular meetings and regular reviews during the development of the manuscript contents. Eventually, the external reviewers have reviewed the first complete draft contributing in the improvement of the manuscript. All members of the Technical Advisory Group and the External Review Group completed and signed the declaration of interests (DOIs) forms. Web searches did not identify any additional interests that could be perceived to affect individual objectivity and independence during the development of the document. No member was judged to have a significant conflict of interest.

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Abbreviation

ACH	Air changes per hour
GUV	Germicidal ultraviolet
IHR	International Health Regulations
IPC	Infection prevention and control
MERS-CoV	Middle East respiratory syndrome coronavirus
SARI	Severe Acute Respiratory Infection
SARS-CoV-1	Severe Acute Respiratory Syndrome Coronavirus 1
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2
UNICEF	United Nation Children's Fund
WHO	World Health Organization

Glossary

Access/Entry to health system	In the context of this document, the first point of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings should have screening capacity to ensure early detection of suspected cases.
Clean items	In the context of this document, the adjective 'clean' is associated with 'items' that come from low-risk areas or that have been reprocessed, cleaned and/or disinfected.
Community facility	Community facilities, (e.g. stadium, gymnasium, hotel) is intended to cohort patients with mild or moderate symptoms to monitor their illness and to reduce the spreading of the disease *(1)*.
Dirty or soiled items	In this document, the adjectives 'dirty' or 'soiled' are associated with 'items' that come from high-risk areas. Specific PPE and procedures are needed to handle these items.
High-risk area or zone	In the context of this document, high-risk areas or zones are spaces where the pathogen is very likely to be found.
Home care	In this document, home care is the process of isolating and treating patients at home.
Home quarantine	Home quarantine is the restriction of activities or the separation of persons who are not ill but who may have been exposed to an infectious agent or disease, with the objective of monitoring their symptoms and ensuring the early detection of cases.
Low-risk area or zone	In the context of this document, low-risk areas or zones are spaces where the pathogen is NOT likely to be found.
Non-SARI pathway	Persons that do not meet the case definition for suspected SARI enter the non-SARI pathway *(2)*.
Point of Entry and Border Health	The International Heath Regulations (IHR, 2005) define a point of entry (border health) as "a passage for international entry or exit of travellers, baggage, cargo, containers, conveyances, goods and postal parcels, as well as agencies and areas providing services to them on entry or exit". There are three types of points of entry: international airports, ports and ground crossings *(3) (4)*.
Quarantine facility	The physical space where persons are quarantined. The quarantine of persons is the restriction of activities or the separation of persons who are not ill but who may have been exposed to an infectious agent or disease, with the objective of monitoring their symptoms and ensuring the early detection of cases. Quarantine is different from isolation, which is the separation of ill or infected persons (confirmed cases) from others to prevent the spread of infection or contamination *(5)*.
SARI	Severe Acute Respiratory Infection
SARI pathway	Persons with symptoms that meet the case definition for suspected SARI enter the SARI pathway *(2)*.
SARI treatment centre or ward	In the context of this document, the physical spaces where patients known or suspected to be infected with SARI receive care.
Screening	It is the process to evaluate whether people meet a standardized case definition *(2)*.
Triage	This refers to the sorting of patients by priority after screening, based on specific criteria (i.e., severity) and can be performed at any point of access to the health care system, including in both pre-hospital and facility-based settings *(2)*.
Uncategorised risk area	In the context of this document, any space not listed as SARI facility or outside the SARI facility.
User	In the context of this document, any person except health professionals and patients.

Executive summary

Context

The response to the COVID-19 pandemic required the construction of dedicated health care infrastructure such as treatment wards and centers, quarantine and screening facilities. To inform the planning and design of those facilities, in March 2020 the interim guidance *"Severe Acute Respiratory Infections Treatment Centre. Practical manual to set up and manage a severe acute respiratory infection (SARI) treatment centre and a SARI screening facility in health-care facilities"* was published.

The decision to develop a new edition to replace the interim guidance was driven by evolving public health strategies, advancements in treatment and care, and lessons learned over the last three years. Moreover, beyond the immediate response to the pandemic, there is a growing emphasis on building a health infrastructure that is sustainable and capable of responding to future outbreaks.

This new edition of the guidance includes considerations for making health care facilities adaptable to other Severe Acute Respiratory Infections besides SARS-CoV-2. This document, with a specific focus on the built environment and, in particular, health care facilities, intends to guide the audience in preparing for and responding to SARI pandemics that can be caused by existing and novel pathogens.

Methods

The development process of this document included several stages: defining the main gaps and new contents compared to the interim guidance published in 2020, identify the new evidence through literature review and formulate the recommendation for the manual. The process also required the establishment of the Technical Advisory Group (TAG) which constituted an ad-hoc advisory panel supporting WHO's World Health Emergencies preparedness, readiness and response to COVID-19. Review of the most recent WHO publications on SARI and COVID-19, scoping review of health facilities design guidelines, and scoping review focused on indoor ventilation have provided the evidence at the base of this work. Eventually, the group of external reviewers have reviewed the first complete draft, contributing in the improvement of the manuscript.

Outcomes

This process resulted in a manual organized into three sections. The 'Fundamentals' section includes the theoretical and scientific background that informs design choices for creating a functional and resilient health facility in response to different epidemic phases. The 'Design Principles' section presents the main design strategies, facility requirements, functioning, and the principles behind the layouts. Finally, the 'Implementation of SARI Facilities' section showcases examples of various facility layouts. This manual encompasses several types of facilities, including new constructions, existing buildings that can be repurposed, existing health facility wards that can be converted, temporary tent solutions, and medium-term solutions built with local materials. It includes new recommendations related to improvements in screening, triage, treatment centre design and set-up, quarantine measures, and the integration and use of community facilities.

Introduction

Summary

The COVID-19 (SARS-CoV-2) pandemic strengthened our understanding of how the physical structures of hospitals and other health care facilities are critically important and potentially modifiable determinants of Severe Acute Respiratory Infection (SARI) prevention, treatment and care**.** These facilities faced extraordinary challenges in responding to the demands of the pandemic and the need to address hospitalization surge capacity, manage the increasing number of cases and keep other services functioning. Some constructed new temporary SARI treatment centres, while others opted to repurpose existing buildings into treatment centres, quarantine and community facilities. This publication is intended to replace the interim guidance "*Severe Acute Respiratory Infections Treatment Centre. Practical manual to set up and manage a severe acute respiratory infection (SARI) treatment centre and a SARI screening facility in health-care facilities*" published in March 2020. It builds on lessons learned from these field experiences, as well as new scientific evidence. It also provides updated technical recommendations for setting up facility infrastructures to better manage infections from current SARI threat and other new respiratory pathogens that may circulate in the future. To this end, it includes new recommendations related to improvements in screening, triage, treatment centre design and set-up, quarantine measures, and the integration and use of community facilities. This publication builds from lessons learned from COVID-19, however the presented principles cover broader SARI infections, as presented in the next paragraph.

Respiratory pathogens

The two pandemics of the 21st century, influenza A (H1N1) in 2009 and COVID-19 (SARS-CoV-2) in 2019 have highlighted the significant health, social, and economic risks posed by respiratory pathogens *(6)*.

A wide variety of bacterial, fungal and viral pathogens can cause severe acute respiratory infections. However, respiratory viruses warrant special attention. Typically they have short incubation periods and can spread easily among people and possibly animals through contact, direct deposition and airborne via infectious respiratory particles of various sizes. These viruses can cause super-spreading events and they demonstrate a tendency for both symptomatic and asymptomatic transmission highlighting the important role of non-pharmaceutical interventions. As we learned, during the COVID-19 (SARS-CoV-2) pandemic, their rapid propagation can result in high morbidity and mortality rates that may potentially overwhelm health care systems and mortuary services.

Due to the characteristics of the respiratory viruses (e.g. super spreading events, symptomatic and asymptomatic transmission, etc.) it can be difficult to contain and detect these pathogens. This can lead to the rapid spread of the pathogens globally. Table 1 lists virus families whose characteristics makes them potential respiratory pandemic pathogens.

Table 1. Potential respiratory pandemic pathogens.

Virus Family	Known Pathogens	Relevance
Orthomyxovirus	Influenza	Most common pathogen historically known to cause a pandemic, including four in the 20th and 21st centuries A(H1N1) in 1918, A(H2N2) in 1957, A(H3N2) in 1968 and A(H1N1) in 2009.
Coronavirus	SARS-CoV-1, SARS-CoV-2, MERS-CoV	Caused the COVID-19 (SARS-CoV-2) pandemic and large epidemics of SARS (SARS-CoV-1) and Middle East Respiratory Syndrome Coronavirus (MERS-CoV). SARS-CoV-2 is capable of asymptomatic and pre-symptomatic transmission through contact, mucosa deposition, and inhalation. High rate of virus evolution.
Respirovirus	Human parainfluenza viruses 1 and 3	Highly contagious with a range of severity of illness. No countermeasures are currently available.
Henipavirus	Nipah	Zoonotic origin with limited human-to-human spread, but very high mortality. No countermeasures are currently available.
Rubulavirus	Human parainfluenza viruses 2 and 4	Highly contagious with a range of severity of illness. No countermeasures are currently available.
Enterovirus	EV-D68, EV-D71	Highly contagious with a range of severity of illness. No countermeasures are currently available.
Rhinovirus	Human rhinovirus C	Highly contagious with a range of severity of illness. No countermeasures are currently available.
Pneumovirus	Human respiratory syncytial virus	Highly contagious with a range of severity of illness. No countermeasures are currently available

Source: https://www.gpmb.org/reports/m/item/preparedness-for-a-high-impact-respiratory-pathogen-pandemic

Purpose, scope and audience

This publication provides technical guidance on the design, establishment, and management of health care facilities that deal with severe acute respiratory infections including: point of entry (border health), entry to health system facilities, treatment centres and treatment wards, quarantine and community facilities, home care and home quarantine. Design strategies and proposals, included in this manual, encompass several types of facilities such as new constructions and existing buildings that can be repurposed, existing health facility wards that can be converted, temporary tent solutions and medium-term solutions built with local materials. Additionally, the document provides recommendations on when different SARI facilities are necessary, based on specific transmission scenarios.

This document serves as a resource for a range of professionals *(7)* such as health professionals, health associate professionals, personal care workers in health, health management and support personnel, health facility designers and planners, logisticians, and water and sanitation experts. Its purpose is to assist these professionals in:

- developing specific national health facility standards relevant to SARI outbreak preparedness, readiness and response in different contexts;
- supporting the application of national standards and establishing specific targets in particular SARI facility settings;
- assessing the environmental health and engineering standards in existing SARI facilities to evaluate the extent to which they achieve or fall short of national plans and local targets;
- ensuring that the construction of new SARI facilities is of acceptable quality; and
- preparing and implementing comprehensive and realistic action plans in order to achieve and maintain acceptable conditions.

Methods and document structure

The manual describing SARI facilities "*Severe Acute Respiratory Infections Treatment Centre Practical manual to set up and manage a SARI treatment centre and a SARI screening facility in health care facilities*" was published in March 2020. It provided guidance on how to appropriately design, install and run a SARI facility, based on the available knowledge at that time.

In developing this new manual on SARI facilities, the Technical Advisory Group (TAG) agreed on the main updates based on the new evidence available, the lessons learned from the field, and the more frequent requests of support from the WHO Regional and Country offices concerning health care facilities during the COVID-19 pandemic. The TAG identified practical needs and expected outcomes, gathered evidence, assessed and synthesized the evidence, and finally, formulated and planned the dissemination and implementation of this knowledge. The following reviews supported the production the new contents of this manual:

- review of the updated existing WHO publications on SARI and COVID-19, performed in October 2022 and December 2023
- scoping review of health facilities design guidelines, performed in October 2022 and updated in December 2023
- scoping review focused on ventilation (requirements, estimation formulas, characteristics of the different ventilation systems), performed between November 2022 and June 2023.

The outcome of this process is the new publication *"Severe Acute Respiratory Infection facilities. Practical manual to design, set up and manage SARI facilities"* that include broader and updated information, compared to the interim guidance of March 2020 (see Box 1).

Box 1. What's new in this manual

Compared to existing interim guidance *"Severe Acute Respiratory Infections Treatment Centre Practical manual to set up and manage a SARI treatment centre and a SARI screening facility in health care facilities"* published in March 2020, this manual includes the following elements.

- Broader typology of facilities such as point of entry (border health), community facility, quarantine facility, physical spaces for home care and home quarantine.
- More comprehensive design strategies for new and existing facilities that can be repurposed into SARI facilities (including both health care facilities and facilities with a different purpose).
- More current review based on updated WHO publications.

The development and assessment of this publication included the establishment of a Technical Advisory Group and an External Review Group. These were created according to WHO policies and procedures. The Technical Advisory Group was an ad hoc advisory panel set up to support WHO World Health Emergencies preparedness, readiness and response to COVID-19 and included the following stakeholders (see also acknowledgments):

- members of the Environment and Engineering Control Expert Advisory Panel (ECAP) for COVID-19;
- engineers and architects from relevant professional networks;
- organizations and institutions specialized in health care settings; and
- WHO staff and consultants from different departments including Emergency Medical Teams, Infection Prevention and Control, and Operations Support and Logistics.

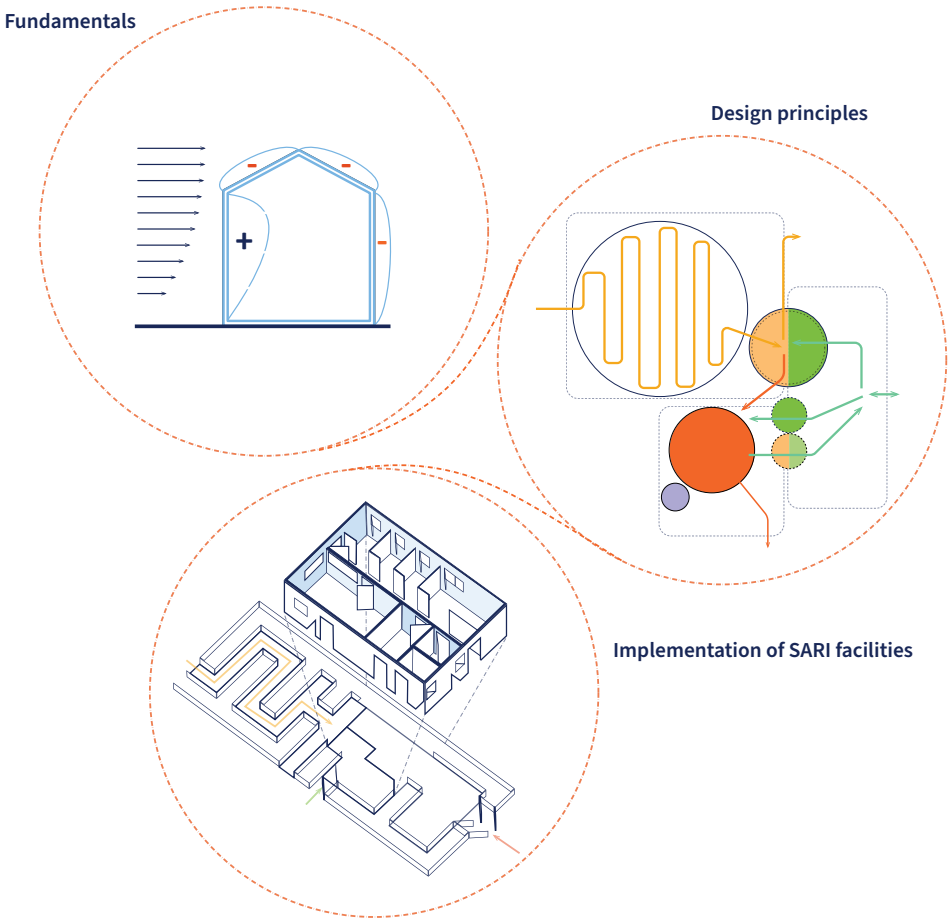
The External Review Group included representatives of ministries, NGOs, universities and professional federations.

The structure and contents of this document have been co-created with the Technical Advisory Group and reviewed by the External Review Group (see Box 2).

Box 2. **Organisation of the Second Edition of the SARI Facilities Manual**

This manual is divided into three sections.

- **Fundamentals**. This section presents the theoretical and scientific background that informs the design and the functioning of a facility.
- **Design principles**. This section presents the main design strategies, facility requirements, facility functioning and design principles behind the layouts.
- **Implementation of SARI facilities**. This section presents examples of various facility layouts.



Fundamentals

1. Managing the epidemic

The changing global environment, with multiple challenges posed by climate change, rapid population growth, unplanned urbanization and a growing global interconnectedness, has led to increased occurrences of emerging and re-emerging infectious diseases. Some of these diseases have the potential to rapidly spread around the world, as evidenced by the COVID-19 pandemic. Outbreaks and health emergencies can happen anywhere and at any time. This means that all countries should aim to strengthen and maintain adequate capacities and effectively progress through the cycle of prevention, preparedness, response and recovery from public health threats. This cycle (Fig. 1) illustrates the continuous process that all organizations and governments should follow to reduce the impact of health emergencies *(8)*.

No step is more important than any other: WHO invests in prevention and preparedness as much as in response and recovery, with an emphasis on rehabilitation. Prevention and preparedness can pre-emptively avoid outbreaks, or contain them early on, reduce the possibility of community transmission, and mitigate the impact on societies.

Placing countries at the heart of all preparedness activities ensures that when a crisis strikes, all necessary elements are already in place.

By strengthening preparedness and response capacities, as defined by the International Health Regulations (IHR) *(3)*, countries can enhance health system resilience and ability to provide universal health coverage. When health systems are strengthened, they are better positioned to

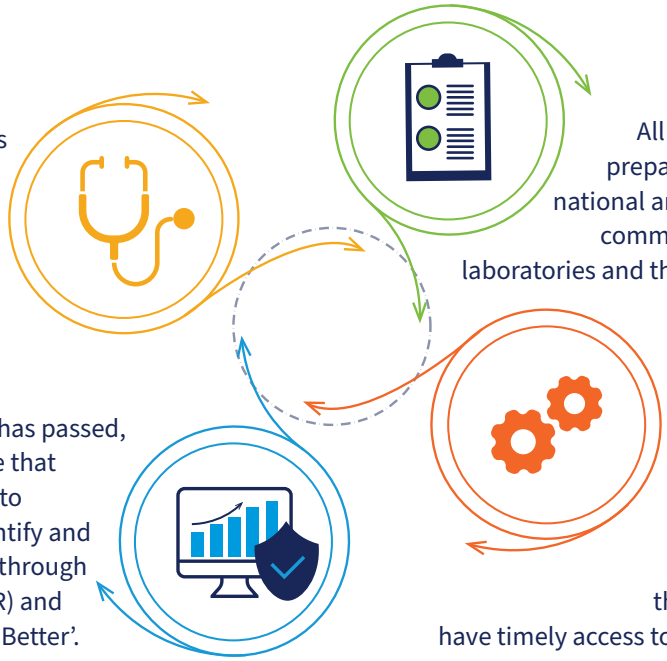


Fig. 1. Emergency cycle

Source: WHO/Europe | Health emergencies – Emergency cycle. https://www.who.int/europe/emergencies/emergency-cycle (2021)

implement the IHR effectively. Well-managed response operations deliver life-saving health interventions to ensure people have timely access to quality health services, and these operations link directly to the recovery stage when the immediate crisis is past. WHO supports countries to learn from each emergency event and to 'Build Back Better' in their wake, further strengthening their health systems for future health crises.

This manual is focused on the structures. However, a holistic preparedness, readiness and response strategy as well as an effective surge plan, must consider other elements such as the availability of essential supplies, trained staff, a functional system, and proper (bio) security and safety plans. Each one of these points represent an essential gear in the emergency cycle mechanism. This 5s strategy (Fig. 2) requires a multidisciplinary approach and effective coordination across the different pillars involved in emergency preparedness and response.

1.1 SARI care pathway

This document refers to the SARI care pathway *(2)*, also called SARI pathway or SARI patient journey in other documents (Annex 1). Patients enter this interdisciplinary care pathway when screened for SARI and identified as a suspect SARI case. They remain on this pathway through their continuum of care until released. The objective throughout the pathway is to ensure the delivery of safe and quality care while stopping onward viral transmission (2). All patients who do not meet the case definition enter the health system through the non-SARI pathway.

Fig. 2. The 5s strategy.

Source: Operations Support and Logistics (OSL) Standard Operating Procedures (SoPs) for emergencies

1.2 Epidemic phases and stages of intervention

New infectious disease threats typically originate locally. It is crucial to comprehend their dynamics to prevent further spread and avoid overwhelming health systems. Epidemic and pandemic diseases generally unfold in four phases, although not all epidemic diseases necessarily undergo each phase. The first phase includes the introduction or emergence in a community. The second phase is characterised by an outbreak with localized transmission, where sporadic infections with the pathogen occur. The third phase is entered when the amplification of the outbreak becomes an epidemic or pandemic. In this phase, the pathogen can transmit from human to human and causes a sustained outbreak in the community and beyond. The fourth phase is marked by reduced transmission, wherein human-to-human transmission of the pathogen decreases, either due to acquired population immunity or effective interventions to control the disease *(9)*. These four phases are illustrated in Fig. 3.

The dynamics of epidemics, as described above, delineate the response and the sequence of interventions required. Further details in Table 2.

1.3 Operational strategies for epidemiological scenarios

Table 2 describes the dynamics of epidemics and delineates country response options and the sequence of interventions, only regarding SARI-related facilities. Countries could experience one or more of these scenarios at the sub-national level and should define the transmission scenario and response actions at the lowest administrative level. Transmission scenarios may also move in both directions, such as “No cases” includes both never having had a SARI case and having no active cases. Countries should be prepared to respond to all transmission scenarios, following a specific framework. For instance, a useful action plan can be found within the Strategic Preparedness and Response Plan for COVID-19 *(10)*. Prioritization of resources for each technical area will depend on which transmission scenario(s) a country is managing. Early detection and surveillance of SARI disease cases could be improved by enhancing laboratory facilities and diagnostic capability. Table 2 describes the facilities and relative actions needed for preparedness, readiness and response for each transmission scenario.

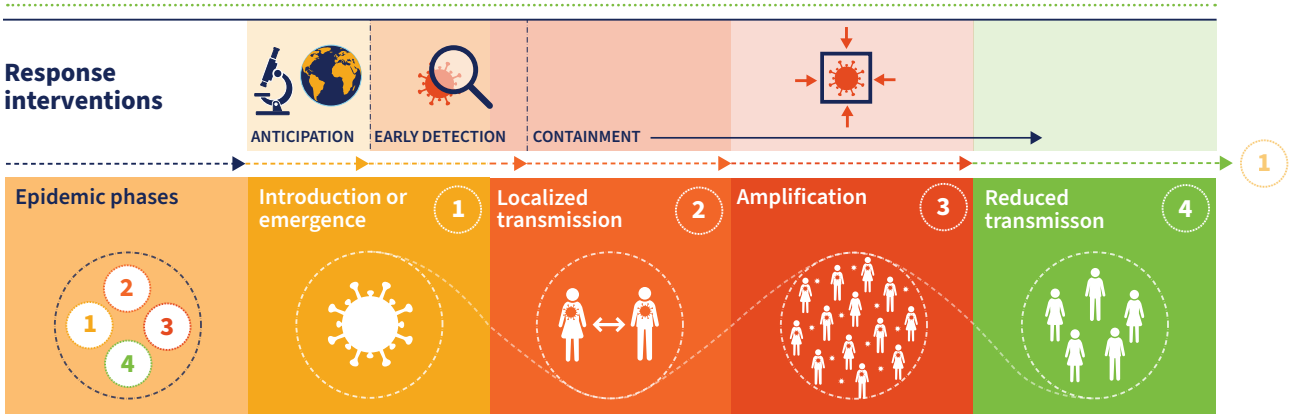


Fig. 3. Epidemic phases and stages of intervention

Source: World Health Organization, “Managing epidemics Key facts about major deadly diseases,” 2018. [Online]. Available: https://www.who.int/emergencies/diseases/managing-epidemics/en/

Table 2. Structures and relative actions needed for preparedness, readiness and response for each transmission scenario

Transmission scenario	NO CASES	SPORADIC CASES	CLUSTERS OF CASES	COMMUNITY TRANSMISSION
	No reported cases.	One or more cases imported or locally detected, without evidence of local transmission.	Cases limited to well-defined clusters, related by time, geographic location and common exposures.	Outbreaks with the inability to relate confirmed cases through chains of transmission for a large number of cases, or by increasing positive tests through sentinel samples (routine systematic testing of respiratory samples from established laboratories.
Aim	Early identification and prevent spread.	Suppress transmission and prevent spread.	Suppress transmission and prevent spread.	Suppress transmission, reduce case numbers, end community outbreaks.
Immediate implementation of SARI facilities	**Point of entry and border health** Identify and set up operational point of entry at international airports, ports and ground crossings. Design principles – Layout **Entry to health system facility** Set up screening and triage at all points of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings. Design principles – Layout	**Point of entry and border health** Identify and set up operational point of entry at international airports, ports and ground crossings. Design principles – Layout **Entry to health system facility** Set up screening and triage at all points of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings. Design principles – Layout **SARI designated wards in health facilities** Set up wards for SARI patients within existing health facilities. Design principles – Layout	**Point of entry and border health** Identify and set up operational point of entry at international airports, ports and ground crossings. Design principles – Layout **Entry to health system facility** Set up screening and triage at all points of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings. Design principles – Layout **SARI designated wards in health facilities and/or setting up of dedicated SARI treatment centres** Set up wards for SARI patients within existing health facilities and/or set up new treatment centre in temporary facilities. Design principles – Layout **Home care and home quarantine** Patients with mild and moderate illness who don't require hospitalization could be treated at home. Design principles	**Point of entry and border health** Identify and set up operational point of entry at international airports, ports and ground crossings. Design principles – Layout **Entry to health system facility** Set up screening and triage at all points of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings. Design principles – Layout **SARI designated wards in health facilities and/or setting up of dedicated SARI treatment centres** Set up wards for SARI patients within existing health facilities and/or set up new treatment centre in temporary facilities. Design principles – Layout **Home care and home quarantine** Patients with mild and moderate illness who don't require hospitalization could be treated at home. Design principles **Quarantine Facility** Set up a dedicated quarantine facility within existing buildings or in new and temporary facilities. Design principles – Layout **Community Facility** Set up a dedicated community facility within existing building or in new and temporary facilities. Design principles – Layout
Prepare for next scenario	**SARI designated wards in health facilities** Identify wards for SARI patients within existing health facilities.	**SARI treatment centres** Identify space within existing health facilities to accommodate surge capacity or prepare to set up a dedicated SARI treatment centre. **Home care and home quarantine** Patients with mild and moderate illness who do not require hospitalization could be treated at home.	**SARI treatment centres** Identify space, within existing facilities or in new facilities to accommodate surge capacity. **Quarantine facility** Identify space within existing facilities or prepare to set up a dedicated quarantine facility. **Community Facility** Identify space within existing facilities or prepare to set up a dedicated community facility.	**SARI treatment centres** Identify space, within existing facilities or in new facilities to accommodate surge capacity. **Quarantine facility** Identify space, within existing facilities or in new facilities to accommodate surge capacity. **Community Facility** Identify space, within existing facilities or in new facilities to accommodate surge capacity.

1.4 Surge capacity

Strengthening health systems and swiftly reorganizing service delivery to respond to a SARI outbreak while maintaining core essential services across the continuum of care is an essential component of outbreak preparedness and response. WHO developed a series of tools to support Member States in visualizing and defining surge plans including policy briefs, the Health Workforce Estimator (HWFE) and Essential Supplies Forecasting Tool (ESFT).

Surge capacity, or the ability of a health system to meet an increased demand for health services, is a cornerstone of the overall approach to managing health emergencies. It has implications for the functioning of the entire health system. The principles of surge capacity should be integrated into health facility preparedness and response capacities for all functions.

Surge capacity entails:

- coordinating a central incident command group to manage and assess health facility resources
- expanding infrastructural capacity to manage an influx of cases
- managing human resources, especially staffing
- providing supplies, equipment, logistics and re-supply mechanisms
- ensuring the availability of specific expertise for critical areas of care
- ensuring and enhancing the safety of staff and patients.

Planning for surge capacity should allow for the progressive scale-up of activities over several stages, with clearly defined activation thresholds for each stage.

1.5 Investing in and building longer-term health emergency preparedness

Countries that invested in preparedness after past health emergencies such as the Ebola Virus Disease and Severe Acute Respiratory Syndrome (SARS), demonstrated better ability to prevent and control subsequent outbreaks, including the COVID-19 pandemic. Early consideration of the entire continuum of preparedness is vital to break the cycle of 'panic and forget', and to ensure sustainable capacities for future public health emergencies. Urgent country-led SARI actions must therefore set the stage for building sustainable capacities. With a transition to longer-term investments and actions anchored in national preparedness plans, countries can build health systems that can surge to meet the needs of health emergencies. This should be given special consideration when countries are moving from response to recovery, to low levels or no transmission, or between SARI epidemic peaks *(11)*.

A significant lesson learned from COVID-19 pandemic is that health care systems and workers, while saving numerous lives, faced extreme pressure in terms of capacity and capabilities, financial resources, and access to vital commodities and supplies including medical oxygen. Ensuring continuity of essential health services and building resilient health systems was crucial not only to mitigate the impact of COVID-19, but also to ensure readiness for other concurrent and future health emergencies. This mechanism is described in Fig. 4. Strengthening primary and emergency care is essential to ensure an adequate, sustainable distribution of a multidisciplinary workforce for both SARI case management and essential services *(10)*.

This manual aims to guide the design of flexible and adaptable health structures capable of rapid changes and prompt responses to emerging needs. It advocates for facilities that can be easily reconfigured and repurposed without major modifications. Standardizing space and components, following a 'one fits all' approach, considering the structural requirements and optimized care standards, and allowing for the quick repurposing of space based on changing needs. Adopting participatory and holistic methods in designing innovative health care facilities involves a diverse range of professionals from various departments and disciplines. This inclusive approach ensures that facility design incorporates a broad spectrum of perspectives and expertise.

To better understand future needs, the project team should consider a scenario planning approach involving stakeholder groups. To ensure that facility design remains flexible and adaptable to future needs and changing circumstances the stakeholder groups should address the following action points *(12):*

- take a forward-thinking approach to design health care facilities that can respond to emerging needs, ensuring the best possible care for patients;
- examine potential changes over the next 5, 10, or 20 years;
- consider lessons learned from past service requirement changes;
- evaluate the accuracy of predictions; and
- weigh the cost of not meeting with these.

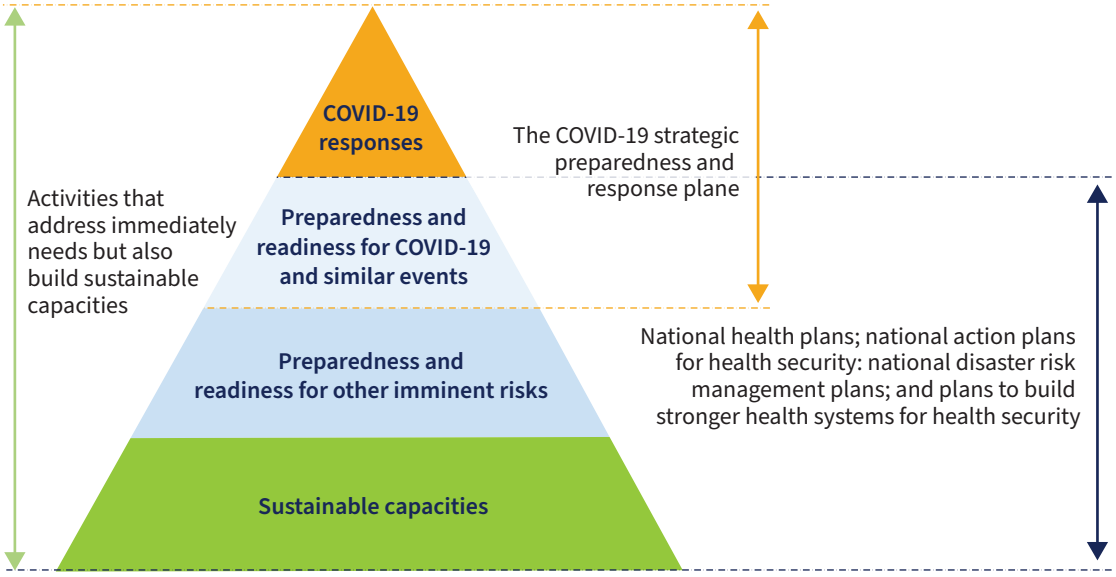


Fig. 4. COVID-19 response measures should lead to longer-term strengthening of capacities for health emergency preparedness.

2. Risk reduction measures in the SARI context

This chapter provides a brief introduction to the SARI mode of transmission, along with the infection prevention and control measures that inform the design of dedicated facilities.

2.1 Mode of transmission

The different virus responsible for SARI infection can spread in several ways: through zoonotic transmission, direct and indirect contact transmission, direct deposition transmission, and inhalation or airborne transmission (Fig. 5). An increasing body of evidence *(13–16)* suggests that it is transmitted through infectious fluids released from an infected individual as particles of different sizes and quantities, during breathing, speaking, coughing and sneezing *(17)*. While the largest particles settle quite rapidly, the smaller ones remain suspended in the air for longer periods and can travel longer distances *(18,19)*. When people are in close proximity, transmission of infectious particles can occur through direct inhalation (short-range) and deposition onto the mucous linings of the respiratory tract and ocular membranes of a susceptible host. The 'long-range' transmission can occur in indoor, enclosed settings when infectious particles accumulate over time in a given volume, at room scale, where the viral concentration is sufficient enough to cause infection once infectious particles are inhaled by a susceptible host. The concentration of infectious particles in the air can increase rapidly with poor ventilation, a small volume of air in an enclosed indoor space, overcrowding (especially with the presence of multiple infected individuals), and the amount of time spent in the space by the infected person *(20)*.

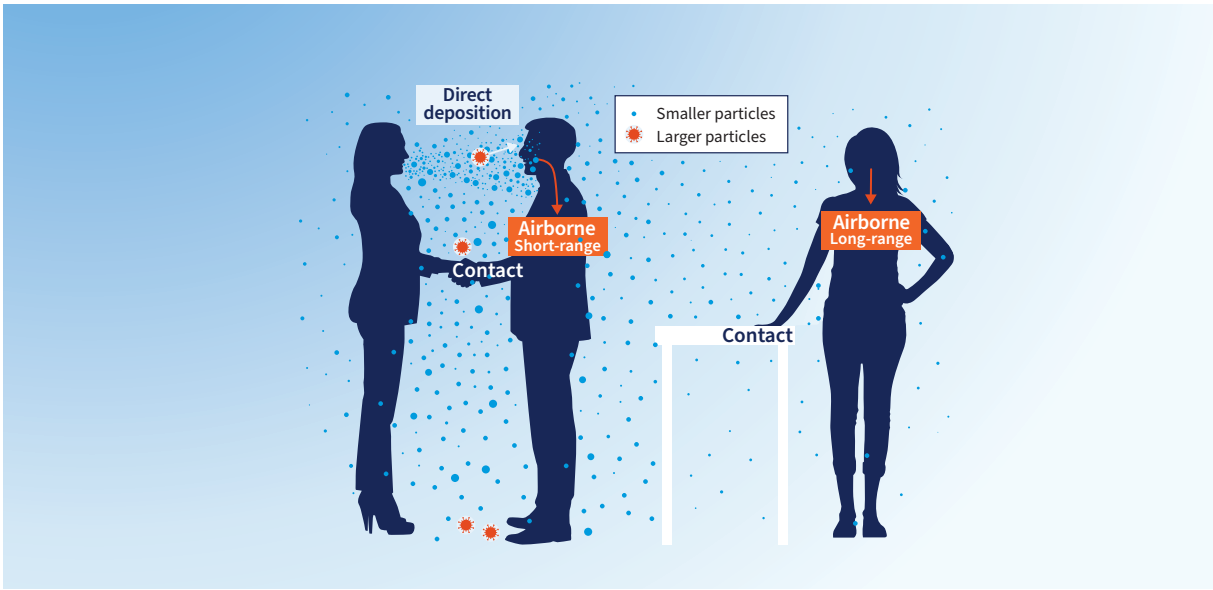


Fig. 5. Mechanism of transmission through infectious respiratory particles.

Source: Adaption with permission from: L. C. Marr and J. W. Tang, "A Paradigm Shift to Align Transmission Routes with Mechanisms,". Clin Infect Dis, Volume 73, Issue 10, 15 November 2021, Pages 1747–1749, https://doi.org/10.1093/cid/ciab722

2.2 The hierarchy of controls concept

The hierarchy of controls is a framework used in occupational health and safety to assess the relative effectiveness of different risk reduction strategies and determine how to implement practical and effective solutions. The idea behind this hierarchy is that the control methods at the top of the graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness has been substantially reduced. Fig. 6 represents the hierarchy of controls as an upside-down pyramid, with five categories represented in descending order of effectiveness: elimination, substitution, engineering controls, administrative controls, and personal protective equipment (PPE).

This model is broadly applicable in helping health care workers, policy-makers and the public understand the relative effectiveness of strategies in preventing the transmission of viruses causing SARI diseases *(21)*. The core concept is that while various hazard controls are effective at minimizing risk, those at the top of the model are more effective in protecting the community than those at the bottom. Effective IPC requires attention to all levels of controls to ensure the overall effectiveness of the system and mutual support among different levels.

While this manual focuses on engineering and environmental controls, some key IPC strategies for health care settings are briefly mentioned below to provide a general understanding. More details regarding IPC guidance for health care and community settings can be found on the IPC WHO webpage.

2.3 Engineering and environmental controls

From strategically placing hand hygiene stations for optimal use to managing water systems to minimize the presence of pathogens, the physical environment plays a crucial role in infection prevention and control. Engineering and environmental controls guide the design and the utilization of buildings *(22)*. Specifically, the design of SARI facilities should carefully address the flow of patients, health professionals, visitors, equipment and waste. Cohorting strategies, indoor ventilation, as well as materials and finishing are also key elements to consider in the design process.

Fig. 6. The hierarchy of controls.

Source: adapted from Sehgal, N. J. & Milton, D. K. Applying the Hierarchy of Controls: What Occupational Safety Can teach us About Safely Navigating the Next Phase of the Global COVID-19 Pandemic. Front. Public Heal. 9, 1688 (2021)

2.3.1 How to define isolation or cohorting criteria

Isolate patients with suspected or confirmed SARI in single rooms or, if unavailable, cohort them in the same room, following these principles.

- Patients should be placed in well-ventilated single rooms (see ventilation requirements), if feasible.
- In a situation where single rooms are not available, or the bed occupancy rate is expected to be 100% or more, confirmed SARI cases should be grouped together (cohorted) in adequately ventilated areas. Beds should be placed at least 1 metre apart. To facilitate the movement of health professionals and to ensure sufficient space for biomedical equipment, a preferable distance of 2 metres between beds is suggested.
- Minimize the unnecessary movement and transportation of patients outside their room or designated area. Designated portable medical imaging equipment and/or other diagnostic equipment could be utilized, ensuring proper cleaning and disinfection according to the manufacturer's instructions after each patient use.
- If patient transport becomes necessary, use predetermined transport routes to minimize exposure for health professionals, other patients and visitors. Provide the patient with a medical mask to wear, if tolerated, during the transport.

2.3.2 Controlling and monitoring access, flows and occupancy

Effective facility design and management strategies are crucial for controlling accesses, flows, and space occupancy based on the profiles of occupants, including health professionals, visitors, and patients. Dedicated entrances, exits, and flows for different groups, along with clear space occupancy categorization, can effectively reduce the risk of exposure to pathogens and minimize cross-contamination in SARI facilities.

Implementing an effective wayfinding system further supports these measures by guiding different groups of people to designated paths, spaces, and destinations within the SARI facility. A clear understanding of occupancy and flows by occupant profiles in each area of the facility enables easier risk assessment and the rational use of PPE by health professionals.

Additionally, the flow of goods such as linen, waste, and food must be carefully planned and managed, incorporating dedicated protocols for clean and soiled items to ensure safe handling and disposal.

2.3.3 Materials and finishing

The recommended characteristics for selecting finishing and furniture are summarized in Table 3 *(23)*.

Table 3. Materials characteristics

Characteristic	Selection guidance
Cleanable	• Avoid items with hard-to-clean features [e.g. crevasses] • Do not use carpet anywhere • Select material that can withstand repeated cleaning and disinfection
Easy to maintain and repair	• Avoid materials that are prone to cracks, scratches or chips, and quickly patch/repair if that occurs • Select materials that are durable and/or easy to repair
Resistant to microbial growth	• Avoid materials that hold moisture, such as wood or cloth, as these facilitate microbial growth • Select metals and hard plastics
Nonporous	• Avoid items with porous surfaces, such as cotton, wood and nylon • Avoid porous plastics, such as polypropylene, in patient care areas
Seamless	• Avoid items with seams • Avoid upholstered furniture in patient care areas

2.3.4 Ventilation as engineering control measure

Ventilation is the process of supplying air to or removing it from a space by natural or mechanical means for purposes that include control of air contaminant levels. Ventilation may involve supply of outdoor air, recirculated air that has been filtered or otherwise treated, or a combination of both. The primary function of ventilation is to dilute and displace contaminated air in a space by replacing or mixing it with less contaminated or uncontaminated air. Ventilation is closely connected with space air distribution because airflow patterns impact the effectiveness of the delivery of air and can affect occupant exposure *(24)*.

In the context of SARI diseases, the infected human occupants are the main source of pollution, from an IPC perspective. Indoor environments may pose a higher risk of infection due to increased concentration of infectious aerosols in the enclosed space. Ventilation serves to reduce this risk by decreasing the concentration of infectious respiratory particles. In fact, a poorly ventilated indoor environment presents a higher presence of contaminants generated in the room and may pose a higher risk of infection to the occupants within that space. A well-designed ventilation strategy and system can mitigate the risk of indoor transmission by decreasing the infectious respiratory particle concentration in the air through three principles — dilution, filtration and disinfection *(25) (26)*.

Building ventilation has three basic elements *(27)*:

- ventilation rate — the amount of uncontaminated air that is provided into the space, to dilute the concentration of airborne pollutants;
- airflow direction — the direction in which air moves between spaces or areas of a building, which should be from cleaner zones toward less clean zones; and
- air distribution or airflow pattern — the pattern of airflow within a space can either mix air within the room to create a lower, uniform concentration of infectious respiratory particles within the room or create a directional pattern that removes infectious respiratory particles near the source.

In health care settings, the following minimum ventilation rates should be provided for infection prevention and control *(25) (27) (28)*:

Space Type	Ventilation Rate for naturally ventilated spaces	Air Changes per Hour (ACH) for mechanically ventilated spaces
Airborne Precaution Rooms	160 litres/second/patient	12 ACH
General Wards and Outpatient Departments	60 litres/second/patient	6 ACH
Corridors and transient spaces that are not used for patient care**	2.5 litres/second per cubic meter of space volume	2 ACH

** When corridors and other areas are used for patient care in emergency situations, ventilation rates should be the same as for General Wards or Airborne Precaution Rooms, as appropriate to the use.

Box 3. Relationship between ventilation rate and air-change per hour

The relationship between ventilation rate in $\left(\frac{l}{s}\right)$ and air-change per hour (ACH) is:

$$ACH = \frac{\left[ventilation\ rate\left(\frac{l}{s}\right) x\ 3600\ \left(\frac{s}{h}\right)\right] x\ 0{,}001\left(\frac{m^3}{l}\right)}{room\ volume\ [m^3]}$$

$$Ventilation\ rate\ \left(\frac{l}{s}\right) = \frac{ACH\ x\ room\ volume\ (m^3) x 1000\left(\frac{l}{m^3}\right)}{3600\ \left(\frac{s}{h}\right)}$$

3. Essential services

3.1 Ventilation system typologies

Ventilation systems can be classified according to the airflow driving force. Indeed, there are three methods used to ventilate a building: natural forces drive natural ventilation, mechanical fans drive mechanical ventilation and mechanical forces combined with natural forces drive hybrid (mixed-mode) ventilation systems.

For effective ventilation, it is crucial to consider building ventilation as part of a more comprehensive strategy for temperature and humidity control. This includes considering the envelope design and strategies for cooling/heating systems that address the local climate conditions and occupants' needs and comfort. Furthermore, it should be recognised that different parts of the building may have different needs in term of ventilation, heating and cooling. Thus, different strategies may be applied to different parts of the building or at different times *(29)*.

To ensure an effective and efficient indoor ventilation approach, both natural and mechanical systems should be designed by technical experts. Simulation techniques may be employed to strengthen the selected ventilation strategy.

3.1.1 Natural ventilation

Natural ventilation relies on natural forces such as wind pressure, buoyancy or stack pressure, or a combination of both. These forces drive outdoor air through purpose-built, building envelope openings. Envelope openings include windows, doors, solar chimneys, wind towers and trickle ventilators. The effectiveness of natural ventilation of buildings depends on factors such as climate, building design, and human behaviour *(27)*. The magnitude and pattern of natural air movement through a building depends on the strength and direction of the natural driving forces and the resistance of the flow path. Wind pressure and buoyancy pressure, the two natural driving forces, can vary over time due to the variation of the wind speed and/or temperature during the day or the seasons. Therefore, the design must consider fluctuations in ventilation rate *(30)*.

When wind strikes a building, it induces a positive pressure on the windward façade and a negative pressure on the leeward side (Fig. 7). This drives the air to flow through windward openings into the building to the low-pressure openings at the leeward side *(27)*. Wind pressure increases with the height from the ground. Stack or buoyancy pressure results from differences in air temperature or humidity, leading to varying densities between indoor and outdoor air. This difference generates an imbalance in the pressure gradients of the interior and exterior air columns, creating air movement. When indoor air is warmer than the outdoor air, the indoor air is less dense and rises. Air enters the building through lower openings and escapes from upper openings. The flow direction reverses, to a lesser degree, when the room air is colder and denser than the outside air. Air enters the building through the upper openings and escapes through the lower openings *(27)*. Wind forces and buoyancy forces are not mutually exclusive. Both forces can operate at simultaneously, with the strength of each.

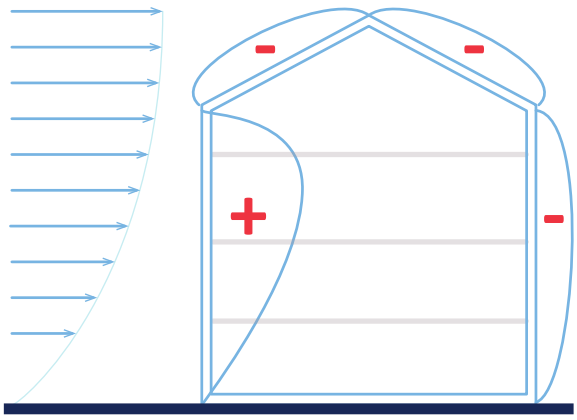


Fig. 7. Wind pressure and natural ventilation

Generally, the following principles should be considered in the design of natural ventilation strategies *(31)*:

- natural ventilation only works if there are at least two openings (or a very tall opening that acts as a two-way opening);
- no partitions or barriers should be present between the two openings, however, if one or more partitions are present, holes, open windows or a grill should be designed and installed to allow for airflow;
- all openings on external walls and partitions must be kept open and free for airflows, however, a practical and realistic approach must be considered to analyse which opening(s) might be closed for security reasons, comfort, and/or privacy in the real operation of the facility;
- the amount of airflow will be controlled by the size of the smallest opening (window or door), including internal doors standing on the airflow path; and
- air will predominantly follow the path of least resistance which must be considered in the design.

More information on the design of naturally ventilated health care facilities can be found in the WHO publication "Natural Ventilation for Infection Prevention and Control in Health-Care Settings".

3.1.1.1 Single-sided ventilation

Single-sided ventilation occurs when one or more openings are located on one side of the ventilated enclosure. A representative example is a room with open windows on one side and closed internal doors on opposite side (Fig. 8). In well-sealed rooms, ventilation is mainly buoyancy driven.

As a rule of thumb, the room width (W) should not exceed 2.5 times the room height (H). To enhance the stack effect, vertical windows or double windows at different heights are preferable over horizontal windows *(29)*.

Single-sided ventilation is less effective than cross-ventilation, as it is limited to zones close to the openings, and therefore, should be avoided for airborne infection control *(27)*.

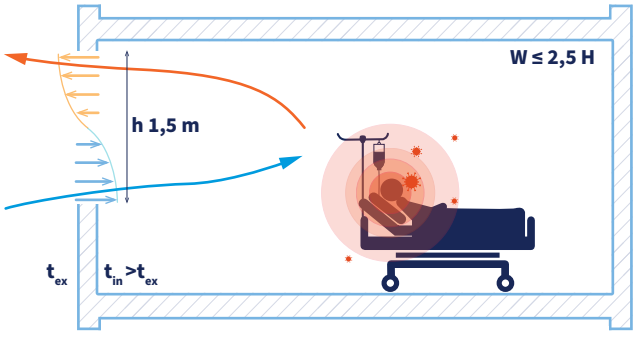


Fig. 8. Single-sided ventilation

Box 4. Estimation

It is possible to estimate single-sided ventilation with the following equation *(29)*:

$$Ventilation\ rate\ \left(\frac{l}{s}\right) = 0{,}25\ x\ A\ (m^2) x \sqrt{\frac{9{,}81\ \left(\frac{m}{s^2}\right)\ x\ h\ (\mathrm{m}) x\ \Delta T\ (°K)}{T_{in}(°K)}}\ x\ 1000\ \left(\frac{l}{m^3}\right)$$

A = smallest opening area (m^2)

h = height of the opening (m)

ΔT = difference between internal and external temperature ($°K$)

T_{in} = internal temperature (°K) = internal temperature ($°C$) + 273

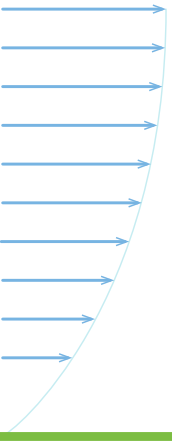
If mosquito nets are installed on the openings, the ventilation rate should be reduced of a 0,3 factor.

The airflow direction is usually assessed through a gas tracer. However, other cost–effective solutions can be used, such as incense sticks or other smoke generators – a smoke test can be used to highlight the direction of the airflow (25).

NOTE: The proposed estimation is a simplification of a complex phenomena. Natural ventilation may vary along time, therefore a statistical approach would give more accurate results. Experts on ventilation should be consulted for site specific and advance estimation.

3.1.1.2 Cross-ventilation

Cross-ventilation is primarily wind-driven and occurs where there are openings on opposite sides of the space (Fig. 9). In this configuration, air enters into one side of the building or room and then flows out the other side, for example through a window or door. As a rule of thumb, to provide effective cross-ventilation, the room width (W) should not exceed five times the room height (H) *(29)*.



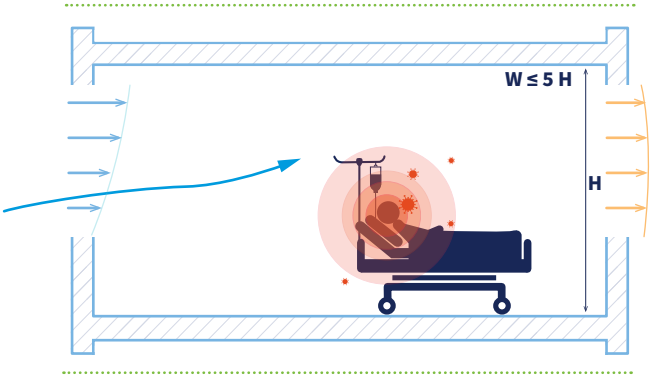


Fig. 9. Cross ventilation

Box 5. Estimation

It is possible to estimate cross-ventilation with the following equation *(27)*:

$$Ventilation\ rate\ \left(\frac{l}{s}\right) = 0{,}65\ x\ wind\ speed\ \left(\frac{m}{s}\right) x\ smallest\ opening\ area\ (m^2) x\ 1000\ \left(\frac{l}{m^3}\right)$$

Wind speed refers to the value at the building height at a site sufficiently away from the building without any obstructions (e.g. at an airport).

If mosquito nets are installed on the openings, the ventilation rate should be reduced of a 0,3 factor.

The airflow direction is usually assessed through a gas tracer. However, other cost–effective solutions can be used, such as incense sticks or other smoke generators – a smoke test can be used to highlight the direction of the airflow *(25)*.

NOTE: The proposed estimation is a simplification of a complex phenomena. Natural ventilation may vary along time, therefore a statistical approach would give more accurate results. Experts on ventilation should be consulted for site specific and advance estimation.

3.1.1.3 Stack ventilation: chimney and atrium

Chimneys or building atriums provide a means of generating stack driven ventilation where air flows across the ventilated space and then is exhausted through a vertical flow path. The essential requirement is for the air in the chimney to be warmer than the ambient air. It is possible to enhance the temperature (and hence the density) differences by using solar heat gains to increase the air temperature in the chimney or lowering the temperature of the external air by water evaporation *(29)*.

A solar chimney works best with materials that are good heat absorbers, such as glass or black paint (Fig. 10), while evaporative towers work well when the ambient air is passed through a water source thus increasing its moisture level before entering the indoor space *(30)*.

Vertical chimneys could be designed for the single room (Fig. 11) or at building level (central chimney or atrium). In

the second case, the rooms or occupied zones are cross ventilated (Fig. 12), while the atrium stack assists the air movement and removal in the upward direction. As a rule of thumb, consider a chimney height to be at least 1m above the highest point of the roof.

Fig. 10. Solar chimney

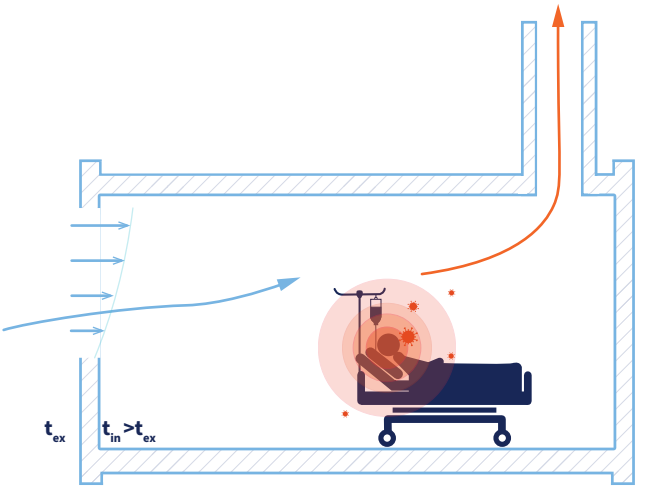


Fig. 11. Vertical chimney

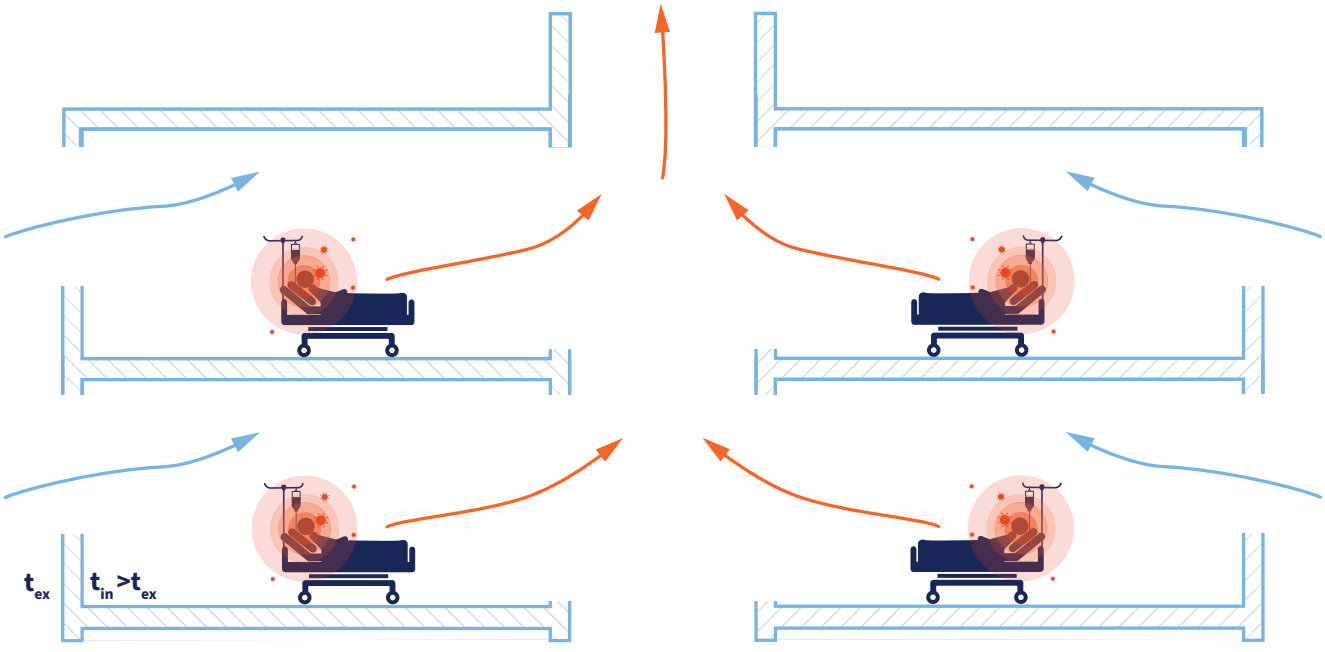


Fig. 12. Atrium

Box 6. Estimation

It is possible to estimate stack ventilation with the following equation *(27)*:

$$Ventilation\ rate\ \left(\frac{l}{s}\right) = 0{,}15x1000\left(\frac{l}{m^3}\right) x\ smallest\ opening\ area\ (m^2) x\sqrt{[t_{in} - t_{ex}\ (°K)]\ x\ stack\ height\ (m)}$$

Where: t_{in} = indoor air temperature; t_{ex} = outdoor air temperature; t (°K) = t (°C) +273

The airflow direction is usually assessed through a gas tracer. However, other cost–effective solutions can be used, such as incense sticks or other smoke generators – a smoke test can be used to highlight the direction of the airflow (25).

NOTE: The proposed estimation is a simplification of a complex phenomena. Natural ventilation may vary along time, therefore a statistical approach would give more accurate results. Experts on ventilation should be consulted for site specific and advance estimation.

3.1.1.4 Wind tower or wind catchers

Wind catchers (Fig. 13, Fig. 14), also known as wind towers, are a type of natural ventilation system that resemble chimneys and aim to "catch" the outdoor wind, usually at a high elevation (e.g. at roof level, to channel the air towards the indoor spaces) *(30)*.

Wind towers are mainly wind-driven ventilation strategies. The positive-pressure side of the wind tower acts as a wind catcher and the negative-pressure side of the wind tower acts as a wind extractor.

Usually, the inlet openings are facing the prevailing wind direction and the outlet faces the opposite side. The efficiency of wind-catchers increases with increasing wind speed *(30)*.

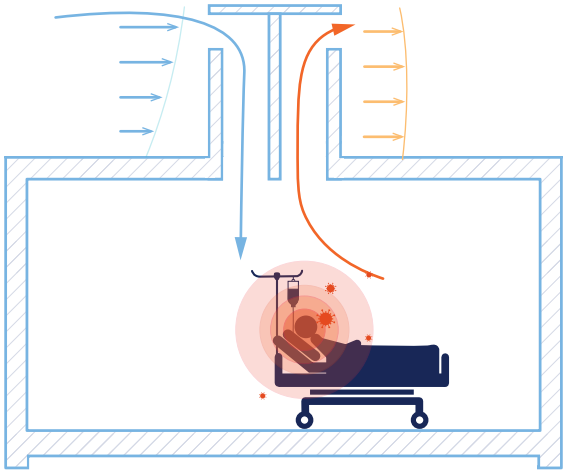


Fig. 13. Windcatcher

3.1.2 Hybrid or Mixed-mode Ventilation

In hybrid (mixed-mode) ventilation, the airflow is driven by wind and buoyancy through purposely installed openings in the building envelope, supplemented, when necessary, by degrees of mechanical system in all or part of the building. The mechanical component of the hybrid system can be a fan for increasing the ventilation rate or controlling the airflow direction, and/or a heat exchanger for heating or cooling the outdoor supply air.

To mitigate risks associated with respiratory diseases, the fans should be installed where the room air can be exhausted directly to the outdoor environment through either a wall or the roof. The size and number of exhaust fans depends on the targeted ventilation rate and must be measured

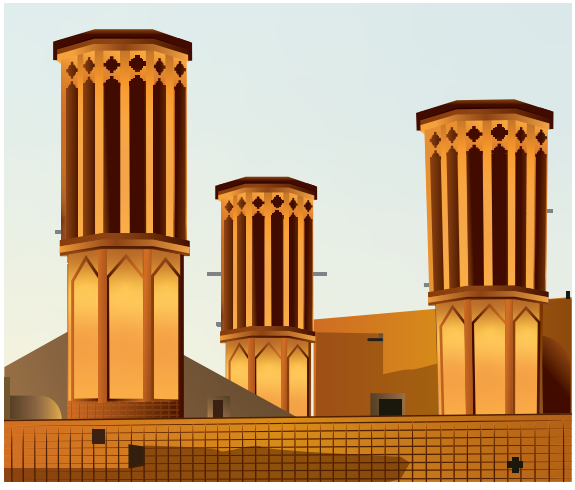


Fig. 14. Traditional Arabic Windcatchers.

Adaptation from photo, source: https://www.archdaily.com/971216/what-is-a-traditional-windcatcher

and tested before use. Another possibility is the installation of whirlybirds (whirligigs or wind turbines, Fig. 15) that do not require electricity and provide a roof-exhaust system that increases airflow in a building.

Fig. 15. Whirlybird.

Hybrid ventilation system design methods can be grouped into three major categories. In fan-assisted stack systems, a fan supplements the extraction of air at the exhaust location of the stack. In top-down systems, the fan extraction is assisted by a wind tower. In buried pipe systems, when land is available, ventilation pipes (ducts) are used to bring air temperature to steady-state values *(30)*.

Box 7. **Estimation**

Air extractor capacity is usually expressed in [l/s] or [m^3/h]. The formula to calculate the extraction fan airflow needed given a specific bed capacity is:

Extractor airflow [l/s] = Maximum bed capacity x 160 l/s/patient

or

Extractor airflow [m^3/h] = Maximum bed capacity x 576 m^3/h/patient

The airflow direction is usually assessed through a gas tracer. However, other cost–effective solutions can be used, such as incense sticks or other smoke generators – a smoke test can be used to highlight the direction of the airflow *(25)*.

3.1.3 Mechanical Ventilation

In mechanical ventilation systems, fans drive airflow. Fans can be installed directly in windows, walls, or on roofs, supplying air into or extracting air from a room, or fans may be connected to duct systems that serve multiple rooms *(27)*. Mechanical ventilation systems can be solely design for ventilation or can be integrated in heating, ventilation, and air conditioning (HVAC) systems, providing temperature and humidity control, in addition to ventilation. Mechanical ventilation systems may be once-through systems that exhaust air directly to the outdoors or may recirculate all or a portion of the air through filters and back into the space *(25)*.

For infection prevention and control, ventilation systems regulate the direction of airflow throughout a building, moving air from cleaner spaces to less clean spaces using unequal rates or air supply and extraction. The distribution of air within a space is crucial in controlling infectious respiratory particles through strategic placement of supply and extract grilles. Infectious aerosols can be largely captured at the source by placing extract grilles as close as possible to the infected patient and placing supply grilles to encourage airflow away from the door and the caregiver *(25)*.

Box 8. **Estimation**

Each mechanical ventilation system is designed for specific airflow rates. Consult the ventilation system blueprint with air inlet/outlet airflow or system technical specifications to verify the system capacity *(25)*.

The airflow direction is usually assessed through a gas tracer. However, other cost–effective solutions can be used, such as incense sticks or other smoke generators – a smoke test can be used to highlight the direction of the airflow *(25)*.

3.2 Air filtration and disinfection

The concentration of infectious respiratory particles in indoor spaces can also be reduced with the use of air filters and disinfection technologies. These solutions should not be used to replace ventilation, but serve as effective supplements in certain scenarios, for example *(25)* :

- when the minimum ventilation rate is not met in areas occupied by suspect or confirmed cases and decreasing space occupancy is not feasible;
- in cases where indoor air is exhausted outside, too close to people or air intakes;
- when the airflow direction is not from cleaner zones to less clean zones; and
- in situations where mechanical ventilation recirculates air from areas occupied by suspect or confirmed cases to other parts of a building.

3.2.1 HEPA filters

High Efficiency Particulate Air (HEPA) filters are a type of mechanical air filter categorized as ISO 35H-ISO40H according to the international standard ISO 29463. These filters can be installed in mechanical ventilation systems or in portable air cleaning devices to mitigate risks associated with SARIs. The HEPA filters can theoretically remove 99.95% of dust, pollen, mould, bacteria, and any airborne particles 0.3 microns (µm) in size. The diameter specification of 0.3 microns correspond to the most penetrating particle size, or rather the size of the particles that are most likely to pass through the filter, meaning that these filters are even more effective with particles both larger and smaller than 0.3 microns.

Air filters must be installed properly, with seals that effectively prevent the bypass of air around the filtration media. Regular monitoring of the filter condition and periodic replacement are necessary for optimal functioning. The manufacturer's recommendations on maintenance and replacement must be followed. Maintenance can release trapped particles from the filter media, therefore it should be performed in an unoccupied space, with fans turned off, and with appropriate PPE.

In mechanical ventilation systems, HEPA filters should be installed in the return duct, ensuring proper air treatment in case of system leakages or air recirculation. For portable HEPA filters, the device selection and installation should follow the following principles *(25) (32)*:

- The air inlet of the device should be positioned as close as possible to the possible source of infection; and
- The air cleaner capacity should at least cover the gap between the minimum requirement and the measured ventilation rate. This is achieved by summing the device Clean Air Delivery Rate (CADR) (m^3/h) with the measured room ventilation rate to meet the required ventilation rate (CADR is usually available in the device technical specifications).

3.2.2 Germicidal Ultraviolet Systems (GUV)

Germicidal ultraviolet (GUV) radiation, also known as UV germicidal irradiation (UVGI), is electromagnetic radiation that can destroy the ability of microorganisms to reproduce by causing photochemical changes in nucleic acids. The spectrum of ultraviolet light extends from wavelengths of about 100–400 nm *(33)*. Wavelengths in the UV-C (200–280 nm) range are especially damaging to cells because they are absorbed by nucleic acids *(33)*. The UV wavelength is the parameter that directly affect the disinfection efficiency of the lamp. Only lamps providing a wavelength in the UV-C range could be used in GUV systems.

Germicidal irradiation can be used in two ways: disinfecting ventilation ducts or serving as room air cleaners, including upper room air disinfection *(34).* In duct applications, UV-C lamps installed in HVAC ductwork disinfect the air before it is exhausted outside or recirculated in the built environment. Upper room GUV is an effective strategy for protecting room occupants when the infectious source is present in the room.

Success in the implementation of GUV systems depends on appropriate installation, quality control, and maintenance to ensure that air disinfection occurs without adverse effects. Overexposure to ultraviolet radiation can cause painful eye and skin damage; hence, GUV systems must be installed and monitored to ensure that optimal UV dose levels are achieved within a permissible limit of human exposure *(35).* Individuals in the treated

space must be shielded from excessive exposure to the UV radiation by shielding fixtures with louvres or bafflers to block radiation below the horizontal plane of the fixtures. Unshielded GUV lamps should only be used in areas that are not occupied *(35)*.

Upper-room GUV systems rely on air mixing between the upper and lower parts of a room. Thus, when implementing this intervention, it is essential to consider factors that may affect the vertical air movement and transport of the infectious microorganisms to the upper portion of the room (e.g., use of simple paddle fans to facilitate air movement in a room, temperature differential between the supply air and room air) *(35)*. The use of GUV considerably increases electrical consumption, an aspect to consider when estimating the electrical supply need, and the cost of operation. The high surface temperature of GUV lamps may increase the likelihood of fire, especially in temporary structures.

3.3 Key elements for selecting the ventilation strategy

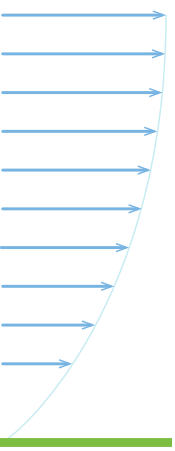
The design of a ventilation system is a critical aspect in ensuring the health and comfort of building occupants. Choosing the most suitable ventilation system depends on several factors, including local climate conditions, building design and construction, energy consumption and the intended use of the building. The decision on whether to use mechanical, hybrid or natural ventilation for infection control should be based on needs, availability of resources at the local level and the overall cost of the system, including future maintenance, to provide the best control to counteract risks *(27).* Engaging specialized engineers in the design process is essential to ensure optimal ventilation system performance. Local conditions and climate factors significantly influence the decision. New constructions or the retrofitting of existing permanent buildings requires a holistic design approach. Building envelope, ventilation, heating and cooling strategies should be planned and designed as part of the same strategy, strengthening energy efficiency. This is particularly true in locations with extreme climate conditions, where heating or cooling are mandatory to ensure an acceptable level of comfort while ensuring minimum ventilation standards.

Conversely, the rapid adaptation of existing structures and implementation of temporary facilities may require a different approach, prioritizing simpler, cost–effective and ready-to-use solutions. In such cases natural ventilation and hybrid ventilation are usually adopted. Occupants' behaviours play a key role when natural or hybrid ventilation strategies are selected. The latter allow for a range of control of environmental parameters by occupants. Minimum ventilation standards are met when the structure is properly designed and properly used by occupants. Standard operating procedures, specifying window opening times and maximum room occupancy, can aid occupants in ensuring the appropriate use of the facility and contribute to a safer indoor environment.

Natural ventilation is a cost–effective solution, requiring a lower investment compared to alternative strategies (36), minimum maintenance *(36) (37)*, and no energy consumption when heating and cooling are not necessary. Natural ventilation is capable of achieving high ventilation rates *(26)*, however, its performance can be difficult to predict as it is influenced by external factors such as wind patterns *(27) (36)*, outdoor climate, as well as occupants' actions *(38)*.

Designing advanced natural ventilation systems for optimal performance can be a challenging task that requires specialized expertise. The main challenges associated with naturally ventilated SARI facilities are the exposure to extreme hot or cold climates. In such conditions, heating and cooling devices that operate in recirculation mode and do not provide ventilation are installed to create a comfortable environment for occupants. In hot climates, closing windows and installing air-conditioning units to mitigate the temperature and occupants' discomfort, represent a threat from an infection prevention and control perspective. Passive design strategies can be introduced to reduce the need of air conditioning *(30) (36)*, limiting occupants' discomfort, energy consumption and ensuring ventilation. In cold climates, keeping windows open for extended periods to ventilate during the cold season when the heating system is in use, can lead to increased energy consumption and decreased occupant comfort. In these situations, when windows are less likely to remain open continuously, adopting frequent and short openings for ventilation to reduce the presence of indoor pollution is preferable over sporadic

and prolonged openings. Establishing standard operating procedures for regular window opening in such cases can help mitigate associated risks.



Hybrid ventilation combines the benefits of natural and mechanical ventilation, avoiding the limitations associated with the unpredictability of natural forces making it a highly flexible system. When shortages of energy supply occur and mechanical means (e.g., fans, extractors) are not reliable, natural ventilation could be used. The mixed-mode system may be difficult to design *(27)* and difficult to control by occupants *(26),* but is relatively simple and easy-to-manage *(39).* The cost of installing a hybrid ventilation system could be considerable, depending on the degree of mechanical equipment required (e.g. fans, extractors, air conditioning). The system requires specialized engineering to be properly designed. The mixed-mode system can provide a controlled and pleasant environment, being able to control temperature and humidity. In extreme climates, temperature and humidity may represent a source of discomfort for the occupants. In such conditions, cooling or heating strategies (therefore energy-consuming) may be required to reduce discomfort. Increasing the passive potential of the building can reduce energy consumption. Natural ventilation or hybrid ventilation should not be preferred when the outdoor air quality is poor, representing a threat to occupant's health *(30).*

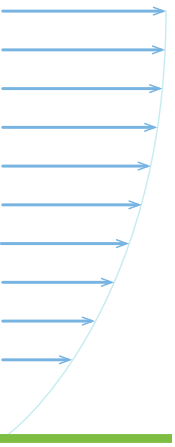
Mechanical ventilation systems are designed and managed by specialized engineers. They are intended to create pleasant and controlled environments for patients and staff, controlling temperature and humidity, which may lead to discomfort in extreme climates (38). These systems are more expensive to install and to maintain but offer a greater degree of control over the ventilation system ensuring a steady ventilation rate, control over airflow direction and filtering the outdoor air from harmful pollution. Proper design and maintenance of the mechanical system is crucial to ensure its performance and reliability. In contexts where energy shortages may occur, mechanical systems may not be fully reliable. The costs for system maintenance and energy consumption could be significant and should be considered before implementation. In areas prone to sandstorms, more frequent maintenance may be required.

Increasing a building passive potential may reduce the need for cooling and heating, and consequently, energy consumption in extreme climates. A more efficient building envelope and system design may need considerable investment during implementation but may reduce the cost over many years of operation. The installation of heat recovery systems is suggested in extreme climates, to reduce energy consumption.

Table 4 summarizes the major advantages and disadvantages of the different ventilation systems.

Table 4. Summary of advantages and disadvantages of different types of ventilation systems for hospital.

	Natural Ventilation	Hybrid (mixed-mode) Ventilation	Mechanical Ventilation
Design	Design of openings for simple natural ventilation does not require specific skills, while advance natural ventilation is more difficult to predict, analyse and design *(27)*.	Potentially difficult to design *(27).*	A full mechanical ventilation system requires specialized engineering design. Longer timespan for implementation.
Climate	Suitable especially for warm and moderate weather *(38)*, but not suitable for extreme conditions.	Suitable for most weather conditions and seasonal changes *(38)*.	Suitable for any climate *(27)*, type of weathers and seasonal changes *(38)*.
Maintenance	Minimum maintenance is needed *(36) (37)*.	Simple and easy to manage maintenance *(39).*	System maintenance, including filters substitution, is necessary over time to ensure proper performance of the ventilation system.
Installation cost	Lower investment compared to the other strategies *(36).*	Considerable cost for installation. It may vary according to the degree of mechanical equipment foreseen (e.g., fans, extractors, air conditioning).	High cost for installation.
Operating cost and energy consumption	No energy is required for ventilating the building. According to the local climate, energy may be required if cooling or heating devices are installed.	Cost for energy should be foreseen, based on the degree of mechanical equipment. According to the local climate, energy may be required if cooling or heating devices are installed.	Costs for system maintenance should be considered. If heating or cooling is needed, the installation of a heat exchanger may help in reducing energy consumption.
System reliability: driving forces	Natural ventilation relies on wind and buoyancy forces which may vary over time (e.g. wind and temperatures are not constant and change along the day and along the seasons) and are difficult to predict. Performance is highly influenced if there are occupants *(38).*	High flexibility. When shortages of energy supply occur and mechanical means (e.g. fans, extractors) are not reliable, natural ventilation could be used. The mixed-mode system may be difficult to control by occupants *(26).*	In contexts where shortages of energy supply may occur, the mechanical ventilation system may not be fully reliable.



	Natural Ventilation	Hybrid (mixed-mode) Ventilation	Mechanical Ventilation
System reliability: airflow direction and ventilation rate	Physical processes, responsible for natural ventilation are complex and predicting ventilation rates is difficult *(36)*. However, this system has the potential of achieving high ventilation rates *(26)*, but is highly influenced by outdoor climates as well as performance of occupants *(38)*. Closing windows and installing units to mitigate the temperature and occupants' discomfort, represent a threat from an infection prevention and control perspective. Airflow direction is difficult to control and the system is not capable of creating negative pressure *(27)*.	A properly designed mixed-mode system can steadily ensure a desired airflow rate and airflow direction over time (different hours of the day or different seasons, according to the design values).	A mechanical system properly designed steadily ensures a desired airflow rate and airflow direction over time (different hours of the day or different seasons, according to the design values).
Occupant comfort	Natural ventilation can provide adequate ventilation rates, but it does not control the temperature and humidity of the incoming outside air, which can lead to discomfort *(30)*. Potential for noise intrusion according to local context *(27)*.	Better occupant satisfaction can be achieved by combining the perceived advantages of openable windows, assisted by mechanical engineering services necessary to provide suitable levels of performance *(39)*.	This option allows for the creation of a pleasant and controlled environment for patients and staff, controlling temperature and humidity *(38)*, regardless of the local climate conditions. However, it offers a smaller range of control of the environment by occupants *(27)*. The mechanical ventilation system could be noisy *(26)*.
Air quality *(40)*	If the outdoor air quality is poor, this approach could represent a threat to occupants' health *(30)*.	If the outdoor air quality is poor, this approach could represent a threat to occupants' health *(30)*. Appropriate air filters could be installed with the mechanical elements.	If the outdoor air quality is poor, this system could be appropriately treated and filtered to ensure healthy air for breathing.

3.4 Oxygen system

Oxygen is an essential medicine required at all levels of the health care system and is crucial for treatment of SARI. This manual provides an overview of the main structural aspects linked to the oxygen system. For more information focused on oxygen systems and the oxygen ecosystem, it is recommended to consult the published guidelines "Foundation of medical oxygen system", "WHO-UNICEF technical specifications and guidance for oxygen therapy devices", "Oxygen sources and distribution for COVID-19 treatment centres" and the website of the WHO Oxygen Scale Up Initiative.

An oxygen system refers to the equipment for the production, storage, distribution, and delivery of medical oxygen. Whereas the production of oxygen takes place onsite in health facilities, or offsite at manufacturing sites, the whole supply chain must follow strict regulations for quality assurance and quality control *(41).* At the facility level, oxygen systems commonly consist of high-pressure gas cylinders, bedside oxygen concentrators, oxygen generating plants, vacuum-insulated evaporator systems with liquid oxygen bulk tanks, piping networks, as well as all the related accessories, regulation and conditioning devices, and medical devices that serve as the interface with patients *(42)* as shown in Fig. 16

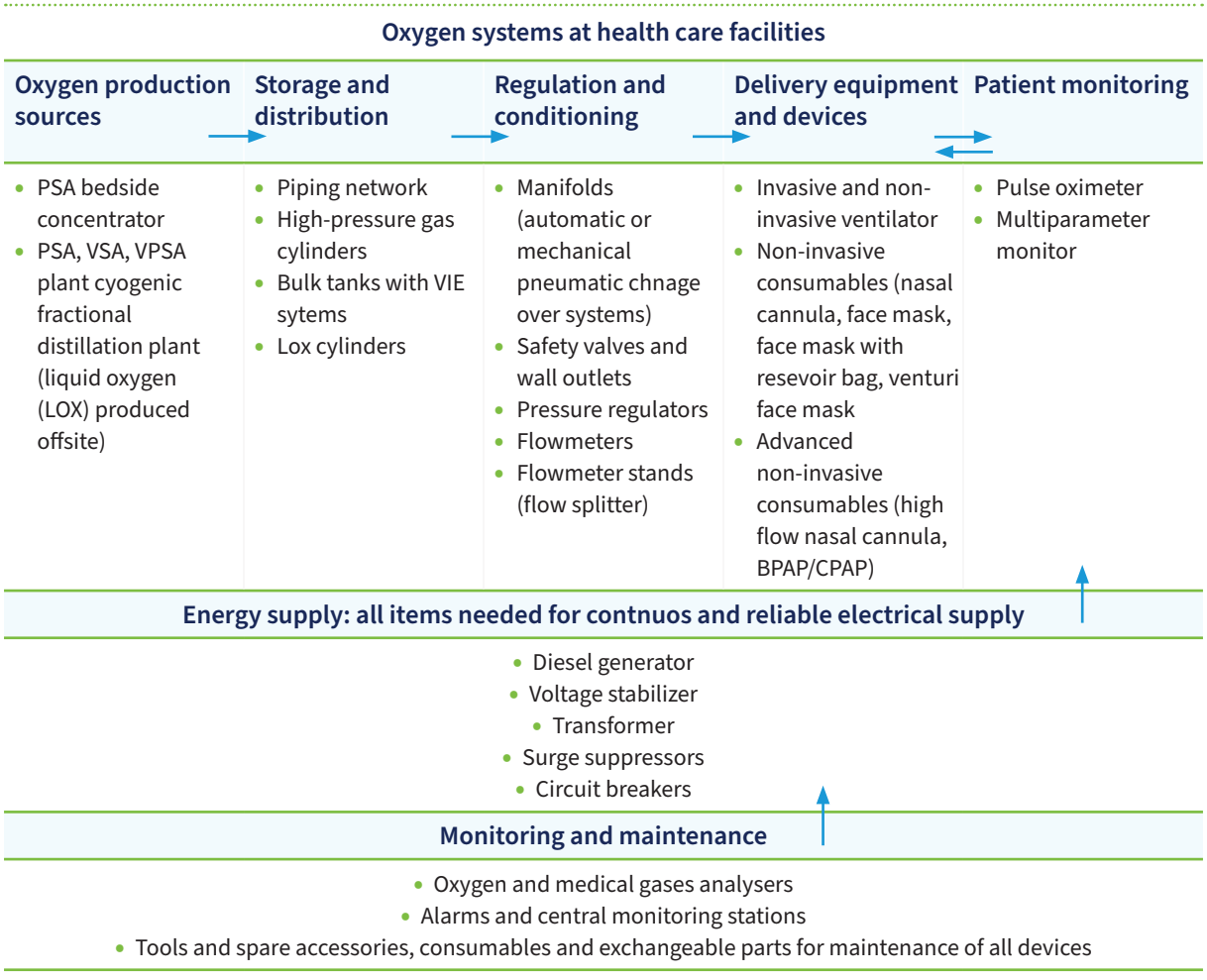


Fig. 16. Oxygen system components.

Source: Adaptation from "WHO-UNICEF technical specifications and guidance for oxygen therapy devices"

Oxygen production, storage, and distribution strategies require specific structural considerations for a well-functioning and safe oxygen system. Compliance with local or international regulations, equipment technical specifications, and manufacturers' recommendations is crucial. Oxygen flow rates can be higher on a per-patient basis at SARI facilities than at general medical facilities due to the higher proportion of patients using oxygen for medical support. This must be considered in the selection of production, storage, and distribution equipment. Health facility managers should plan in advance for an increasing demand of medical oxygen in case of a SARI epidemic, outlining a strategy to enhance oxygen availability at the source, including identifying suppliers and planning production, storage, and distribution systems accordingly.

For oxygen generation plants, the following criteria should be considered as general rules and discussed with whomever will supply and implement the oxygen system in the SARI facility.

Recommendations for oxygen storage and distribution include *(43)*.

- Liquid oxygen storage tanks are commonly stored outdoors in most climates. Liquid oxygen must be converted to vapour for distribution within a facility. Vaporizer devices absorb heat from the atmosphere to convert liquid oxygen to gas vapour. Vaporizers must be selected and installed to support the maximum anticipated oxygen flow rate at the lowest ambient temperature that the system will experience.
- Enclosed spaces used for oxygen storage must be well ventilated to limit the concentration of oxygen that may result from leaks. Mechanical ventilation may be used, but natural ventilation is preferred due to high reliability and reduced operating cost.
- Bulk storage tanks must be located for easy access by delivery tankers. Enclosed storage areas for cylinders should be near a loading dock or other delivery point, with access corridors and doors wide enough to transport cylinders on trolleys.
- Bulk storage tanks are heavy loads and require foundation slabs than can support the load and maintain the tank in a plumb or level position. Because concentrated oxygen is denser than air, care must be taken to prevent leaks from entering areas under support slabs – slabs should be supported directly on the ground.
- All materials around oxygen storage, whether indoors or outdoors must be non-combustible. Roads and slabs near storage tanks must not be constructed of asphalt, which can burn in the presence of concentrated oxygen. Floors within an enclosed storage space and on pathways between truck loading and the storage area must be durable against the transport and movement of heavy cylinders.
- No fires, smoke, oil, or grease are permitted in the area. Dedicated signage should be placed at the point of entry. Storage tanks, vaporizers, and pressure relief devices must be installed at a safe distance from the health facility. Consult local regulations for the permissible distance and use international regulations if this is not addressed by local regulations. Where portions of the system are installed indoors, appropriate fire suppression systems should be installed.
- Distribution piping should be segmented into zones with valves to permit maintenance in one area without interrupting service to other areas. Valves must be either readily visible or locked into the open position for normal operation.
- Oxygen distribution and tank pressures should be monitored to alert facilities staff to potential trouble.

Where oxygen production facilities are located on site, additional considerations apply *(43)*.

- All recommendations for oxygen storage and distribution apply to oxygen generation plants.
- Oxygen generators and concentrators require sufficient airflow to keep the compressors cool, to drive off heat produced by the process. Moreover, it should mitigate the risk of an oxygen enriched atmosphere. Manufacturer recommendations should be followed. Natural ventilation or mechanical ventilation should be chosen according to the local climate conditions.
- Discharge air from oxygen production equipment should be ducted directly to the outdoors if the equipment is enclosed.

- The environment for production equipment should be maintained in a temperature and humidity range recommended by the manufacturer, generally 5–35 °C and 15–95% relative humidity. Cooling systems may be installed in hot-climate countries.
- Oxygen production equipment requires electric power to function. If the electrical power source is not reliable, this can be mitigated with oxygen storage tanks, electrical power storage batteries, or emergency power generators. Provide enough storage or fuel to provide continuous oxygen supply through periods without the normal power source. Appropriate electrical connections, adaptors, cables, circuit breakers, and earthing should be utilised.
- The oxygen production site should be distant enough from vehicle circulation, generators and any other source of pollution and dust, especially from CO2 pollution, or places where flammable items are stored.
- Containerised oxygen generation plants may have other requirements for sheltering.

3.5 Water, sanitation and waste management

The provision of safe water, sanitation and waste management and hygienic conditions is essential for preventing and protecting human health during all infectious disease outbreaks, including SARI diseases. Ensuring evidence-based and consistently applied Water, Sanitation and Hygiene (WASH) and waste management practices in health care facilities is essential to prevent human-to-human transmission of pathogens *(44)*.

For the latest updates and more detailed information, consult the "Infection prevention and control in the context of coronavirus disease (COVID-19): a living guideline".

3.5.1 Water safety, water quality and water quantity

With regards to water management, the primary objective is to ensure large quantities of safe water easily accessible at all times. A reliable water supply is crucial, from the source to distribution points. If no water supply system is available, anticipate trucking water to the site including the installation of storage and distribution systems *(45)*. Proper wastewater collection systems, treatment and disposal should also be in place. Wastewater and sludge should be contained and treated either on-site or conveyed off-site in well-designed and managed wastewater and/or faecal sludge treatment plants *(44)*.

To enhance water safety, several measures can be implemented, starting with source water protection, water treatment (at point of production, distribution, collection or consumption), and safe storage of treated water in regularly cleaned and covered containers at home.

Supply water may need supplementary chlorination to ensure adequate disinfection and a sufficient level of residual chlorine up to the point of consumption or use. Main water supplies may not achieve adequate water safety at the point of delivery due to problems at the water treatment works and contamination in the distribution system. Stored water may also need supplementary chlorination before use. Water must not be contaminated in the health care setting during storage, distribution and handling *(45)*.

Water is required for the following care and IPC procedures:

- drinking water
- hand washing (with soap/water or chlorine solution)
- cleaning (floor, surfaces, fomites, buckets, utensils, etc.)
- decontamination of materials, beds, buildings, and surfaces
- decontamination of reusable PPE
- showers and toilets
- laundry
- fire safety
- food preparation (not applicable if the food preparation is an outsourced service).

More information could be found in the publication "Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19".

Box 9. Water quantity

The suggested (45) daily water need for a SARI treatment centre is approximately 100 litres / patient / day

Note: include at least 2-day backup of safe water (0.5mg/l free residual chlorine) to ensure a constant supply *(46)*.

Further information on WASH in health care setting could be found in the WHO publication "Essential environmental health standards in health care" and "WASH Fit", and at the webpage "WASH in Health Care Facilities".

3.5.2 Waste management

Health care waste produced during patient care, including in the case of those patients with a suspect or confirmed SARI infection, is considered infectious waste and should be safely collected in clearly marked lined containers and sharps safety boxes. Health care waste generated from facilities treating SARI patients is no different than waste coming from facilities without SARI patients *(44)*. This waste should be treated, preferably on-site, and then safely disposed. If waste is moved off-site, it is critical to understand where and how it will be treated and disposed, and provision for a safe and supervised transport system may be required. Waste generated in waiting areas of health care facilities can be classified as non-hazardous and should be disposed in strong black bags and closed completely before collection and disposal by municipal waste services. All those who handle health care waste should wear appropriate PPE. The volume of infectious waste during the SARI outbreak is expected to increase, especially through the use of PPE. Therefore, it is important to increase the capacity to handle and treat this health care waste. Additional waste treatment capacity, preferably through alternative treatment technologies, such as autoclaving or high temperature burn incinerators, may need to be procured and systems may need to be put in place to ensure their sustained operation. More information can be found in the publication "Water, sanitation, hygiene, and waste management for SARS-CoV-2, the virus that causes COVID-19".

3.6 Electricity

Electricity is a crucial component for the functioning of essential services in a SARI facility as it enables high-quality patient care by ensuring the operation of oxygen production and biomedical devices, as well as meeting general distribution needs within the facility. To ensure continuity of care, a SARI facility should be equipped with a primary reliable electrical source with a backup system. Equipment with high energy consumption, such as oxygen generation plants, may require a dedicated energy supply.

For a secure and reliable electricity supply, the selected site for implementation of the SARI facility should allow easy connection to the electrical grid. If the site is located in remote areas, the local production of energy should be planned, possibly prioritizing sustainable energy sources. When feasible, multiple sources of energy supply should be considered to reduce the risk of load-shedding in periods of high demand or extreme events. A robust and redundant system to ensure a secure and reliable electricity supply may address any potential issues that may arise *(47)*. Electrical systems must comply with local standards and regulations, and qualified technicians should be involved in the design and implementation of the electrical system.

For the electrical installation of a SARI treatment centre, the following priorities must be considered.

- The safety of individuals (protection against electrocution and fire).
- The protection of devices (protection against fire, power instability and effects of lightning).
- The service continuity (protection against service breakdowns, failure of power sources or effects of any other interruption).
- The cost control (aspects that lead to the most accurate choice and sizing of the power sources, and control of the power demand; to facilitate the estimation of the energy, Annex 2 provides the list of medical equipment needed for SARI patients' treatment, useful to estimate the electrical consumption).
- The environmental sustainability (use power sources that meet the criteria above but also provide the lowest emission of air pollutants and carbon dioxide).

If possible, the electrical system should be planned in order to be accessible for maintenance from the low-risk zones of the SARI facility. This will allow for a quicker and safer intervention in the event of system damage.

3.7 Fire safety

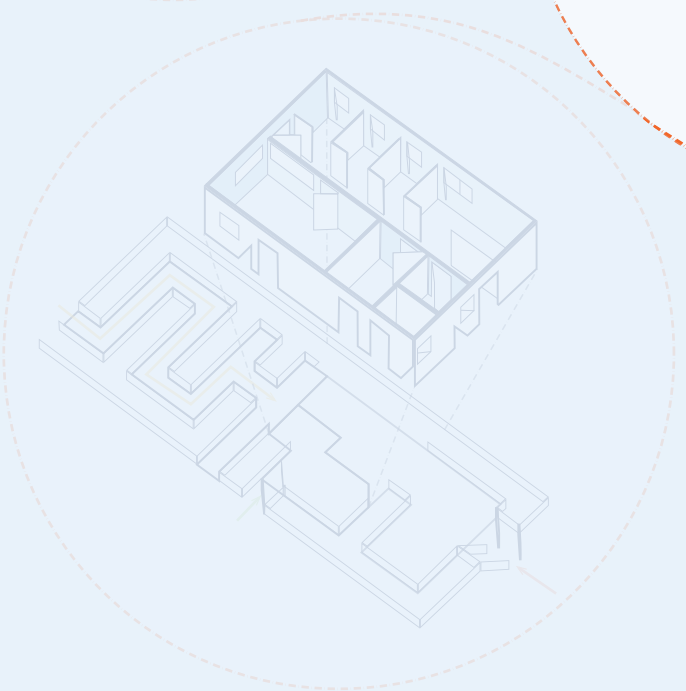
Fire safety is crucial considering that a SARI facility, and in general, health care facilities deal with a large number of patients who may have limited mobility or other health issues that can make them vulnerable in case of a fire and evacuation. Local regulations and guidance on the fire code for permanent buildings must be followed. In a temporary setting, where a SARI facility is installed in tents, for example, consider a safety distance between tents of a minimum of 2.5 times their height *(48).*

SARI facilities should be designed with a clear fire safety strategy in mind including the following aspects.

- The SARI facility must be compliant with fire codes or other guidance and regulation available at local and national level.
- A fire prevention system (including alarms, detection and suppression) must be compliant with local regulation.
- Electrical systems and equipment must be regularly inspected and maintained to prevent electrical fires.
- A fire safety strategy should be conceived as an integral part of the design. A risk of ignition should be minimized; strategies of fire containment should be in place (i.e. compartmentation, fire-resistant construction materials and doors in permanent buildings); the design should facilitate escape.
- The layout of the building should facilitate the evacuation of patients in the event of a fire and allows access to the building perimeter by fire-fighting appliances.
- Staff should be trained on fire safety procedures and protocols, including evacuation plans, use of fire extinguishers, how to respond to fire alarms, and how to recognize potential hazards and report them.
- Evacuation plans should be in place for patients with limited mobility or in critical care, practiced regularly to ensure that everyone is prepared in the event of an emergency, regularly reviewed and updated to ensure that they are effective.
- Smoking must be strictly prohibited in health care facilities, and smoking areas should be located away from the building to reduce the risk of fire.

Many SARI facilities are equipped with an oxygen system, which represents a potential danger in term of fire risk. Pure oxygen is not inflammable by itself. However, it can cause other objects to ignite quickly and rapidly, setting things on fire as it burns faster and hotter than normal air. Leakages and poorly ventilated spaces may represent a threat, making the enclosed environment enriched by oxygen. Oxygen-enriched atmospheres in combination with fuel sources or combustible materials and a heat source can cause fire. Some mitigation measures *(49)* can reduce the risk of fire.

Design Principles



4. Preliminary considerations and design choices

When a country is experiencing sporadic cases, a cluster of cases and community transmission, decision-makers have several options to consider to satisfy the increasing demand of beds for patient treatment and for early identification of suspect cases. The choice of implementing SARI facilities depends on the transmission scenario, as shown in Table 1.

In any case, the timespan for implementation, the availability of spaces and resources play a significant role in the decision-making process. In an emergency context, intervention that allows for quick implementation is preferable as it ensures that the structure is available when the need for beds arise.

The available options include (Fig. 17).

- Reallocating existing services within health care facilities. This involves dedicating a health facility ward or wing to SARI patients, ensuring proper isolation measures or separation from other wards. This option also includes not-in-use health facilities that could be re-opened for the purpose. This approach is usually adopted when a country is experiencing sporadic cases or cluster of cases.
- Repurposing of existing non-medical buildings. This involves facilities with large open spaces (e.g., training halls, exhibition centres, and malls) or with a series of rooms typical of accommodation premises (e.g., hotels, dormitories and schools to some extent). Usually, these facilities are considered when a country is experiencing a cluster of cases or community transmission, to allocate Treatment Centres, Quarantine Facilities or Community Facilities.
- Constructing a new SARI facility. This usually involves a temporary or semi-permanent quick-to-install solution such as tents, prefabricated structures and containers, among other options. Depending on the type of SARI Facility that will be installed (for early detection of cases or for patient treatment), a plot of sufficient dimension should be available for the purpose.

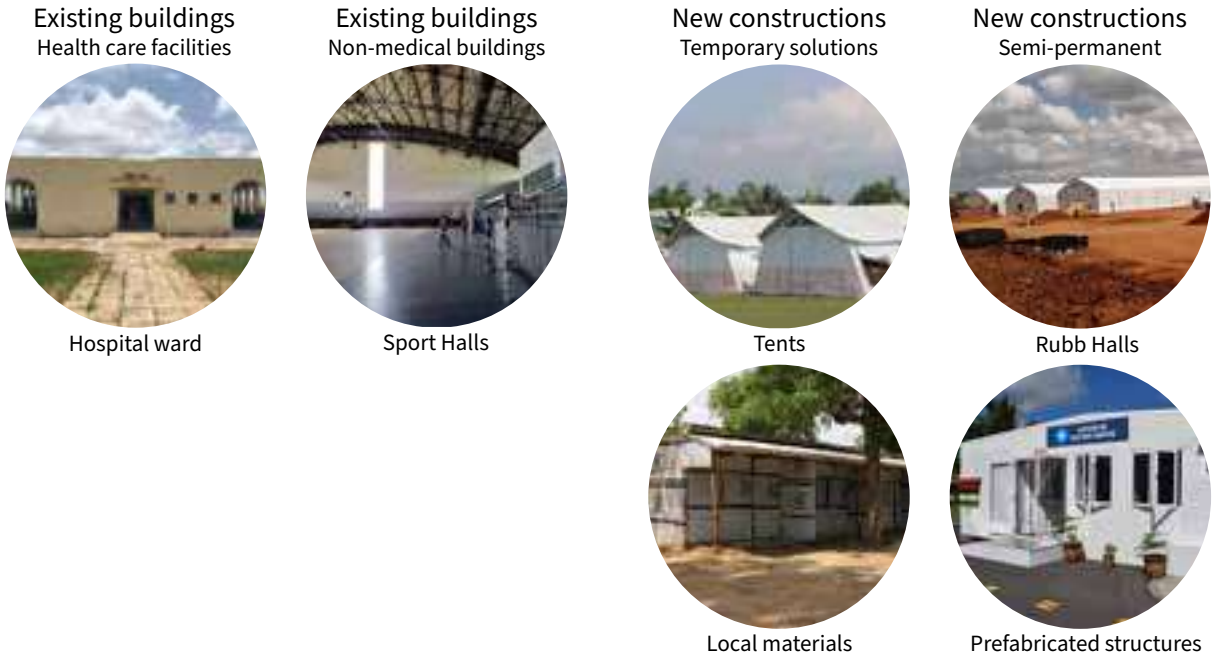


Fig. 17. Examples of SARI facility structural typologies.

Source: Téchne archive

The decision as to whether select one option or another, or a combination of options should be evaluated on a case-by-case basis. Nevertheless, some general considerations should be taken into account. Existing buildings, generally offer more efficient and effective patient care, ensuring better quality in terms of accessibility, services, and comfort for both patients and staff. They also tend to better respond to local climate and weather conditions. Existing buildings are more likely to meet the required safety standards and regulations for health care facilities, ensuring the safety of patients and health professionals. Furthermore, basic infrastructure such as electricity, plumbing, heating and cooling is likely to be already in place. In addition to the general considerations made for the existing buildings, the existing health care facilities may also already have strategic equipment, systems and functions that increase the functionality of the SARI facility and reduce the set-up costs. For example, existing health care facilities may already have medical gases distribution, dedicated or easily accessible diagnostic services, and biomedical devices.

Alternatively, temporary solutions may be more cost–effective, being easily and quickly deployable, easy to be installed and removed. Temporary structures are readily available and can be used promptly in emergency situations. However, regardless of the option chosen, integration with the existing health system is preferable. Having available plots for temporary structures or existing buildings within or nearby the existing hospital compound allows for quicker patient referral, better accessibility to diagnostic services or operating theatres in case of emergency, and easier facility management, avoiding the duplication of budget, staff, and supply systems. Engaging health facility managers, health professionals, as well as engineering, logistic and administrative professionals in the decision-making process is essential to ensure a comprehensive discussion and the most appropriate solution for the context.

4.1 Repurposing existing buildings

There are many advantages in choosing an existing building for the set-up of a SARI facility. This is especially true for those SARI facilities (i.e. treatment centres, community facilities, quarantine facilities, etc.) where the duration of stay/admission is expected to be long. The process steps and the factors to consider differ significantly between repurposing a health care facility and a non-medical building. Retrofitting a non-medical facility is generally more expensive and time-consuming but can provide a considerably higher number of beds, without compromising hospital and other essential health care services.

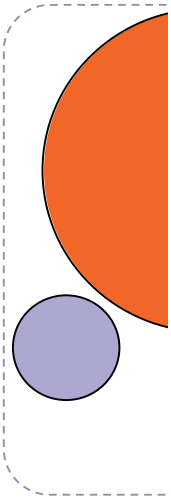
In both cases, a feasibility study is suggested to assess the achievability of the intervention. Such study should take into account existing structure conditions, required interventions, costs, and the implementation timespan. During emergencies, the feasibility study should not represent an obstacle to the quick intervention and should be conducted with the aim of:

- understanding the building conditions;
- planning the needed interventions; and
- estimating the resources needed for the implementation to prevent unexpected challenges and delays during the implementation phase.

The best approach is to conduct these feasibility studies for existing structures as part of a broader preparedness strategy, to save time in case of an epidemic.

Critical aspects of the building to consider include structural components, mechanical and electrical infrastructure, and plumbing systems. The WHO tool "Ensuring a safe environment for patients and staff in COVID-19 health-care facilities: a module from the suite of health service capacity assessments in the context of the COVID-19 pandemic" is available to facilitate assessment and the repurposing of infrastructure.

4.1.1 Health facilities



Repurposing non-essential health facilities, wards, wings, units, clinics, etc. is a more time and resource–efficient approach for setting up a SARI treatment unit. Typically, these buildings already comply with national regulations and standards for health care settings, ensuring a high standard of care with dedicated area for patients, staff and support services. This approach requires fewer interventions, facilitating rapid repurposing and quick beds availability. Additionally, it simplifies facility management in terms of supply and staffing, waste management, linen and reusable PPE management, as these services are already in place. Moreover, it ensures proximity and easy access to diagnostic or emergency services, eliminating the need for patients to be transported outside the facility.

Health facilities or hospitals can be designed intentionally or by chance with empty areas that can be converted into SARI treatment areas. These spaces may include parking lots, waiting rooms, conference or training spaces, medical buildings, hospital wards or wings and other areas that are temporarily not in use. Priority should be given to spaces with existing or easy access to electrical systems, medical gases (especially oxygen), water points, and good ventilation. After selecting the area, particular attention should be given to the study of patient flows, ensuring the separation of SARI patient flows from non-SARI patient flows.

The total number of beds in a health facility could also be increased by adjusting the number of beds per room (e.g., converting single rooms into double rooms). This solution should be considered only when patients have tested positive, and the cohorting of positive-testing patient approach has been adopted. Proper distancing between beds, adequate ventilation and all the IPC measures mentioned in this manual should be ensured.

If empty areas for surging capacity are not available, it may be possible to reallocate existing functions or partially reorganize the health service to dedicate wards to SARI patients. However, it is essential to carefully evaluate this strategy to ensure that essential and emergency services are not disrupted. To increase the number of beds available in existing health facilities and relieve the immediate pressure on the health system, the use of telemedicine and homecare for patients with other conditions may be helpful, and non-essential interventions can be postponed. This should be done with caution and appropriate planning to avoid any potential negative impact on other health care services.

When SARI and non-SARI patients are treated in the same health facility, it is crucial to consider specific measures for the Emergency Department (ED). To prevent cross-contamination, a clear separation should be established between the SARI pathway and the non-SARI pathway, starting from outside the health facility. This can be achieved through a screening station that separates patients arriving by ambulance or autonomously into the appropriate pathway. At the ED level, a dedicated triage and waiting area should be available for both pathways. It is also important to identify dedicated corridors, elevators, and distributive spaces that lead to the treatment and the diagnostic areas (if any) for SARI patients. Furthermore, areas where the presence of SARI patients is foreseen should be equipped with donning and doffing stations to ensure the proper use of PPE.

Box 10. Basic site information to facilitate the potential SARI ward assessment

- Overall site plan and GPS coordinates;
- Technical drawing and main dimensions: plans (mandatory), elevations, sections;
- Structural layout;
- Mechanical, Electrical and Plumbing system layouts;
- Medical gases and an oxygen system plan;
- Strategical services location within the hospital (screening, ED, diagnostic area, etc.);
- Paths to connect entrance, strategical services and SARI ward (number and location of elevators, staircases, ramps);
- Building photos and/or video;
- Documentation of the main accesses and existing roads around the site; and
- Documentation of existing infrastructure/ services (water, waste, electricity, oxygen and medical gases, communications systems, etc.).

4.1.2 Non-medical buildings

To temporarily ease the burden on hospitals and meet the demand for beds, repurposing non-medical buildings such as training halls, exhibition centres, malls, and schools is a viable option. To facilitate the selection of a suitable building for this purpose, several factors should be considered. It is advisable to conduct a feasibility study to assess whether the building can be efficiently converted, and if adequate resources are available prior to starting design and construction works. This preliminary study should include considerations about building availability in terms of time, level of maintenance, and potential costs to revert to the previous activity.

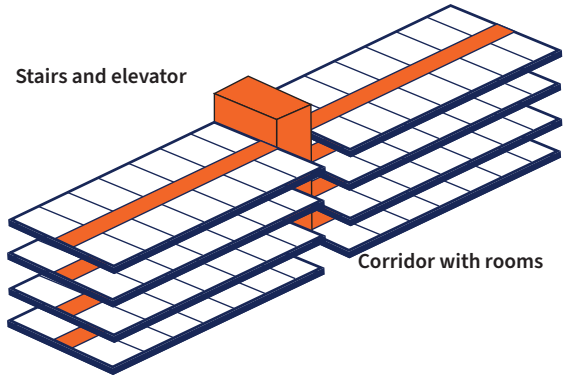


Fig. 17. Schematic representation of accommodation premises. A vertical distribution building such as hotel.

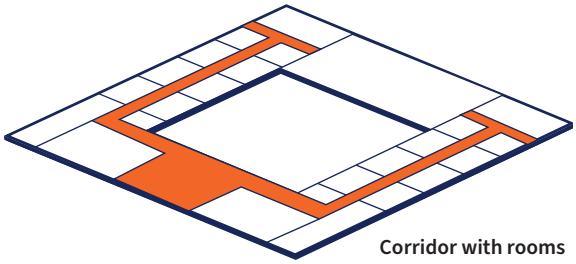


Fig. 18. Schematic representation of accommodation premises. A horizontal distribution building such as a school.

Two main building types could be identified as more suitable for repurposing.

- Accommodation premises (e.g., hotels, dormitories, schools to some extent, etc.). These buildings are characterized by a series of rooms, shared or individual, with dedicated or shared toilets, an entrance with a reception/security desk and several support services areas (e.g., canteen, laundry, storage). These features make them suitable for hosting quarantine facilities or treatment facilities (see Fig.17, 18).
- Open hall buildings (e.g., sports halls, training halls, exhibition centres, malls, etc.). These buildings are characterized by one or a few large open spaces, large entrance halls with a reception area, and several support services (e.g., changing rooms, storage). These characteristics make them suitable for hosting community facilities, and treatment for mild and moderate cases (Fig. 19).

In both cases, certain building features should be checked to ensure the feasibility of the project and to minimize the required building modifications for repurposing the building to a SARI facility. This includes the review of the following elements.

- Accessibility. Check whether the building is accessible by wheelchairs, stretchers, or hospital beds along all patients' pathways. Examine clearances of doors, corridors, elevators, stairs, and ramps to ensure smooth passage and rotation.

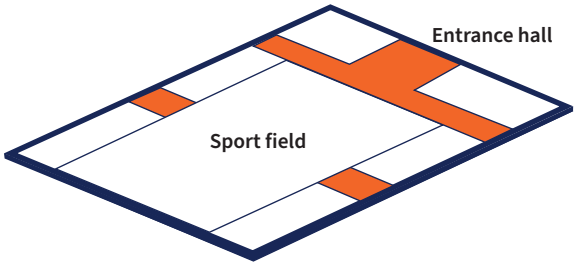


Fig. 19. Schematic representation of an open hall building such as a sport hall.

- Dimensions of critical service areas. Evaluate the dimensions of critical service areas to accommodate basic necessary furniture and equipment, comply with basic IPC measures, and ensure proper occupant movement and activities.
- Main infrastructure systems. Examine main infrastructure systems (such as electricity, HVAC, plumbing systems) to ensure they meet the needs of the new functions required. Assess the capacity to accommodate expected loads and ensure accessibility. Consider emergency power needs at this stage. Involvement of a qualified technician is crucial for the assessment and implementation of necessary modifications. If improvements to systems are required, ensure that the roof structure or designated spaces can meet the needed structural requirements.
- Materials and finishes. Identify materials and finishes that need replacement or covering if they do not comply with IPC standards presented in this manual (e.g., carpets, curtains).
- Post-repurposing building inspection. After repurposing, conduct a thorough inspection to verify that the building meets safety code requirements. Ensure that the fire system is functional, emergency exits are clear, and emergency paths are accessible. This step is critical to guarantee the safety and compliance of the repurposed facility.

Box 11. Basic site information to facilitate the existing building assessment

- overall site plan and GPS coordinates
- technical drawings and main dimensions: plans (mandatory), elevations, sections, elevations, sections
- structural layout
- mechanical, electrical and plumbing system layouts
- site photos or video, aerial photos
- main accesses and existing roads around the site
- rail, road, and other linkages
- existing infrastructure/services (water, electricity, communication, etc.)

4.2 New facilities

Numerous factors may lead to the decision to install a new SARI facility. Among others factors, the absence of suitable existing facilities, or a surge in bed demand that overwhelms the bed availability in existing structures. In the emergency context, when time is a pivotal factor, typically the preference is for temporary or semi-permanent structure characterized by quick installation technologies.

4.2.1 Site identification, selection and survey

When deciding to install a new facility, various factors should be considered in the preliminary stages, before design and construction. Potential site opportunities and limitations should be analysed as they have an impact on the facility. Selecting an appropriate site for constructing a SARI facility is a crucial, as it has a significant impact on its success and functioning. The choice of a site will determine the potential problematic issues that may be encountered concerning ground characteristics and natural hazards, cultural aspects and community acceptance, and eventually site dimensions and the strategic location within the health system. Therefore, it is important to take the necessary time to carefully choose the most adequate site possible, rather than settling for the first available option.

The potential scale of the outbreak, including the size and duration, should be defined from the beginning. The site should have adequate access for patients, visitors, and staff, and should ensure extra space if surge capacity is needed. Proximity to the outbreak epicentre and existing health facilities accelerate patients' referral for those who test negative for SARI but require medical attention for other conditions, thus enhancing integration of the SARI facility in the existing health system. The site should be flat, level, geologically stable, and have proper drainage capacity. Flood-prone areas and locations close to rivers or bodies of water should be avoided. Meteorological conditions and seasonal periods should be considered, as well as prevailing winds and sun orientation. Prevailing winds and microclimate elements should be especially considered if the facility is going to be naturally ventilated (see section "Natural Ventilation").

An area with connections to existing grids and resources such as water, electricity, communication, roads and infrastructures should be prioritized to expedite the facility set-up.

Box 12. Basic site information to facilitate the plot assessment

- site photos or video, aerial photos
- GPS coordinates
- site plan and main dimensions
- site levels, topography
- main accesses and existing roads
- existing services
- ground conditions including hydrological conditions
- prevailing winds
- existing trees, landscape
- existing transport access
- rail, road, other linkages
- existing infrastructure/services (water, electricity, communication, etc.)
- existing health facilities

4.3 Decommissioning

When the number of cases is decreasing and SARI facilities are scaling down, being no longer in use, they should undergo the technical process of decommissioning before being dismantled or repurposed. Decommissioning the structures is intended to ensure:

- For permanent structures, the return to the activities prior to their use as a SARI facility. This can refer to the whole structure or a part of it (e.g., one hospital ward). When only a part of the facility is decommissioned, after the process the area should be cordoned off to prevent unauthorized re-entry to avoid recontamination.
- For permanent structures specifically built during the outbreak, the repurposing as per direction of the relevant health authorities.
- For temporary structures, safe return of the land that hosted the temporary SARI facility to the community.

The technical process of decommissioning includes different steps:

- Preparation. All the equipment undergoing this process should be assessed and revised, considering the future application (e.g., tents, medical equipment, generators, pumping devices, incinerators, etc.). A dedicated space for drying equipment/materials during the cleaning phase and a clean zone to temporarily store the decommissioned material should be identified prior to beginning this process.
- Decontamination. This process aims to prevent the possible future exposure to contaminated structures, equipment or material. Specific cleaning and disinfection protocols should be followed, the IPC officer should observe the process. The clean drying area for decontaminated items should be labelled.
- Repurposing or dismantling. This refers to the disassembly of temporary infrastructure and the potential reuse and/or recycling of materials and equipment. Non-reusable, damaged or deteriorated items should be demolished and properly disposed. No equipment or material should be abandoned on site.

A dedicated team should be identified for the procedure and specifically trained for this purpose. Personal Protective Equipment should be worn during the procedure and clear signage and delimitation should be used to mark the cleaned areas that have already undergone the process.

5. Cultural aspects and community acceptance

Cultural aspects and community acceptance play a significant role in the design and delivery of health care services. Understanding the cultural values and beliefs of the community being served by the SARI facility is essential to provide culturally appropriate and acceptable care. Once the emergency is over, in some contexts, the local community may show resistance to using the non-medical buildings previously used as SARI facilities. In such cases, an education campaign may be necessary to clarify the absence of risk.

The design of health care facilities needs to reflect various local cultural norms and practices, including those related to gender and minorities, dignity and privacy, and spirituality, to ensure that their services are inclusive and responsive to the needs of all patients and their families. Privacy and dignity are fundamental principles that should be achieved throughout the whole patient's journey in a SARI facility, crucial for providing quality care to all patients. Regardless of their gender identity, every individual deserves to have their privacy respected and to be treated with dignity. To achieve this, SARI facilities should strive to provide separate sleeping arrangements and washroom facilities for individuals that identify as a man, woman, both, neither or somewhere along the gender spectrum (e.g., universal washrooms) and should not require patients to pass through areas used by different genders. Same-sex accommodation options include same-sex wards and single rooms *(50).* Mixed wards with separate bays for men and women may be acceptable depending on the local context, only when the other options are not feasible.

The use of transparent surfaces, especially in treatment zones, ensure the constant monitoring of patients' conditions from staff areas. While this design element is key for providing high quality care and the reduction of staff exposure to the pathogen, it also risks undermining patient privacy and dignity. Curtains or shutters systems represent a good solution to improve these aspects.

In the event of a patient's death in the facility, the design should ensure that visitors can safely view and pay respect to the deceased, maintaining IPC standards, dignity, spirituality, and respecting local culture and beliefs.

Overall, the SARI facilities should never convey a sense of isolation. While implementing the safe IPC measures described in this manual, visitors should be allowed to see the patients. The facility design should enhance the feeling of transparency and community inclusion, avoiding patients isolation and stigmatization, while building trust and confidence in the health care system.

An architectural approach to creating well-integrated buildings within their context and their community could increase social inclusion, sense of ownership and future care and maintenance *(51)*. This will be supported with the use of local materials, structural and construction systems including local craftsmanship during construction.

6. Persons with disabilities

All individuals, including persons with disabilities, should be able to easily and safely access and use a SARI facility. Persons with disabilities are individuals who have physical, mental, intellectual, or sensory impairments or health conditions which in interaction with various environmental and societal barriers (e.g., physical, attitudinal, communication, etc.) may limit their participation in society on an equal basis with others *(52)*. These barriers are even more likely to be experienced by the most marginalized among persons with disabilities, such as older persons, women, children, and young persons, among others.

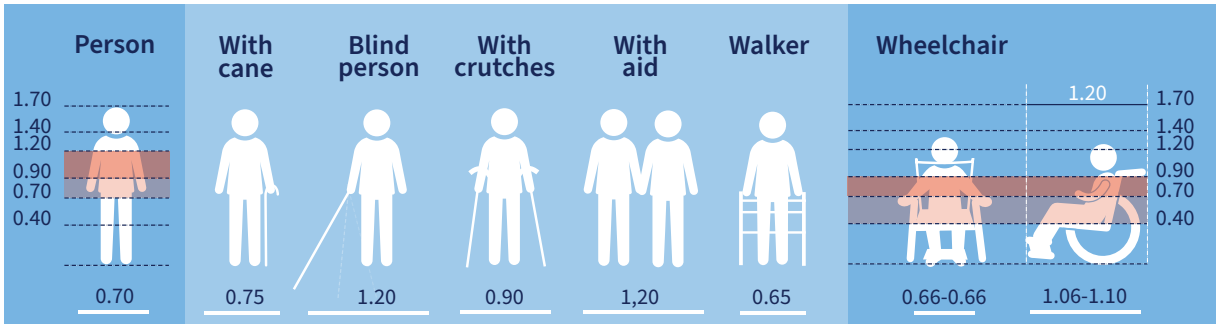
Having accessible and universally designed health facilities can improve the overall health outcomes for persons with disabilities. It can ensure that they receive timely and appropriate medical care without facing barriers such as physical obstacles, poor signage, inaccessible equipment, lack of accessible information, and negative attitudes, while promoting inclusivity.

6.1 Accessibility and reasonable accommodations

Local mandatory standards for accessibility and barrier free design, that cover the subject of access for people with disabilities, should be always a requirement and prioritized during the design. When local regulation is not available, standard urban design considerations, architectural design considerations, and anthropometric factors are available in many design manuals which can be incorporated as best practice in the design approach. One useful example is the United Nations "Accessibility for the disabled. A design manual for a barrier free environment".

Examples of accessibility requirements to be considered include the following characteristics:

- Physical access for people with mobility impairments who may use a range of different mobility devices (Fig. 21). Specific anthropometric and range parameters for people with reduced mobility *(53)* should be taken into account while designing corridors and pathways, ramps and stairs, toilets and rooms.
- The wayfinding system and general signage which should be readable and readily understood by all. This means for instance that large letters (at least 15 mm in height), with appropriate colour contrast with the surrounding surfaces, and international symbols for accessibility should be used in the signs.
- Information on health care and treatment should be provided in different accessible formats. This includes for instance information provided in Braille, using the Easy to read system, or raised letters.
- Ensure places for people with disabilities are available in centrally located areas, ensuring they are properly and equitably visible from the nursing station.



(Unit measures in metres)

Fig. 21. Anthropometric factors for accessibility.

Source: adaptation from "Accessible and Inclusive Design Handbook", Logistics department MSF OCBA

Although facilities may be committed to ensuring that all their physical environments and spaces, communications, information and other services are accessible, some obstacles or barriers may still be present (e.g., because of project constraints, use of existing buildings that do not comply with new regulations on accessibility, limited budget, etc.). Moreover, some obstacles or barriers may require longer times to be completely removed. In these cases, parts of the facility may be temporarily adapted for use by patients or staff with disabilities. A minimum number of rooms suitably sized and designed for use by people with disabilities should be always provided. In these cases, patients and staff with disabilities may also need reasonable accommodations to access and use the facilities. Reasonable accommodations are necessary and appropriate modification(s) and adjustment(s) not imposing a disproportionate or undue burden on the facility, while ensuring persons with disabilities all their human rights and fundamental freedoms on an equal basis with others. Examples of reasonable accommodations may be the availability of a personal assistant or supporter, the possibility to use a service dog or an emotional support animal, or the provision of targeted information in accessible formats.

6.2 Child and family-friendly spaces

Pregnant women, children and adolescents are groups of people that require special consideration in the context of a SARI outbreak. SARI treatment wards should always be equipped with several rooms dedicated to these individuals.

Spaces dedicated to children, consistent with the SARI context, should have the following characteristics *(54)*:

- offer children opportunities to develop, learn, play, and build and strengthen resiliency;
- protect all children and/or specific groups of children from any potential threat;
- provide a stimulating and supportive environment for children to improve their psychosocial well-being; and
- reduce harm from the isolation and loneliness (visibility) and constitute a healing environment.

7. SARI facilities

This section introduces primary design principles for various SARI facilities. The aim of this section is to provide essential information to guide the design process and outcome, irrespective of local conditions, type of construction or unique and context-specific characteristics. Within the scope of the preliminary design of SARI facilities, the following design principles provide the necessary elements to advance a quality design by identifying the functions that define the structure, the activities that take place within it, and the design criteria enabling optimal results (e.g., suitable environment for SARI patient care, optimal functional organization and safety for facility users).

The design principles for each facility include two elements: 1) a table that summarizes the facility characteristics and design criteria, and 2) a conceptual graphic diagram that offers supplementary visual information. The tables provide a comprehensive list of functions and their respective descriptions, design criteria and dimensional specification that define a SARI facility. These functions are divided into two categories: 'Minimum Functions', which encompasses the essential and fundamental functions, and 'Recommended Functions for Optimal Care', which encompasses all other functions that enhance the overall quality of the facility. The functions are also captured as bubbles in the conceptual graphic diagrams to illustrate the logical progression of spaces and their recommended proximity. The diagrams also depict the risk level (low-high) associated with each function and the recommended flows of people and goods through the facility.

It is important to note that the table and the diagram that describe each SARI facility complement each other and should be consulted together for a comprehensive understanding of the main characteristics that influence the design and the functioning of a SARI facility.

The facility characteristics and dimensional specification proposed in the tables serve as a guidance for designers, providing design criteria to ensure optimal care. They do not set minimum requirements. SARI facilities should, in any case, comply with national and local standards and regulations.

7.1 Point of Entry and Border Health

Point of entry and border health provisions in the International Health Regulations (2005) are designed to minimize public health risks caused by the spread of diseases through international traffic. The IHR (2005) define a point of entry as "a passage for international entry or exit of travellers, baggage, cargo, containers, conveyances, goods and postal parcels, as well as agencies and areas providing services to them on entry or exit". There are three types of points of entry: international airports, ports and ground crossings *(3) (4)*.

A point of entry must be designed in a way to enable a rapid flow of people and avoid overcrowding. It should be properly sized to prevent slowdowns in the circulation while ensuring a proper wayfinding and guide all travellers through the screening stations. The facility characteristics and design criteria are presented in Table 5.

Table 5. Facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Crowd management area**	People crossing borders should be guided to the screening station avoiding bottleneck. Physical barriers and proper signage facilitate and guide the movement of crowds.	This area should be designed to ensure adequate physical distancing, fluid (uninterrupted) circulation and prevent bottlenecks. Proper wayfinding is essential to facilitate movement.	• facility staff • facility users and visitors.	10 l/s/person	• Ensure at least 1 m between people *(55).* • Provide a hand hygiene station before accessing the facility: soap and water or alcohol-based hand rub. • Consider a minimum of 4 m^2 per person as dimensional criteria. • Configure rooms to foster a line of 1 person, using partitions, fences, ground signage and proper wayfinding system. • During periods of potential high people flow, establish outdoor waiting areas equipped with shading systems, chairs or benches.
2	**Screening**	Screening of travellers aiming at identifying suspect cases. Main activities performed: • screening according to case definition (using national algorithm); • temperature check.	This area should be designed to: • Permit safe interaction between staff and travellers. • Guarantee sufficient privacy to travellers answering personal questions.	• facility staff • facility users and visitors.	10 l/s/person	• Ensure at least 1 m in between people *(55)* or consider the use of transparent screen between staff area and travellers' area.
3	**Temporary isolation**	Temporary isolation of the identified suspect cases, waiting for the referral to the appropriate facility. If Rapid Diagnostic Tests are available, patient's samples are collected in this room.	This area should be clearly separated from other people's circulation. Ensure staff visibility, communication and safe interaction with the patient awaiting referral, while maintaining sufficient privacy.	• facility staff • facility users • restricted visitors i.e., parents of children and caregivers.	60 l/s/person OR 6 ACH	Depending on the specific location and strategy, the temporary isolation can be: • a simple identified space where suspect cases wait the referral; or • a dedicated self-contained room (if first care is provided, medical staff must be available). In both cases, the isolation area should have: • a hand hygiene station: soap, water, clean towel or alcohol-based hand rub; • a station to perform Rapid Diagnostic Test; • a dedicated toilet for patients; • a dedicated exit for the referral to ensure proper patient flow; and • proper waste segregation, management and transportation.
4	**Donning**	Room or space intended to put on the required PPE. Staff put on PPE before accessing the high-risk area.	The donning area has a unidirectional flow from low-risk areas to high-risk areas in a continuous forward motion (i.e. from staff area to patient area)	• facility staff.	Well ventilated.	• The size of the donning area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5 x 1,2 m per person is needed for staff movement during donning activity *(57)*. • Provide a hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE donning, improve posture and enable self-inspection (56). • Installation of devices to support informative tools such as posters or videos to guide staff during donning procedure. • Additional space for PPE storage should be foreseen.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
5	**Doffing**	Room or space intended to take off the required PPE. Staff carefully take off the PPE after exiting the high-risk areas.	The doffing area has a unidirectional flow from high-risk areas to low-risk areas in a continuous forward motion. (i.e. from patient area to staff area). The floor demarcation indicates the separation between the different risk zones.	• facility staff.	Well ventilated.	• The size of the doffing area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5 x 1,2 m per person is needed for staff movement during doffing activity *(57).* • Provide a hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE removal, improve posture and enable self-inspection *(56).* • Space for PPE correct disposal and proper waste management procedures should be foreseen *(56).* • Installation of devices to support informative tools such as posters or videos to guide staff during doffing procedure. • Presence of large observational windows to observe the doffing personnel is an added value *(56).*

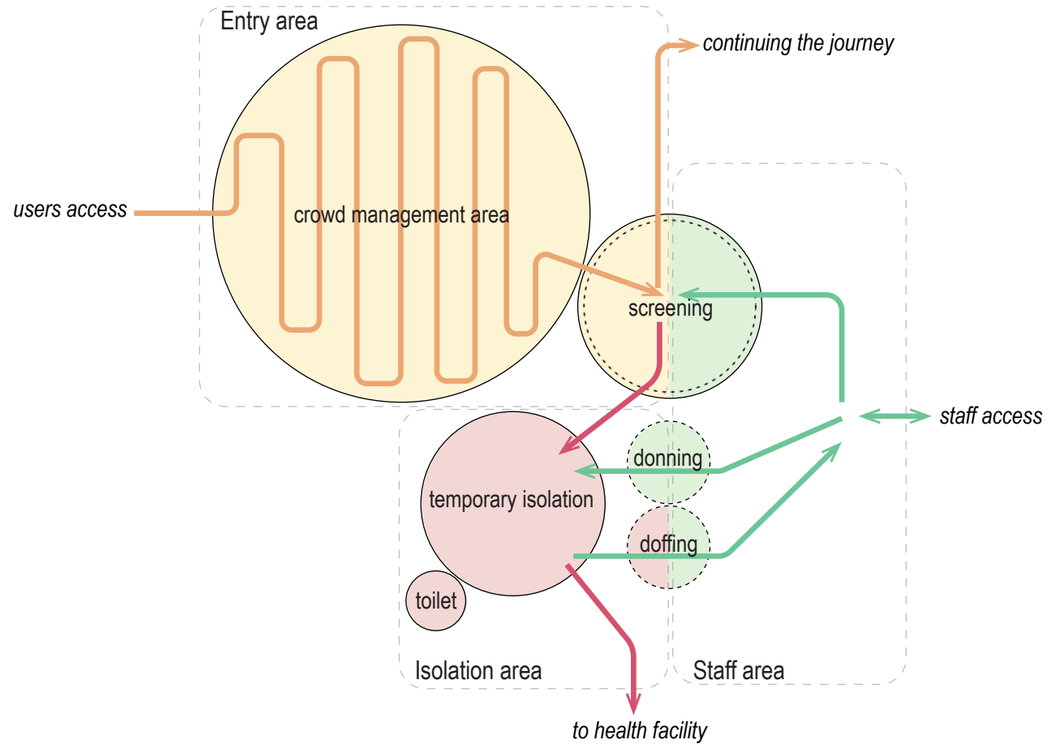
Minimum Functions

Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

Point of entry and border health



7.2 Quarantine Facility

The quarantine of persons is the restriction of activities or the separation of persons who are not ill but who may have been exposed to an infectious agent or disease. The objective of the quarantine is to monitor their symptoms and ensuring the early detection of cases. Quarantine is different from isolation, which is the separation of ill or infected persons (confirmed cases) from others to prevent the spread of infection or contamination *(5)*. For all contacts of individuals with confirmed or probable SARI infection, WHO continues to recommend quarantine in a designated facility or in a separate room in the household *(58) (59)*.

The implementation of quarantine implies the use or creation of appropriate facilities in which a person or persons are physically separated from the community while being cared for *(5)*. Accommodation must provide an appropriate level of comfort and services and allow safe interaction between users. The facility characteristics and design criteria are presented in Table 6.

Table 6. The facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Screening Reception**	Screen all persons at first point of contact in health facility. Identification of the persons who are not ill but who may have been exposed to an infectious agent or disease. The procedure includes: • temperature check; and • person registration.	This area should be designed to: • permit safe interaction between staff and users; and • guarantee sufficient privacy to people answering personal questions.	• facility staff • facility users and visitors.	10 l/s/person	• Ensure at least 1 m between people *(55)* or consider the use of transparent screen between staff area and users area. • Provide a hand hygiene station before accessing the facility: soap and water or alcohol-based hand rub. • During periods of potential high people flow, establish outdoor waiting areas equipped with shading systems, chairs or benches.
2	**Quarantine room**	Separation of persons who are not ill but who may have been exposed to an infectious agent or disease, with the objective of monitoring their symptoms and ensuring the early detection of cases *(58)*. Similar management as for accommodation sector with strengthened IPC measures and contact tracing activities. Health promotion, risk communication and community engagement activities are carried out. Regular communication contents should be defined considering the target population hosted in the quarantine area.	• Quarantine facilities should be conceived to enable early detection of cases while preventing other users to get exposed. • The facility should be designed to accommodate persons for several days. While individual rooms are essential to prevent transmission, enabling safe interaction and communication in between users can contribute to mental health and well-being. • Privacy and comfort should be guaranteed. • Natural daylight should be used as primary light source and access to the exterior is an added value. • At least some of the quarantine accommodations should comply with universal design principles to host vulnerable people or people with disabilities.	• facility staff • patients • restricted visitors i.e., parents of children and caregivers.	10 l/s/person	• As dimensional criteria for design, consider 9 m^2 for individual room (toilet not included) for eating, sleeping, and carrying out minimum daily activities. • Self-contained room is preferable. If shared toilets, ensure regular cleaning after each use. • Some of the rooms/toilets for quarantine should be designed respecting parameters for people with reduced mobility (consider net width 75-80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement, ramp with 6% slope maximum) or for people with special needs (i.e. children with one caregiver). • Communication systems from the quarantine area to staff area may be foreseen.
3	**Consulting room**	Consulting room for clinical assessment is needed for persons who developed symptoms and to provide basic care provision. If testing capacity is in place, sample is collected in this room.	This area should be located nearby the quarantine area (accommodation) to ensure proper flow and reduce movements in shared spaces.	• facility staff • patients • restricted visitors i.e., parents of children and caregivers	10 l/s/person	• Consider 12 m^2 for a standard consulting room *(57)*. • The number of consulting rooms should be proportionated to the quarantine capacity. • Different entrances for staff and patients are preferable. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Accessible by people with reduced mobility (consider net width 75-80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement and 6% maximum slope ramps instead of steps). Ensure space for: • table and chairs • changing area separated with curtains for privacy • couch • supply trolley • minimum drugs storing.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
4	**Temporary isolation**	Temporary isolation of the identified suspect or confirmed cases, waiting for the referral to the appropriate facility.	• This room should be located nearby the consulting room. • This area should be clearly separated from other people's circulation. • Staff visibility, communication and safe interaction with outside assuring enough patient privacy should be ensured while waiting for referral.	• facility staff • patients • restricted visitors i.e., parents of children and caregivers.	60 l/s/person OR 6 ACH	Depending on the specific location and strategy, the temporary isolation can be: • a simple identified space where suspect cases wait the referral; • a dedicated self-contained room (if first care is provided, medical staff must be available); or • the individual quarantine room, if the above-mentioned options are not available. In general, in the isolation area: • a dedicated toilet is preferable; • dedicated exit for the referral is preferable.
5	**Donning**	Room or space intended to put on the required PPE. Staff put on PPE before accessing the high-risk area.	The donning area has a unidirectional flow from low-risk areas to high-risk areas in a continuous forward motion (i.e. from staff area to patient area)	• facility staff.	Well-ventilated.	• The size of the donning area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5 x 1,2 m per person is needed for staff movement during donning activity *(57).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE donning, improve posture and enable self-inspection *(56).* • Installation of devices to support informative tools such as posters or videos to guide staff during donning procedure. • Additional space for PPE storage should be foreseen.
6	**Doffing**	Room or space intended to take off the required PPE. Staff carefully take off the PPE after exiting the high-risk areas.	The doffing area has a unidirectional flow from high-risk areas to low-risk areas in a continuous forward motion. (i.e. from patient area to staff area). The floor demarcation indicates the separation between the different risk zones.	• facility staff.	Well-ventilated.	• The size of the doffing area should ensure that all items are always within arm's reach of the health care worker *(56)*. A net surface of 1,5 x 1,2 m per person is needed for staff movement during doffing activity *(57).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE removal, improve posture and enable self-inspection *(56).* • Space for PPE correct disposal and proper waste management procedures should be foreseen *(56).* • Installation of devices to support informative tools such as posters or videos to guide staff during doffing procedure. • Presence of large observational windows to observe the doffing personnel is an added value *(56).*
7	**Staff offices**	Space for administrative jobs	This space should be adequate for administrative work. Space for archive should be foreseen and natural daylight should be used as primary light source.	• facility staff.	10 l/s/person	• Ensure at least 1 m between people • For sizing continuous use open plan administration areas (with six or more workstations) an allowance of 5 m^2per workstation may be used *(57).*
8	**Staff changing room**	Staff must change personal clothes in this room and access the facility with clean scrubs.	Areas shall be provided separately for male and female staff *(60).* Estimates of the amount of changing space and locker provision should take into account the numbers of staff *(61).*	• facility staff.	10 l/s/person	Staff changing rooms should include: • locker areas for clothes and personal belongings storage; • staff showers and sanitary facilities; • space for seats; • for the purposes of creating a briefing schedule, staff changing areas may be sized at 1,4 m^2 per locker *(62).*
9	**Storage / warehouse**	Logistic store for consumables.	Properly sized according to facility dimension, number of users.	• facility staff.	Well-ventilated.	• Easily accessible from exterior. Openings and corridors should be wide enough to let goods movement with mechanical means. • Option for storage of items that may need cold chain.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
10	**Laundry**	Linen and reusable PPE should be cleaned and disinfected as for specific protocol. Laundry can be managed on-site or off-site.	If internal laundry service is available, it should be located nearby the patient area to reduce the movement and facilitate the flow of dirty and clean materials. The laundry area has a unidirectional flow from high-risk (dirty items) to the low-risk (clean items) area.	• facility staff.	Well-ventilated.	The space should include the following areas: • separate entrance/exit and temporary storages area for dirty materials and clean materials; • washing and disinfection area; • drying area (outdoor if possible); • ironing and packaging area. • The hygiene products are appropriately stored. • Hand hygiene station is available: soap, water, clean towels or alcohol-based hand rub.
11	**Waste area**	General waste should be segregated from infectious and disposed as general municipal waste. Infectious waste produced during patient care, including those with confirmed SARI infection should be collected safely in clearly marked lined containers and sharp boxes. This waste should be treated and then safely disposed *(44)*.	Waste management can be done on-site or off-site. Either way, a dedicated space for temporary storage of waste is recommended. Waste storage and management is preferable in external spaces.	• facility staff.	Well-ventilated.	• Waste area should be easily accessible from exterior, with door lock to prevent access by unauthorized personnel. • Waste should be lifted from the ground, protected from weather elements by a roof and from animals by fencing. • If waste is treated in place, the incinerators smokes should not affect the heath structure neither the neighbours. Considering prevailing winds, it should be in the leeward side. • The floor must be hard and non-porous. • Hand hygiene station is available: soap, water, clean towels or alcohol-based hand rub.

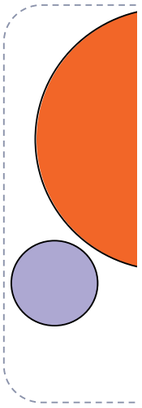
Minimum Functions

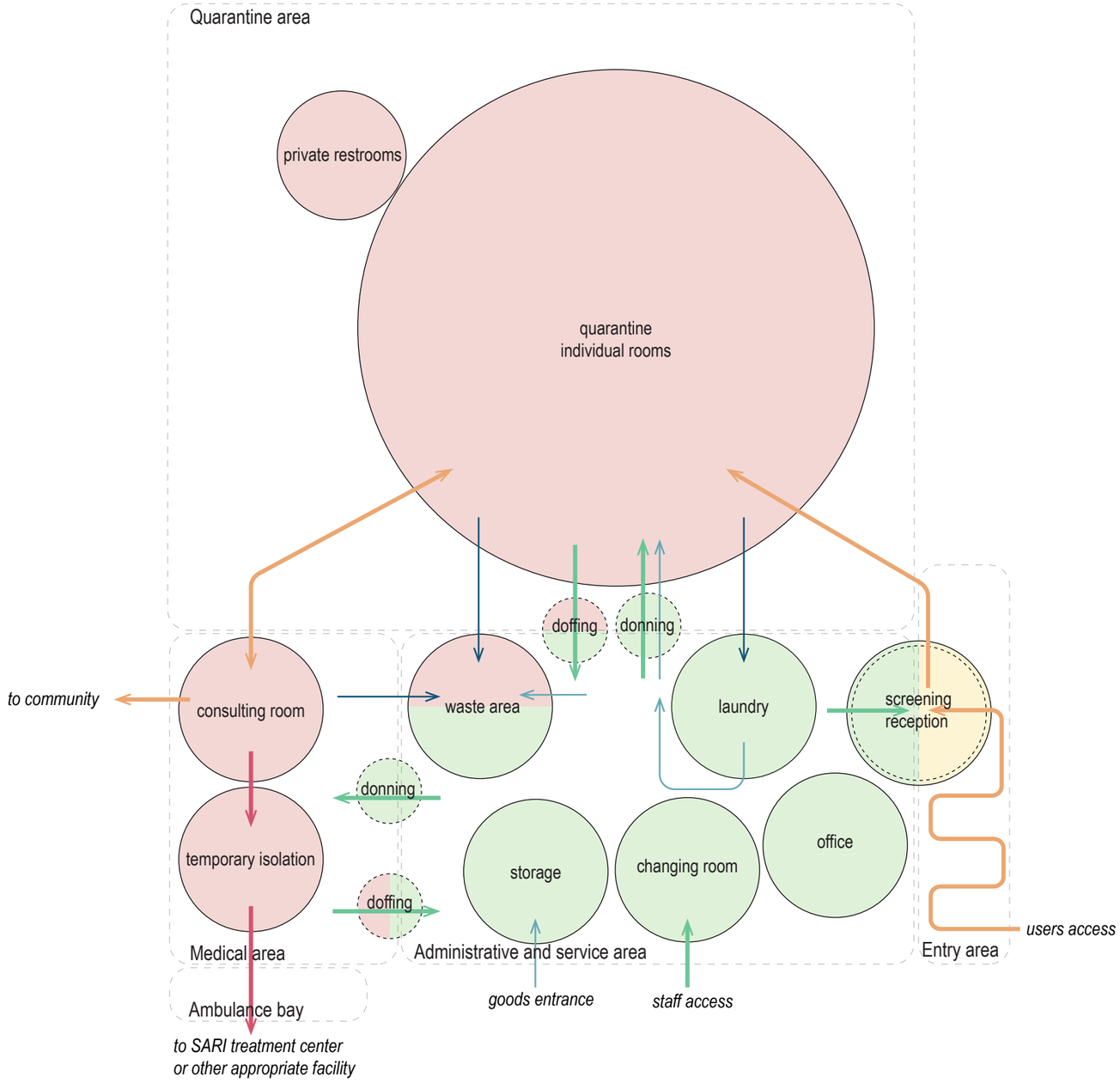
Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

Quarantine facility





7.3 Entry to Health System

All points of access to the health system, including primary health centres, clinics, hospital emergency units, and ad hoc community settings should have screening capacity to ensure early detection of suspected cases. From a structural perspective, the ''entry to health system'' facility varies according to the specific medical activities implemented. For instance, it could be a simple screening station at a dentist clinic, a screening, triage and consultation room in a primary health clinic or a screening, triage, consultation and resuscitation room in a hospital. The facility characteristics and design criteria are presented in Table 7.

These facilities may be stand-alone facilities, commonly called "screening", "triage" or "dépistage", or may be included in other types of health facilities. In any case they represent the first step (with community-based surveillance) for patients to access SARI pathway.

Table 7. The facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Screening Reception**	Screen all persons at first point of contact in health facility. Identification of the suspect cases that should follow the SARI protocols. Screening can be performed in areas such as the emergency unit, outpatient department/ primary care clinic, in the community by a community health worker or by telemedicine *(2)*. The procedure includes: • person registration • temperature check • asking patients a series of simple questions based on standardized case definition *(2)*.	This area should be designed to: • Permit safe interaction between staff and users; • Guarantee sufficient privacy to persons answering personal questions.	• facility staff • facility users and visitors.	10 l/s/person	• Ensure at least 1 m between people (55) or consider the use of transparent screen between staff area and users area. • Ensure there are separated exits for patient who meet and patient who does not meet the case the definition. • Provide a hand hygiene station before accessing the facility: soap and water or alcohol-based hand rub. • During periods of potential high people flow, establish outdoor waiting areas equipped with shading systems, chairs or benches.
2	**Triage**	• Acuity-based triage is the standard method of sorting patients in the medical setting. Standard validated tool should be used to assess for severity of patients and designation to appropriate part of the facility or the health care system *(1) (2)*. • Acuity based triage in the emergency unit or similar area to sort patients into categories based on need for time-sensitive treatment. • Clinical assessment for severity of disease, including assessment of risk factors. • If the capacity of testing is in place, patient's samples are collected in this room.	Triage, clinical assessment and sampling collection take place in a consulting/ examination room. This space is located at the entry point of the facility, close to the screening station, in order to allow clear and rational patients flow. Easy access to diagnostic area (if available) should be foreseen.	• facility staff • patients • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers (2).	60 l/s/person OR 6 ACH	• Consider 12 m^2 for a standard examination/ consulting room *(57)*. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Accessible by people with reduced mobility (consider net width 75–80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement and 6% maximum slope ramps instead of steps). • Different entrances for staff and patients are preferable. Ensure space for: • table and chairs • changing area separated with curtains for privacy • couch • supply trolley. Further dimensional criteria should be based on the clinical assessment protocols, medical devices available and further diagnostic spaces available at facility level.
3	**Donning**	Room or space intended to put on the required PPE. Staff put on PPE before accessing the high-risk area.	The donning area has a unidirectional flow from low-risk areas to high-risk areas in a continuous forward motion (i.e. from staff area to patient area).	• facility staff.	Well-ventilated.	• The size of the donning area should ensure that all items are always within arm's reach of the health care worker *(56)*. A net surface of 1,5 x 1,2 m per person is needed for staff movement during donning activity *(57)*. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE donning, improve posture and enable self-inspection *(56)*. • Installation of devices to support informative tools such as posters or videos to guide staff during donning procedure. • Additional space for PPE storage should be foreseen.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
4	**Doffing**	Room or space intended to take off the required PPE. Staff carefully take off the PPE after exiting the high-risk areas.	The doffing area has a unidirectional flow from high-risk areas to low-risk areas in a continuous forward motion. (i.e. from patient area to staff area) The floor demarcation indicates the separation between the different risk zones.	• facility staff.	Well-ventilated.	• The size of the doffing area should ensure that all items are always within arm's reach of the health care worker *(56)*. A net surface of 1,5 x 1,2 m per person is needed for staff movement during doffing activity *(57)*. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE removal, improve posture and enable self-inspection *(56)*. • Space for PPE correct disposal and proper waste management procedures should be foreseen *(56)*. • Installation of devices to support informative tools such as posters or videos to guide staff during doffing procedure.
5	**Temporary isolation room**	Temporary isolation of the identified suspect cases, waiting for the referral to the appropriate facility of ward.	• This room should be located nearby the consulting room. • This area should be clearly separated from other people's circulation. • Staff visibility, communication and safe interaction with outside assuring enough patient privacy should be ensured while waiting for referral.	• facility staff • patients • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2)*.	60 l/s/person OR 6 ACH	According to the specific location and strategy, the temporary isolation could be: • a simple identified space where suspect cases can wait the referral; or • a dedicated self-contained room (if first care is provided, medical staff must be available). In general, regardless of the chosen option: • dedicated toilet is preferable • a dedicated exit for the referral is preferable.

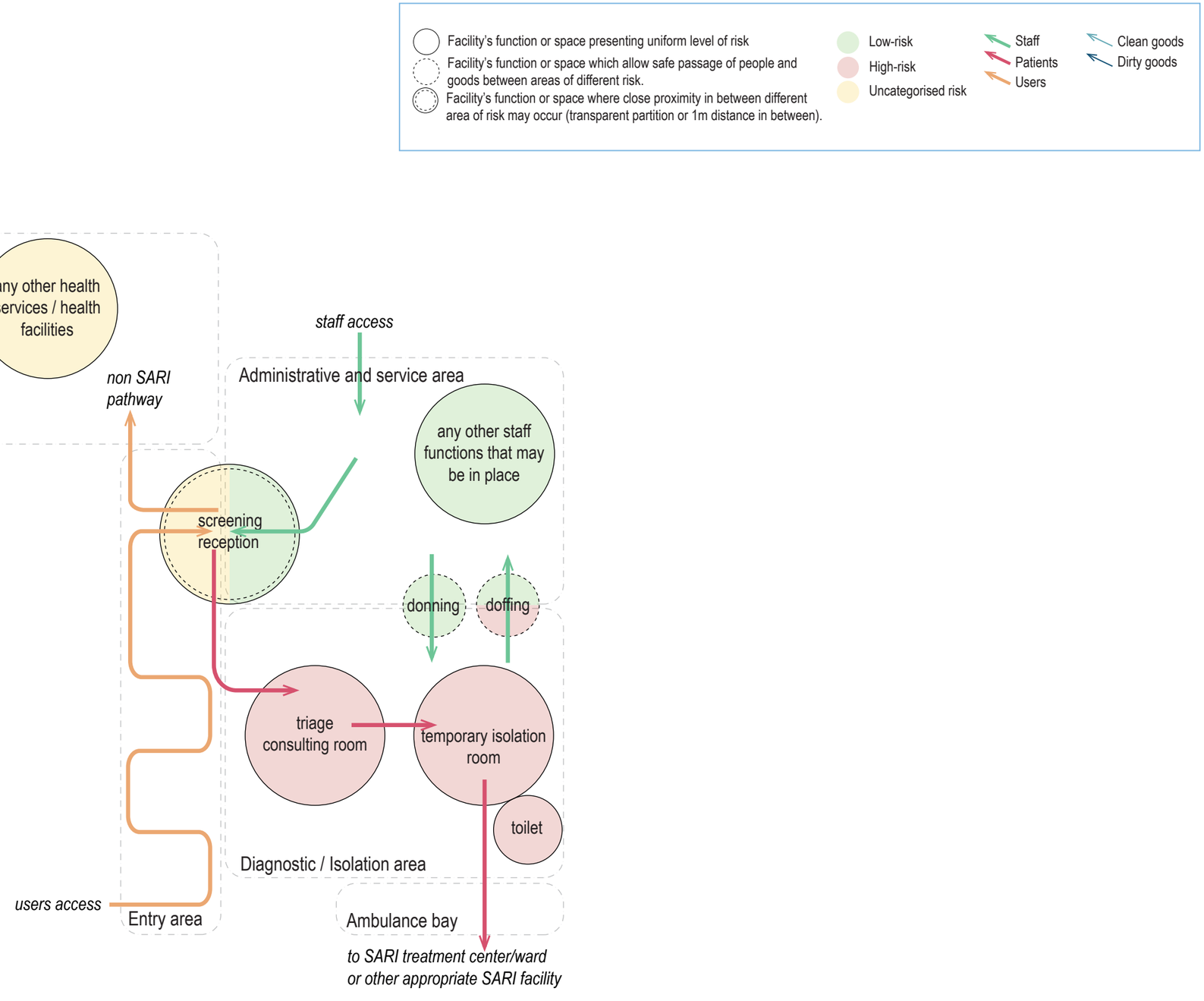
Minimum Functions

Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

Entry to health system



7.4 SARI Treatment Centre or Ward

SARI dedicated health facility or dedicated ward into an existing structure where SARI patients receive appropriate care. The facility characteristics and design criteria are presented in Table 8.

Table 8. The facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Screening**	Screen all persons at first point of contact in health facility. Identification of the suspect cases that should follow the SARI protocols. Screening can be performed in areas such as the emergency unit, outpatient department/ primary care clinic, in the community by a community health worker or by telemedicine *(2).* The procedure includes: • person registration • temperature check • asking patients a series of simple questions based on standardized case definition *(2).*	This area should be designed to: • Permit safe interaction between staff and users; and • Guarantee sufficient privacy to persons answering personal questions.	· facility staff; · facility users and visitors.	60 l/s/person OR 6 ACH	• Ensure at least 1 m in between people *(55)* or consider the use of transparent screen between staff area and users' area. • Ensure there are separated exits for patient who meet and patient who does not meet the case the definition. • Provide a hand hygiene station before accessing the facility: soap and water or alcohol-based hand rub.
2	**Waiting area**	Waiting area dedicated to patients waiting for the following step according to the SARI pathway.	This area should be designed in order to avoid overcrowding, ensure distancing and clear circulation.	· facility staff; · patients; · in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	60 l/s/person OR 6 ACH	• Ensure at least 1 m between people *(55).* • As dimensional criteria for design, consider at least 3 m^2 for individual booths or at least 6 m^2 per patient in open spaces *(63).*
3	**Triage**	• Acuity-based triage is the standard method of sorting patients in the medical setting. Standard validated tool should be used to assess for severity of patients and designation to appropriate part of the facility or the health care system (2) (1). • Acuity based triage in the emergency unit or similar area to sort patients into categories based on need for time-sensitive treatment. • Clinical assessment for severity of disease, including assessment of risk factors. • If the capacity of testing is in place, patient's samples are collected in this room.	Triage, clinical assessment and sampling collection take place in a consulting/ examination room. This space is located at the entry point of the facility, close to the screening station, to allow clear and rational patients flow. Easy access to diagnostic area (if available) should be foreseen	· facility staff; · patients; · in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	60 l/s/person OR 6 ACH	• Consider 12 m^2 for a standard examination/ consulting room *(57).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Accessible by people with reduced mobility (consider net width 75–80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement and 6% maximum slope ramps instead of steps). • Different entrances for staff and patients are preferable. Ensure space for: · table and chairs; · changing area separated with curtains for privacy; · couch; and · supply trolley. Further dimensional criteria should be based on the clinical assessment protocols, medical devices available and further diagnostic spaces available at facility level.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
4	**Resuscitation room**	Patients who arrived in critical condition (triaged as ‘’red’’) should immediately been transferred to the resuscitation room.	For rapid reception of patients, the resuscitation area is easily accessible to the main emergency unit entry areas including the ambulance entrance, main entrance and triage area. The resuscitation area is easily visible from the main nurses station and physician work area, and staff is aware of its location and function. The resuscitation area has enough space to accommodate multiple providers and equipment. Easy access to radiology, operating theatres and intensive care unit *(64).*	• facility staff • patients.	160 l/s/person OR 12 ACH	• The room should be accessible by hospital bed or stretcher. Doors and corridor should be wide enough. • Oxygen delivery devices should be in place. • Backup generators for medical equipment and alternative oxygen reserves (e.g. high-pressure cylinders) are crucial for oxygen needs to ensure that patient treatment is not interrupted. • An anteroom to patients’ rooms can improve airflow control. • Easily accessible from exterior: patients transported by ambulance may access this room. • When possible, more than one place is preferable arranged in individual rooms or in a shared room separated by curtains. Consider 12 m^2 per bed. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Ideally, it should be provided 360-degree access to the patient beds/ stretchers, and space for staff to move around the patient.
5	**Critical cases ward**	Treatment of patient with critical symptoms.	• Suspect and confirmed cases shall be treated in different areas; individual rooms are preferable for suspected cases. Generally, multi-bedrooms allow closer monitoring of patients and facilitate staff work. • Patient’s room and ward should be designed to ensure safe care provision, comfort and privacy while enabling direct patient observation. • Natural daylight should be used as primary light source. • If the health care facility is not entirely dedicated to patients affected by Severe Acute Respiratory Infection, this ward should be located away from vulnerable groups. • The location and design should enable expansion if additional beds are required in the future *(65).*	• facility staff; • patients; • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	160 l/s/person OR 12 ACH	• Doors and corridor should be wide enough to ensure access with hospital beds and stretcher. • Oxygen should be available at the bedside of the patient. • Backup generators for medical equipment and alternative oxygen reserves (e.g. high-pressure cylinders) are crucial for oxygen needs to ensure that patient treatment is not interrupted. • An anteroom to patients’ rooms can improve airflow control. • Proximity or direct access to diagnostic area/operating theatre if any is an added value. • Huge transparent partition between patient room and nursing station allows easier patient monitoring rationalising the use of PPE. • Bedside monitoring equipment should be located to permit easy access and viewing, and should not interfere with the visualisation of, or access to the *patient (65).* • Consider around 1 m^2 at bedside for biomedical devices. • Sluice room should be available at ward level. • Clinical equipment store with easy access to the bed areas may be foreseen. It is a dedicated area for the storage and charging of transfer equipment *(66).* • For single isolation room around 18 m^2 should be foreseen *(67).* In multi-bed rooms: • consider 2 m between beds; • single bedroom / bay dimensions should be 3,90 x 3,90 m, with no objects in the circulating zone around the bed *(65);* • each bed space should be separated to provide a degree of privacy. If curtains are used the bed space should still be well illuminated and ventilated *(57)*;

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
6	**Severe cases ward**	Treatment of patient with severe symptoms.	• Suspect and confirmed cases shall be treated in different areas; individual room are preferable for suspected cases. • Patient's room and ward should be designed to ensure safe care provision, comfort and privacy while enabling direct patient observation. • Natural daylight should be used as primary light source. • If the health care facility is not entirely dedicated to patients affected by Severe Acute Respiratory Infection, this ward should be located away from vulnerable groups.	• facility staff; • patients; • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	160 l/s/person OR 12 ACH	• Doors and corridor should be wide enough to ensure access with hospital beds and stretcher. • Oxygen should be available at the bedside of the patient. • Backup generators for medical equipment and alternative oxygen reserves (e.g. high-pressure cylinders, bedside concentrators) are crucial for oxygen needs to ensure that patient treatment is not interrupted. • An anteroom to patients' rooms can improve airflow control. • Bedside monitoring equipment should be located to permit easy access and viewing, and should not interfere with the visualisation of, or access to the patient *(65).* • Toilets and shower should be available. Male and female separation is required. Individual rooms with enclosed restrooms are preferable for suspect cases. • Clinical equipment store with easy access to the bed areas may be foreseen. It is a dedicated area for the storage and charging of transfer equipment *(66).* In multi-bed rooms: • consider 2 m between beds; • single bedroom / bay dimensions should be 3,45 x 3,6 m, with no objects in the circulating zone around the bed *(68);* • each bed space should be separated to provide a degree of privacy. If curtains are used the bed space should still be well illuminated and ventilated *(57).*
7	**Mild–moderate cases ward**	Treatment of patient with mild or moderate symptoms.	• Suspect and confirmed cases shall be treated in different areas; individual rooms are preferable for suspected cases. • Patient's room and ward should be designed to ensure safe care provision, comfort and privacy while enabling direct patient observation. • Natural daylight should be used as primary light source and access to the exterior is an added value.	• facility staff; • patients; • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	60 l/s/person OR 6 ACH	• Doors and corridor should be wide enough to ensure access with hospital beds and stretcher. • Male and female separation is required. Individual rooms with enclosed restrooms are preferable for suspect cases. • Some of room/toilet should be designed respecting parameters for people with reduced mobility (i.e., consider 75–80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement). • Single bedroom / bay dimensions should be 3,45 x 3,6 m, with no objects in the circulating zone around the bed *(68)*. In multi-bed rooms: • consider 2 m between beds; • each bed space should be separated to provide a degree of privacy. If curtains are used the bed space should still be well illuminated and ventilated *(57)*.
8	**Ward nursing station**	Staff workplace within treatment wards. This area is dedicated to staff for patients monitoring, patients file management, drugs preparation and routines activities.	• While designing the nursing station consider staff safety. • Proximity and direct visual contact with all the patients, especially severe and critical cases is recommended. • Donning room should be in proximity.	• facility staff.	10 l/s/person	• Whether the nursing station is located in the staff or in the patient area depend on national protocols, model of work and HR availability. • Mechanism of information transfer from patient area to nursing area may be foreseen. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
9	**Donning**	Room or space intended to put on the required PPE. Staff put on PPE before accessing the high-risk area.	The donning area has a unidirectional flow from low-risk areas to high-risk areas in a continuous forward motion (i.e. from staff area to patient area).	• facility staff.	Well-ventilated.	• The size of the donning area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5x 1,2 m per person is needed for staff movement during donning activity *(57).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE donning, improve posture and enable self-inspection *(56).* • Installation of devices to support informative tools such as posters or videos to guide staff during donning procedure. • Additional space for PPE storage should be foreseen.
10	**Doffing**	Room or space intended to take off the required PPE. Staff carefully take off the PPE after exiting the high-risk areas.	The doffing area has a unidirectional flow from high-risk areas to low-risk areas in a continuous forward motion. (i.e. from patient area to staff area). The floor demarcation indicates the separation between the different risk zones.	• facility staff.	Well-ventilated.	• The size of the doffing area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5x 1,2 m per person is needed for staff movement during doffing activity *(57).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Placing mirrors to assist during PPE removal, improve posture and enable self-inspection *(56).* • Space for PPE correct disposal and proper waste management procedures should be foreseen *(56).* Installation of devices to support informative tools such as posters or videos to guide staff during doffing procedure. • Presence of large observational windows to observe the doffing personnel is an added value. *(56).*
11	**Clean Utility**	Temporary storage at ward level.	This room provides storage for sterile supplies, consumables and clean linen for a number of wards. Supplies trolleys are brought here for restocking *(61).* The number and the room dimension should be in proportion to the number of patients. In facilities with few beds it could be centralized at facility level.	• facility staff.	.	• The space should be accessible by trolleys or mechanical means for bags movement. • The room dimension depends on the linen and consumable storage furniture, staff movement and the number of beds at ward level. • Storage opening directly from circulation areas may be more convenient in particularly for goods for which stocks are maintained by an exchange trolley service *(61).*
12	**Soiled utility**	Temporary storage, at ward level, for dirty material to move to waste zone, laundry or reprocessing equipment area.	The location of this room should minimise travel distances for staff from patient areas to reduce the risk of spillages and cross contamination, and to increase working efficiencies *(57).* The number and room dimension should be in proportion to the number of patients and the equipment available at ward level. In facilities with few beds it could be centralized at facility level.	• facility staff.	Well-ventilated.	• The space should be accessible by trolleys or mechanical means for bags movement. • Sluice sink and bedpan processing equipment may be available in this room. • According to the facility protocols, soiled linen, soiled equipment and waste may be stored in separated rooms, before moving respectively to laundry, reprocessing equipment area, waste zone. • Dedicated space for housekeeping materials strategically located in the ward.
13	**Discharge**	Patients are released from SARI care pathway following specific case management criteria and protocols. The exit point is controlled.	Easily accessible from patients' ward.	• facility staff • patients.	Well-ventilated.	Exit directly toward outside.
14	**Morgue**	A morgue or mortuary is a room or area where dead bodies are kept until burial or cremation.	Safe preparation and exposition of the dead body. Visitors can access this space which should be a dignified space for the last farewell.	• facility staff • visitors.	Well-ventilated.	• The room should be accessible by hospital bed or stretcher. Doors and corridor should be wide enough. • The area should be easily accessible by the external side. • Visitors should have safely access to this room, transparent partitions may be foreseen for this purpose. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
15	**Diagnostic area**	Room/s for diagnostic devices (i.e. X-ray) may be available at facility level.	This area should be designed according to the diagnostic devices available. It should be easily accessible both from the admission area and the treatment area.	• facility staff • patients.	60 l/s/person OR 6 ACH OR per local regulation.	Doors and corridor should be wide enough to ensure access with hospital beds and stretcher. Normally this area is characterized by: • examination room; • control room with direct visibility on the examination area; • changing cubicles for patients; • further specific design strategies should be chosen according to the diagnostic devices available.
16	**Laboratory**	Laboratory service can be managed on-site or off-site. All suspect cases should be tested to determine if they are a confirmed case. Until proven negative, all suspected cases should remain in the SARI care pathway. If testing is not available, the person becomes a probable case (based on clinical suspicions) and should be cared for in the SARI pathway.	SARI test capacity with safe handling procedures. Collected samples could be analysed off-site if a laboratory is not available at facility level. If lab is available internally, dedicated storage is needed. Lab waste should be carefully disposed and managed.	• facility staff.	Negative pressure must be maintained inside the facility. Both supply and exhaust air must be HEPA-filtered *(69)*.	• The laboratory activities can be performed safely, efficiently and ergonomically *(69)*. • The normal movement of personnel, specimens, materials and waste can be performed safely without disturbing or affecting ongoing work in laboratories *(69)*. • In case of an emergency, there is sufficient space for personnel to move quickly, or be assisted, carried or even dragged if illness or injury has occurred *(69)*. • Hidden spaces or surfaces, such as behind or underneath furniture and equipment, can be accessed for maintenance, cleaning and decontamination *(69)*. • There is adequate space and access for any necessary safety equipment, such as isolation switches, fire extinguishers and safety showers *(69)*. • Hand hygiene station is available: soap, water, clean towels or alcohol-based hand rub.
17	**Reprocessing equipment**	Room or space for care, cleaning and disinfection of reusable medical devices. Sterilization, if available, is located in this area.	• devices are reprocessed at centralised level; • location of this area should be chosen in order to minimize travel distance from critical and severe wards.	• facility staff.	Well-ventilated.	• Separate entrance (dirty equipment) and exit (clean equipment) are recommended. The flows of the equipment is unidirectional from less clean zones to cleaner zones. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. • Easy-to-clean finishing. • Proper waste disposal should be in place. Ensure space for: • temporary store for medical equipment; • cleaning, disinfecting and sterilization (if available) devices; and • area for drying and devices inspection.
18	**Waste area**	General waste should be segregated from infectious and disposed as general municipal waste. Infectious waste produced during patient care, including those with confirmed SARI infection should be collected safely in clearly marked lined containers and sharp boxes. This waste should be treated and then safely disposed *(44)*.	Waste management can be done on-site or off-site. Either way, a dedicated space for temporary storage of waste is recommended. Waste storage and management is preferable in outdoor spaces.	• facility staff.	Well-ventilated.	• Waste area should be easily accessible from exterior, with door lock to prevent access by unauthorized personnel. • Waste should be lifted from the ground, protected from weather elements by a roof and from animals by fencing. • If waste is treated in place, the incinerators smokes should not affect the heath structure neither the neighbours. Considering prevailing winds, it should be in the leeward side. • The floor must be hard and non-porous. • Hand hygiene station is available: soap, water, clean towels or alcohol-based hand rub.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
19	**Laundry**	Linen and reusable PPE should be cleaned and disinfected as for specific protocol. Laundry can be managed on-site or off-site.	If internal laundry service is available, it should be located nearby the patient's area to reduce the movement and facilitate the flow of dirty and clean materials. The laundry area has a unidirectional flow from high risk (dirty items) to low risk (clean items) area.	• facility staff.	Well-ventilated.	The space should include the following areas: • separate entrance/exit and temporary storages area for dirty materials and clean materials; • washing and disinfection area; • drying area (outdoor if possible); • ironing and packaging area; • the hygiene products are appropriately stored; and • hand hygiene station is available: soap, water, clean towels or alcohol-based hand rub.
20	**Pharmacy**	Drugs should be available at facility level according to national protocols.	Adequate space, equipment, and supplies shall be available for all professional and administrative functions relating to pharmacy services. These resources shall meet all applicable laws and regulations; shall be located in areas that facilitate the provision of services to patients, nurses, prescribers, and other health care providers; and shall be integrated with the hospital communication and delivery or transportation systems *(70)*.	• facility staff.	Well-ventilated.	• Easily accessible from exterior; and • Openings and corridors should be wide enough to let goods movement with mechanical means.
21	**Storage / warehouse**	Logistic store for consumables.	Designated staff manage the warehouse.	• facility staff.	Well-ventilated.	• Easily accessible from exterior. Openings and corridors should be wide enough to let goods movement with mechanical means.
22	**Staff changing room**	Staff must change personal clothes in this room and access the facility with clean scrubs.	Areas shall be provided separately for male and female staff *(60)*. Estimates of the amount of changing space and locker provision should consider the numbers of staff *(61)*.	• facility staff.	10 l/s/person	Staff changing rooms should include: • locker areas for clothes and personal belongings storage; • staff showers and sanitary facilities; and • space for seats. For the purposes of creating a briefing schedule, staff changing areas may be sized at 1,4 m^2 per locker *(62)*.
23	**Staff offices**	Space for administrative jobs.	This space should be adequate for administrative work. Space for archive should be foreseen and natural daylight should be used as primary light source.	• facility staff.	10 l/s/person	• At least 1 m distance between people • For sizing continuous use open plan administration areas (with six or more workstations) an allowance of 5 m^2 per workstation may be used *(57)*.

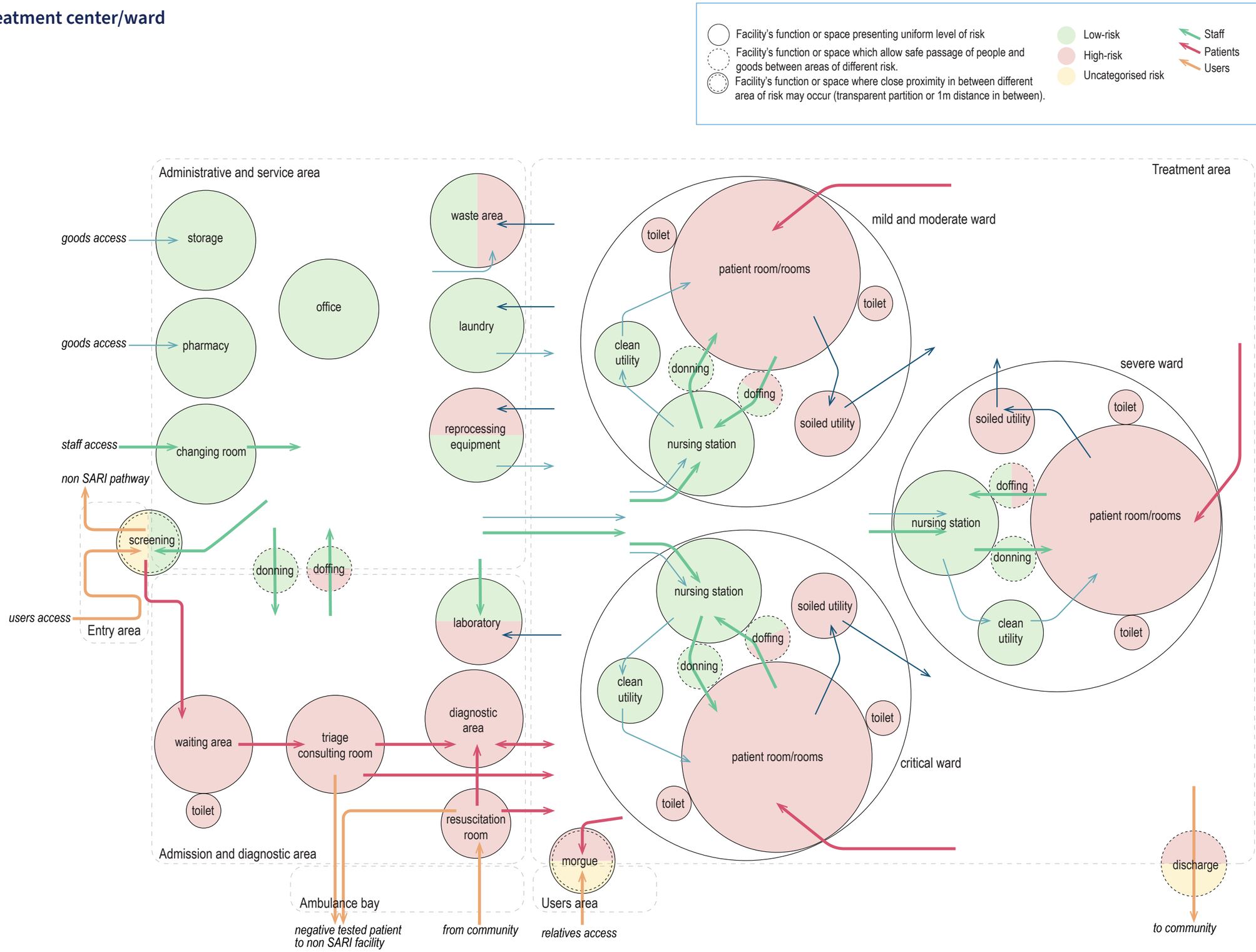
Minimum Functions

Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

SARI treatment center/ward



7.5 Community Facility

Patients with mild and moderate illness may not require emergency interventions or hospitalization; however, isolation is necessary for all suspect or confirmed cases to contain virus transmission. The decision to monitor a suspect case in a health facility, community facility or home should be made on a case-by-case basis (2).

Community facility (i.e. stadium, gymnasium, hotels) are intended to cohort patients with mild or moderate symptoms that need to be monitored in order to try to reduce the spreading of the disease(1). Community facilities should be located close to hospital or treatment facilities for quick referral in case of patients' conditions worsening. The facility characteristics and design criteria are presented in Table 9.

Table 9. The facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Screening**	Screen all persons at first point of contact in health facility. Identification of the suspect cases that should follow the SARI protocols. Screening can be performed in areas such as the emergency unit, outpatient department/ primary care clinic, in the community by a community health worker or by telemedicine *(2).* The procedure includes: • person registration; • temperature check; • asking patients a series of simple questions based on standardized case definition *(2).*	This area should be designed to: • Permit safe interaction between staff and users; • Guarantee sufficient privacy to persons answering personal questions.	• facility staff; • facility users and visitors.	10 l/s/person.	• Ensure at least 1 m in between people *(55)* or consider the use of transparent screen between staff area and users' area. • Ensure there are separated exits for patient who meet and patient who does not meet the case the definition.
2	**Consulting room**	Consulting room for clinical assessment is needed for persons who developed symptoms and to provide basic care provision. If testing capacity is in place, sample is collected in this room.	This area should be located nearby the quarantine area (accommodation) in order to ensure proper flow and reduce movements in shared space. Space for minimum drugs storing should be foreseen.	• facility staff; • patients; • restricted visitors. i.e., parents of children and caregivers.	60 l/s/person OR 6 ACH	• Consider 12 m^2 for a standard consulting room *(57).* • Accessible by people with reduced mobility (consider net width 75–80 cm for wheelchairs passages and 150 cm for wheelchair rotation and movement and 6% maximum slope ramps instead of steps). • Number of consulting rooms should be proportionated to the quarantine capacity. • Different entrances for staff and patients are preferable. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub. Ensure space for: • table and chairs; • changing area separated with curtains for privacy • couch; and • supply trolley.
3	**Mild-moderate cases ward**	Treatment of patient with mild or moderate symptoms. Suspect and confirmed cases shall be treated in different areas; individual rooms are preferable for suspected cases. Patients' accommodation with basic services: hygiene, food, health care.	Inpatients presenting mild or moderate symptoms are treated and kept under monitoring by staff in the mild and moderate ward. Gender segregation and cultural factors should be foreseen for patient safety. Enabling safe interaction and communication in between users can contribute to mental health and well-being.	• facility staff • patients • in areas with SARI community transmission, restrict visitors to those that are essential such as the parents of paediatric patients and caregivers *(2).*	60 l/s/person OR 6 ACH	• the room should be accessible by hospital bed or stretcher. Doors and corridor should be wide enough. Consider 2 m between beds if the room is not individual. • Single bedroom / bay dimensions should be 3,45 x 3,6 m, with no objects in the circulating zone around the bed *(68).* • Separated male and female toilets and showers. • To consider prayer room/space and/or recreation space. Preferably outdoor areas or well-ventilated spaces.
4	**Ward nursing station**	Staff workplace within treatment wards. This area is dedicated to staff for patients monitoring, patients file management, drugs preparation and routines activities.	While designing the nursing station consider staff safety. Direct visual contact with all the patients is recommended. Donning room should be in close proximity.	• facility staff.	10 l/s/person	Whether the nursing station is located in the staff or in the patient depend on national protocols, model of work and HR availability. Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
5	**Donning**	Room or space intended to put on the required PPE. Staff put on PPE before accessing the high-risk area.	The donning area has a unidirectional flow from low-risk areas to high-risk areas in a continuous forward motion (i.e. from staff area to patient area).	• facility staff.	Well-ventilated.	• The size of the donning area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5 x 1,2 m per person is needed for staff movement during donning activity *(57).* • Additional space for PPE storage should be foreseen. • Placing mirrors to assist during PPE donning, improve posture and enable self-inspection *(56).* • Installation of devices to support informative tools such as posters or videos to guide staff during donning procedure. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.
6	**Doffing**	Room or space intended to take off the required PPE. Staff carefully take off the PPE after exiting the high-risk areas.	The doffing area has a unidirectional flow from high-risk areas to low-risk areas in a continuous forward motion. (i.e. from patient area to staff area). The floor demarcation indicates the separation between the different risk zones.	• facility staff.	Well-ventilated.	• The size of the doffing area should ensure that all items are always within arm's reach of the health care worker *(56).* A net surface of 1,5 x 1,2 m per person is needed for staff movement during doffing activity *(57).* • Placing mirrors to assist during PPE removal, improve posture and enable self-inspection *(56).* • Space for PPE correct disposal and proper waste management procedures should be foreseen *(56).* Installation of devices to support informative tools such as posters or videos to guide staff during doffing procedure. • Presence of large observational windows to observe the doffing personnel *(56).* • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.
7	**Clean utility**	Temporary storage at ward level.	This room provides storage for sterile supplies, consumables and clean linen for a number of wards. Supplies trolleys are brought here for restocking *(61).* The number and the room dimension should be in proportion to the number of patients. In facilities with few beds it could be centralized at facility level.	• facility staff.	Well-ventilated.	• The space should be accessible by trolleys or mechanical means for bags movement. • The room dimension depends on the linen and consumable storage furniture, staff movement and the number of beds at ward level. • Storage opening directly from circulation areas may be more convenient in particularly for goods for which stocks are maintained by an exchange trolley service *(61).*
8	**Soiled utility**	Temporary storage, at ward level, for dirty material to move to waste zone, laundry or reprocessing equipment area.	The location of this room should minimise travel distances for staff from patients area *(57).* The number and room dimension should be in proportion to the number of patients at ward level. In facilities with few beds it could be centralized at facility level.	• facility staff.	Well-ventilated.	• The space should be accessible by trolleys or mechanical means for bags movement. • According to the facility's protocols, soiled linen and waste may be stored in separated rooms, before moving respectively to laundry, waste zone. • Dedicated space for housekeeping materials strategically located in the facility.
9	**Discharge**	Patients are released from SARI care pathway following specific case management criteria and protocols. The exit point is controlled.	Easily accessible from patients' ward.	• facility staff; • patients.	Well-ventilated.	Exit directly toward outside.
10	**Staff changing room**	Staff must change personal clothes in this room and access the facility with clean scrubs.	Areas shall be provided separately for male and female staff *(60).* Estimates of the amount of changing space and locker provision should consider the numbers staff *(61).*	• facility staff.	10 l/s/person	Staff changing rooms should include: • locker areas for clothes and personal belongings storage; • staff showers and sanitary facilities; and • space for seats. For the purposes of creating a briefing schedule, staff changing areas may be sized at 1,4 m^2 per locker *(62).*

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
11	**Staff offices**	For administrative jobs.	This space should be adequate for administrative work. Space for archive should be foreseen and natural daylight should be used as primary light source.	• facility staff.	10 l/s/person	• At least 1m distance between people. • For sizing continuous use open plan administration areas (with six or more workstations) an allowance of 5 m^2 per workstation may be used *(57)*.
12	**Waste area**	General waste should be segregated from infectious and disposed as general municipal waste. Infectious waste produced during patient care, including those with confirmed SARI infection should be collected safely in clearly marked lined containers and sharp boxes. This waste should be treated and then safely disposed *(44)*.	Waste management can be done on-site or off-site. Either way, a dedicated space for temporary storage of waste is recommended. Waste storage and management is preferable in external spaces.	• facility staff.	Well-ventilated.	• Waste area should be easily accessible from exterior, with door lock to prevent access by unauthorized personnel. • Waste should be lifted from the ground, protected from weather elements by a roof and from animals by fencing. • If waste is treated in place, the incinerators smokes should not affect the heath structure neither the neighbours. Considering prevailing winds, it should be in the leeward side. • The floor must be hard and non-porous. • Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.
13	**Pharmacy**	Drugs should be available at facility level according to national protocols.	Adequate space, equipment, and supplies shall be available for all professional and administrative functions relating to pharmacy services. These resources shall meet all applicable laws and regulations; shall be located in areas that facilitate the provision of services to patients, nurses, prescribers, and other health care providers; and shall be integrated with the hospital's communication and delivery or transportation systems *(70)*.	• facility staff.	Well-ventilated.	Easily accessible from exterior. Openings and corridors should be wide enough to let goods movement with mechanical means.
14	**Storage**	Logistic store for consumables.	Designated staff manage the warehouse.	• facility staff.	Well-ventilated.	Easily accessible from exterior. Openings and corridors should be wide enough to let goods movement with mechanical means.
15	**Laundry**	Linen and reusable PPE should be cleaned and disinfected as for specific protocol. Laundry can be managed on-site or off-site.	If internal laundry service is available, it should be located nearby the patient's area to reduce the movement and facilitate the flow of dirty and clean materials. The laundry area has a unidirectional flow from high-risk (dirty items) to low-risk (clean items) area.	• facility staff.	Well-ventilated.	The space should include the following areas: • separate entrance/exit and temporary storages area for dirty materials and clean materials; • washing and disinfection area; • drying area (outdoor if possible); and • ironing and packaging area. The hygiene products are appropriately stored Hand hygiene station: soap, water, clean towels or alcohol-based hand rub.

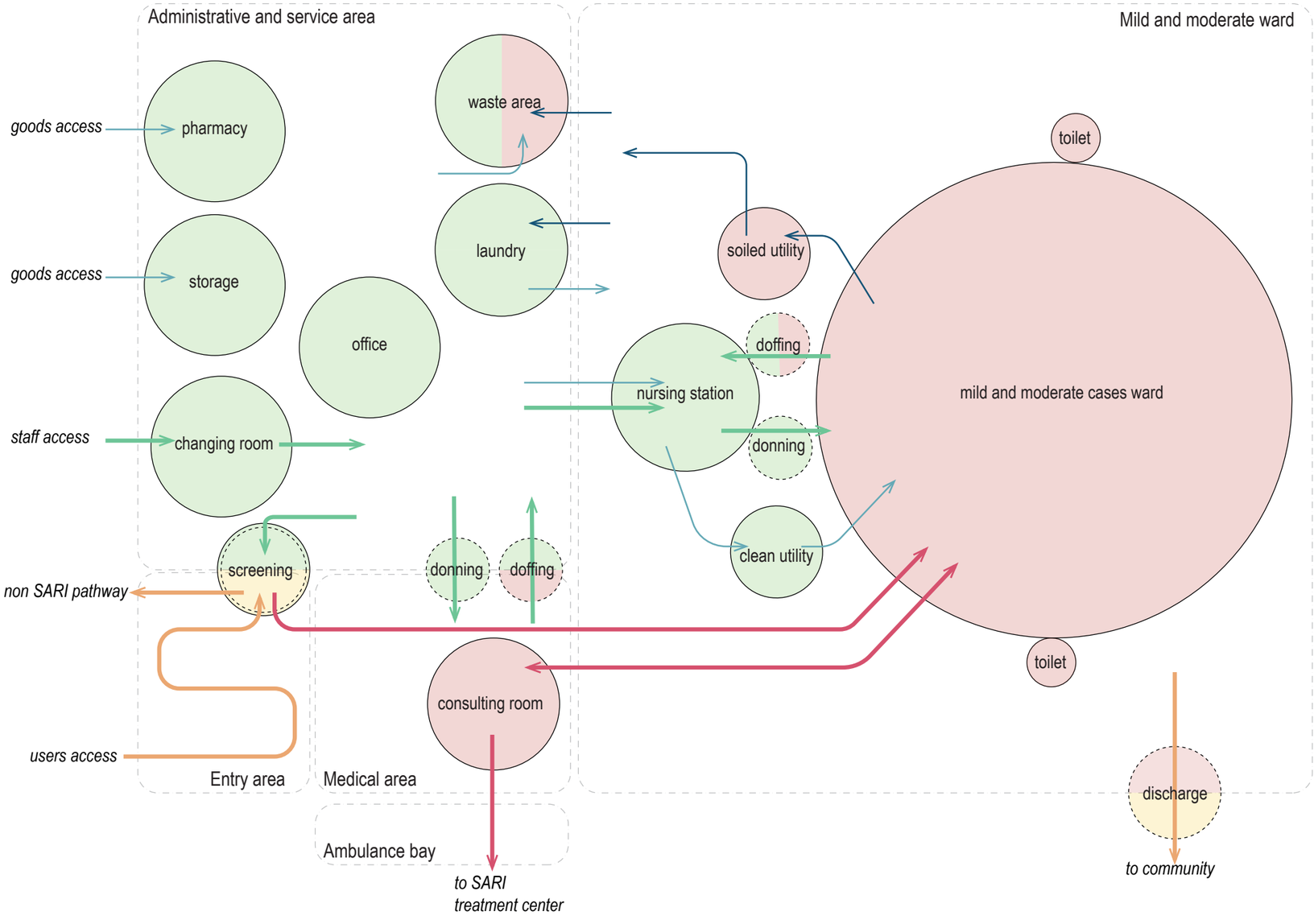
Minimum Functions

Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

Community facility



7.6 Home care and home quarantine

Patients with mild and moderate illness may not require emergency interventions or hospitalization; however, isolation is necessary for all suspect or confirmed cases to contain virus transmission. The decision to monitor a suspect case in a health facility, community facility or home should be made on a case-by-case basis *(2).*

Home care may be considered for an adult or child with confirmed or suspected SARI when inpatient care is unavailable or unsafe (e.g. when capacity is insufficient to meet the demand for health-care services). Such patients who have been discharged from hospital may also be cared for at home, if necessary. Caring for an infected person in the home, rather than in a medical or other specialized facility, increases the risk of transmitting the virus to others in the home. However, the isolation of people who are infected with SARI disease can make an important contribution to breaking the chains of transmission of the virus. The decision as to whether to isolate and care for an infected person at home depends on the following three factors: 1) clinical evaluation of the patient, 2) evaluation of the home setting and 3) the ability to monitor the clinical evolution of the infected person at home *(71).* The space characteristics and design criteria are presented in Table 10.

Table 10. The facility characteristics and design criteria

	Function or space	Main purpose and activities	Design principles	Occupancy profiles	Ventilation requirement *(25)*	Spatial criteria
1	**Patient room**	Patient is receiving care at home and is monitored through telemedicine and home hospitalization programmes, or by community health workers. The patient is isolated from the rest of the households in order to prevent secondary cases.	• The space should be designed to accommodate persons for several days. While individual room is essential to prevent transmission, enabling safe interaction and communication between users can contribute to mental health and well-being. Privacy and comfort should be guaranteed. • Natural daylight should be used as primary light source and access to the exterior is an added value. • Waste generated at home during quarantine, while caring for a sick family member or during the recovery period should be packed in strong bags and closed completely before disposal and eventual collection by municipal waste services. If such services are not available, as interim measure, safely burying or controlled burning may be done *(44).*	Patients	10 l/s/person. If no ventilation assessment can be done, keep the room well ventilated with frequent windows opening.	• If individual room is not available, ensure at least 1 m between people *(55).* • Private toilet is preferable. • Operating windows to allow proper ventilation are recommended. • Strong bags and bins to collect the waste generated in the quarantine/ toilet room should be available. Waste bags must be sealed before leaving the patient's room area.

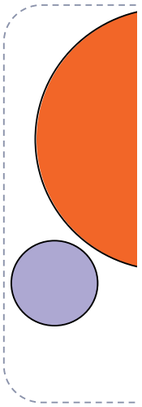
Minimum Functions

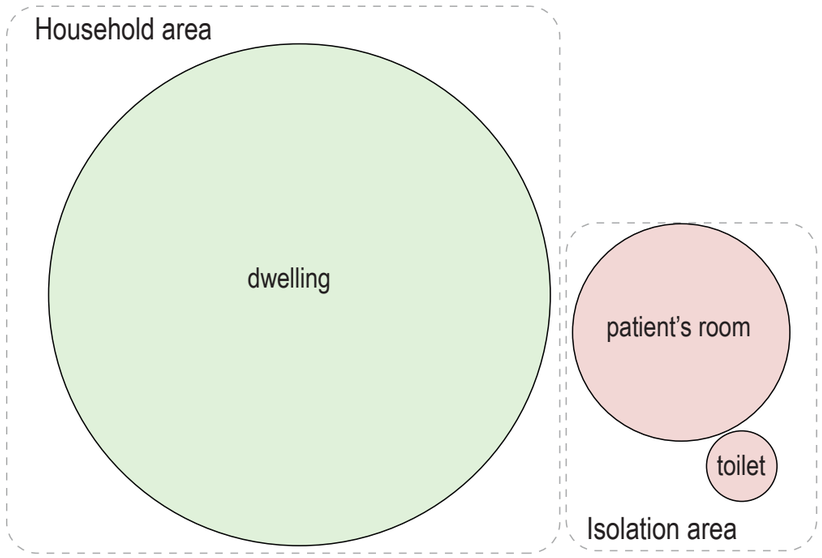
Core and essential functions or spaces required for the correct functioning of the facility.

Recommendations for optimal patient care

Functions that could be located on-site or off-site and/or that could share the space of the core functions. If on-site, they may facilitate and increase the efficiency of the overall facility functioning.

Home care and home quarantine





Facility's function or space presenting uniform level of risk

Facility's function or space which allow safe passage of people and goods between areas of different risk.

Facility's function or space where close proximity in between different area of risk may occur (transparent partition or 1m distance in between).

Low-risk

High-risk

Uncategorised risk

Staff

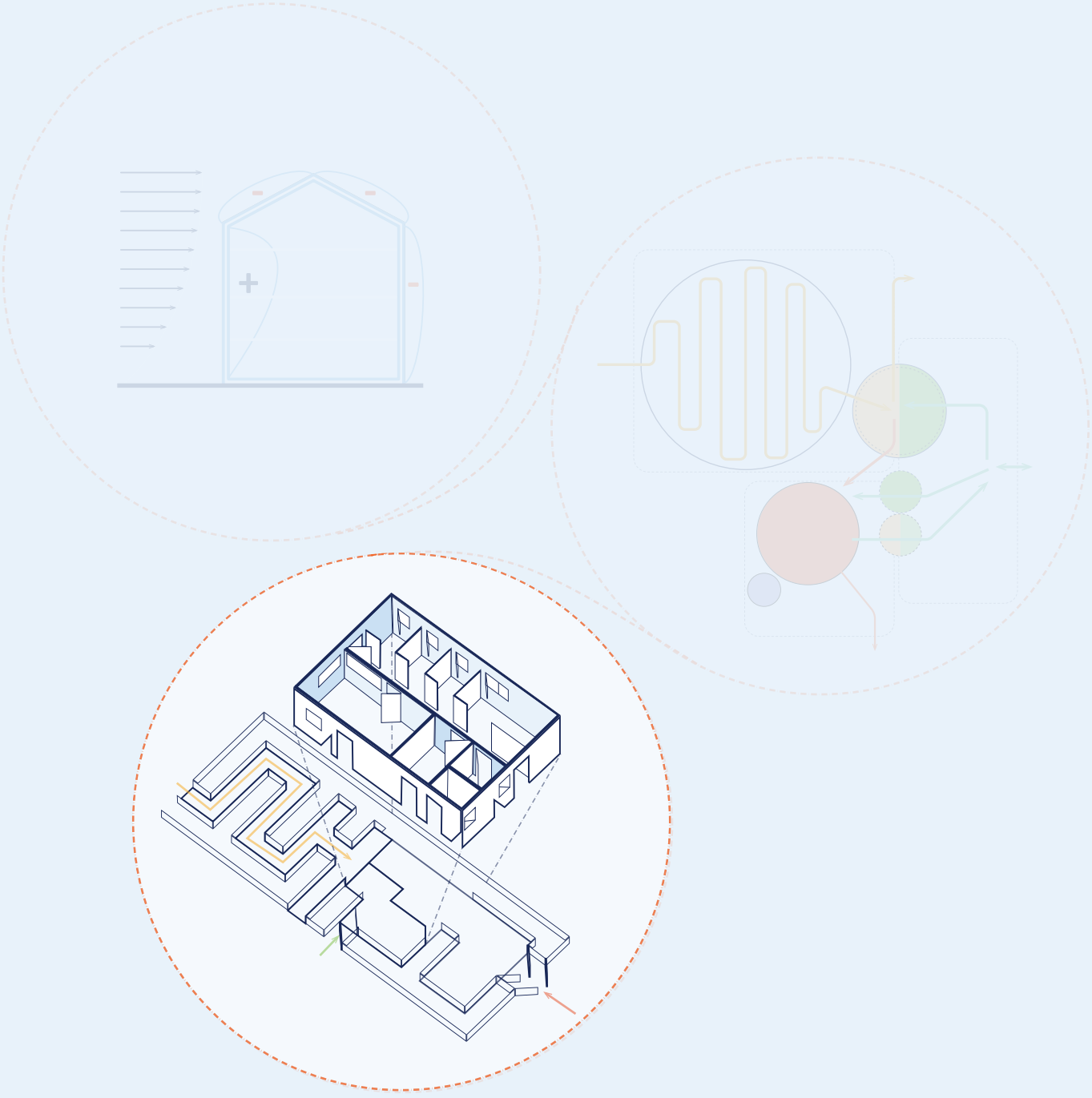
Patients

Users

Clean goods

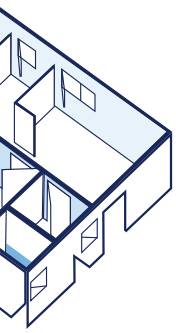
Dirty goods

Implementation of SARI facilities



Implementation of SARI facilities

8. SARI Facility layouts



This section introduces SARI facility layouts to show the application of design principles and providing practical solutions. The layouts should be intended as potential examples and should be critically reviewed before any application in a specific context.

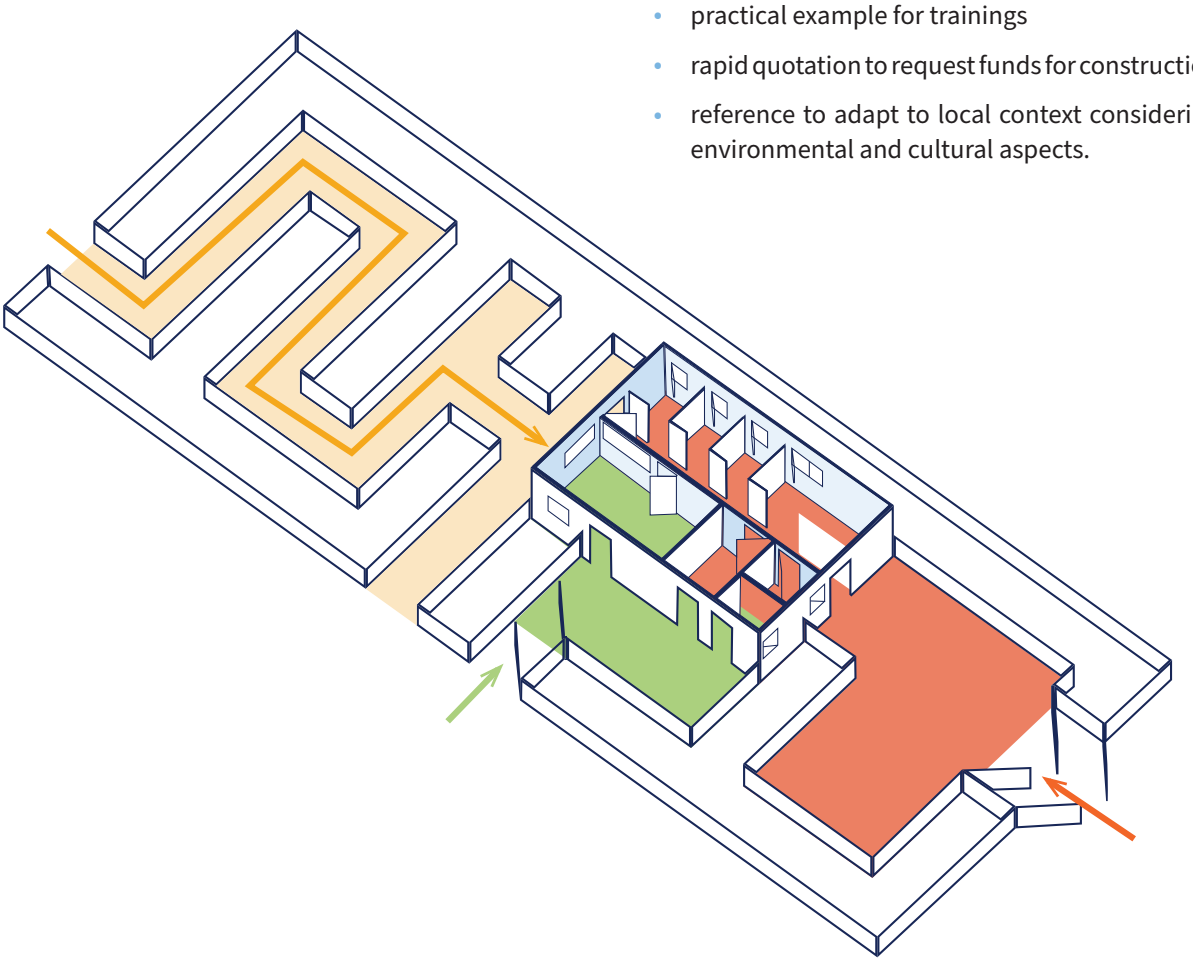
The size of the SARI facilities presented in this section represents optimal dimensions for construction, management and supply. The layouts are designed with a modular approach, allowing for easy scaling up or down based on specific needs.

For each SARI facility two layouts are illustrated.

- Temporary structures. These layouts use standard tents of 24, 48, 72 m^2. In some cases, the layout presents a few elements (i.e. internal partitions, toilets, etc.) that are not included in standard tents, but are intended to be built locally with the materials available.
- Semi-permanent structures. These layouts provide generic solutions, and the main element of interest is the space distribution. Architectural elements like walls, transparent surfaces, doors etc. that depend on building materials, building technology, structural layout and eventually on the local context, are indicative and must be reviewed and adapted based on the project-specific requirements. To follow local regulations or to design a climate resilient facility, minor changes to the layout should be adopted, for example changes to the openings, thickness of walls, functions located in indoor/outdoor spaces etc. The important aspect is to avoid modification that implies changes to the staff and patients flows and generally to all the key elements described in the previous section of this manual.

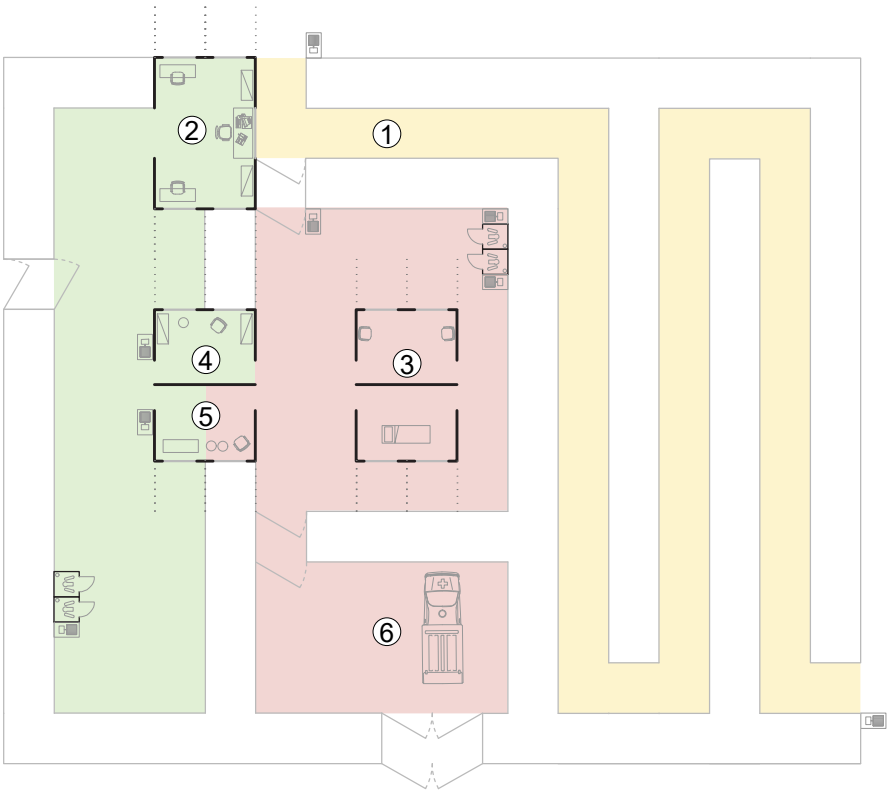
These layouts serve various purposes:

- reference for the facility design
- practical example for trainings
- rapid quotation to request funds for construction
- reference to adapt to local context considering environmental and cultural aspects.



8.1 Point of Entry

8.1.1 Temporary solution in tents

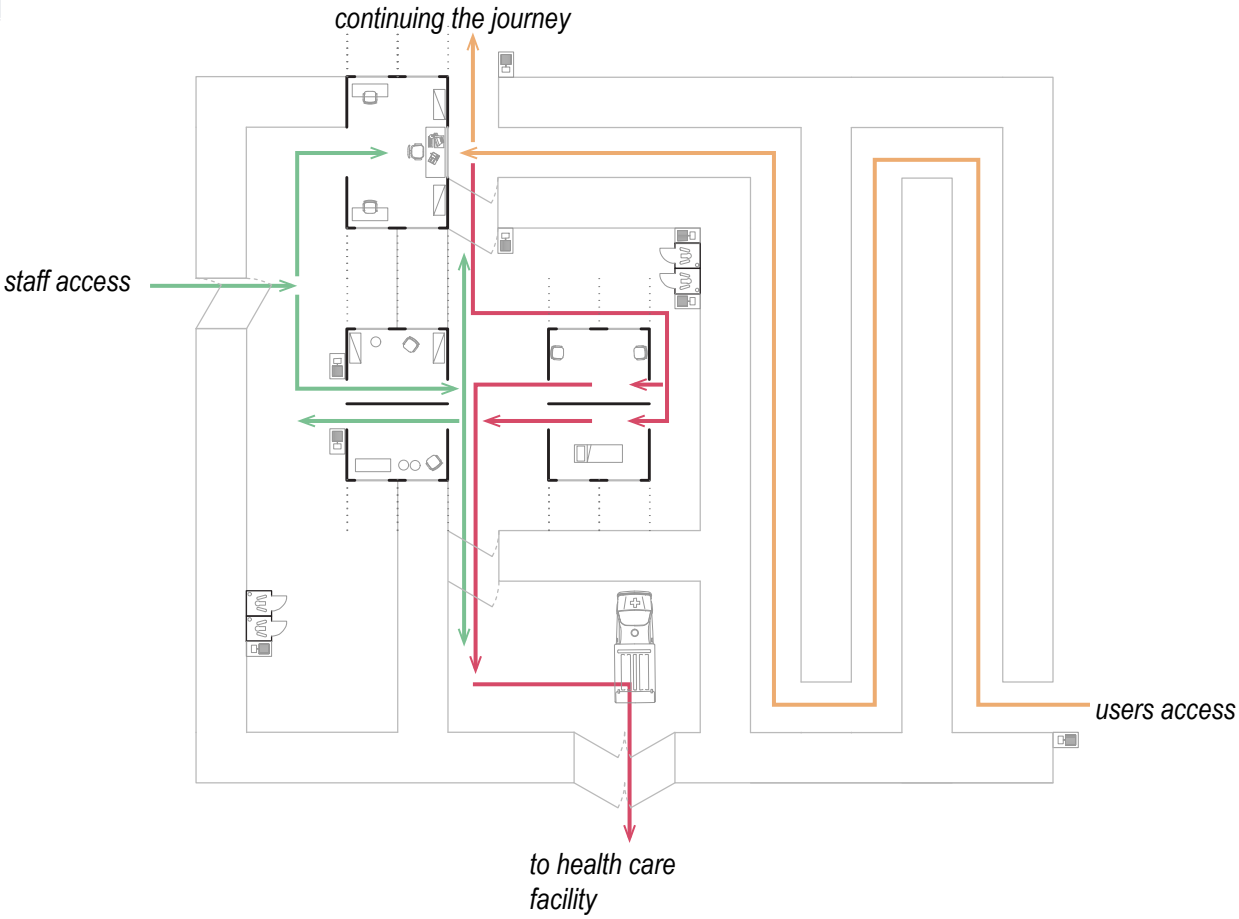


1. crowd management area
2. screening
3. temporary isolation
4. donning
5. doffing
6. ambulance bay

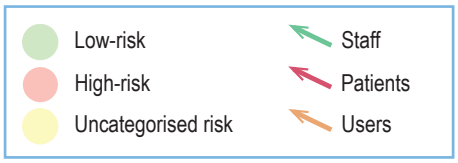
Low-risk
High-risk
Uncategorised risk

Staff
Patients
Users

0 1 2 5 10m



Site Minimum dimensions: 30 x 34 m
24 m² tents: 3
48 m² tents: 0
72 m² tents: 0



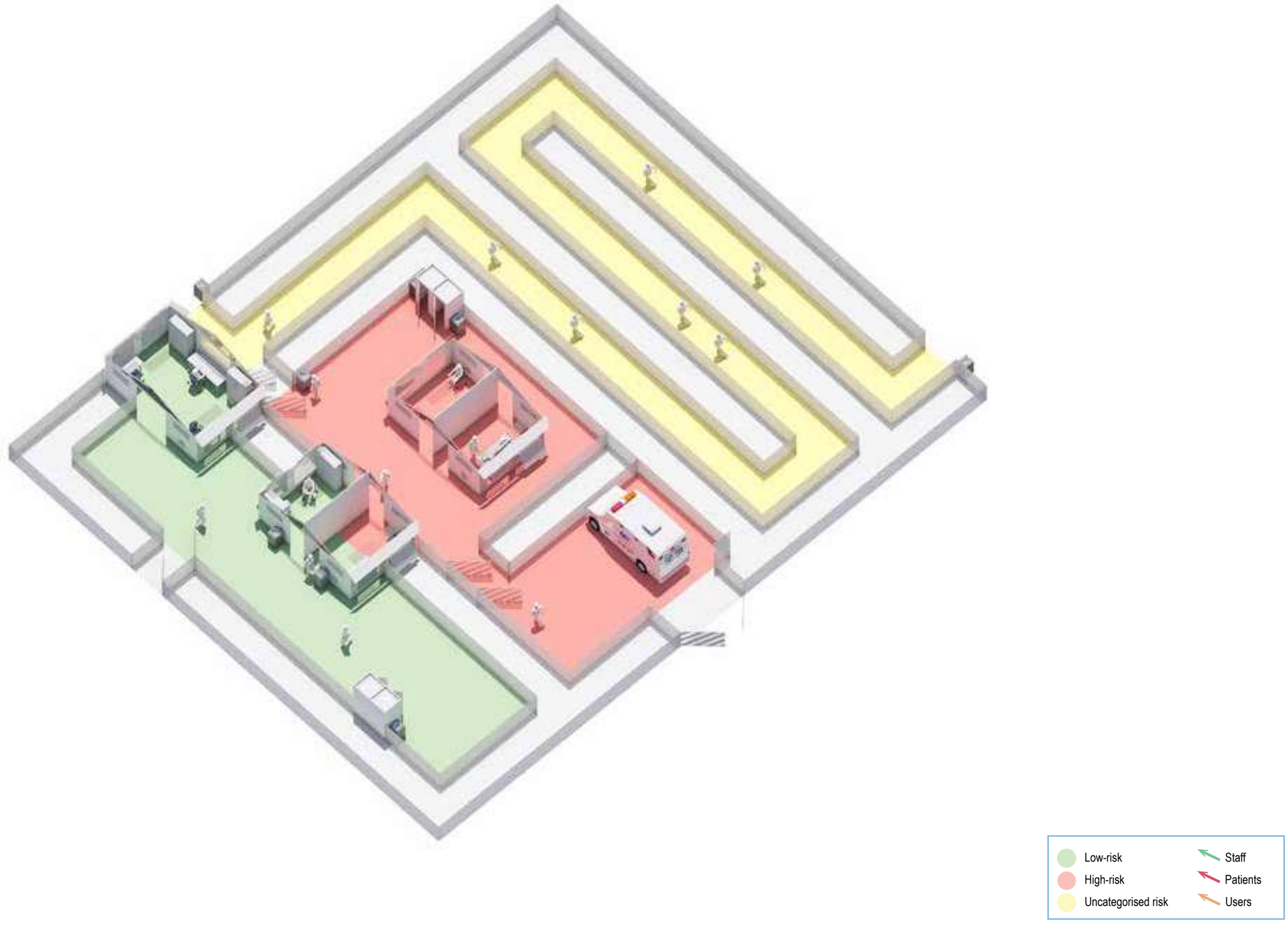
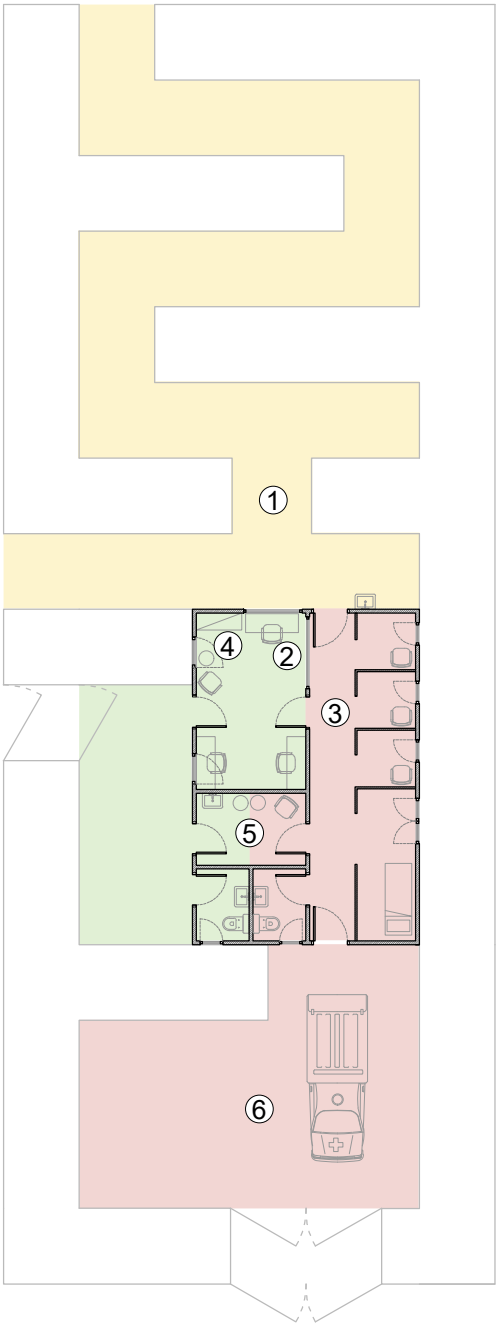


Fig.22. 3D representation

8.1.2 Semi-permanent solution with local materials

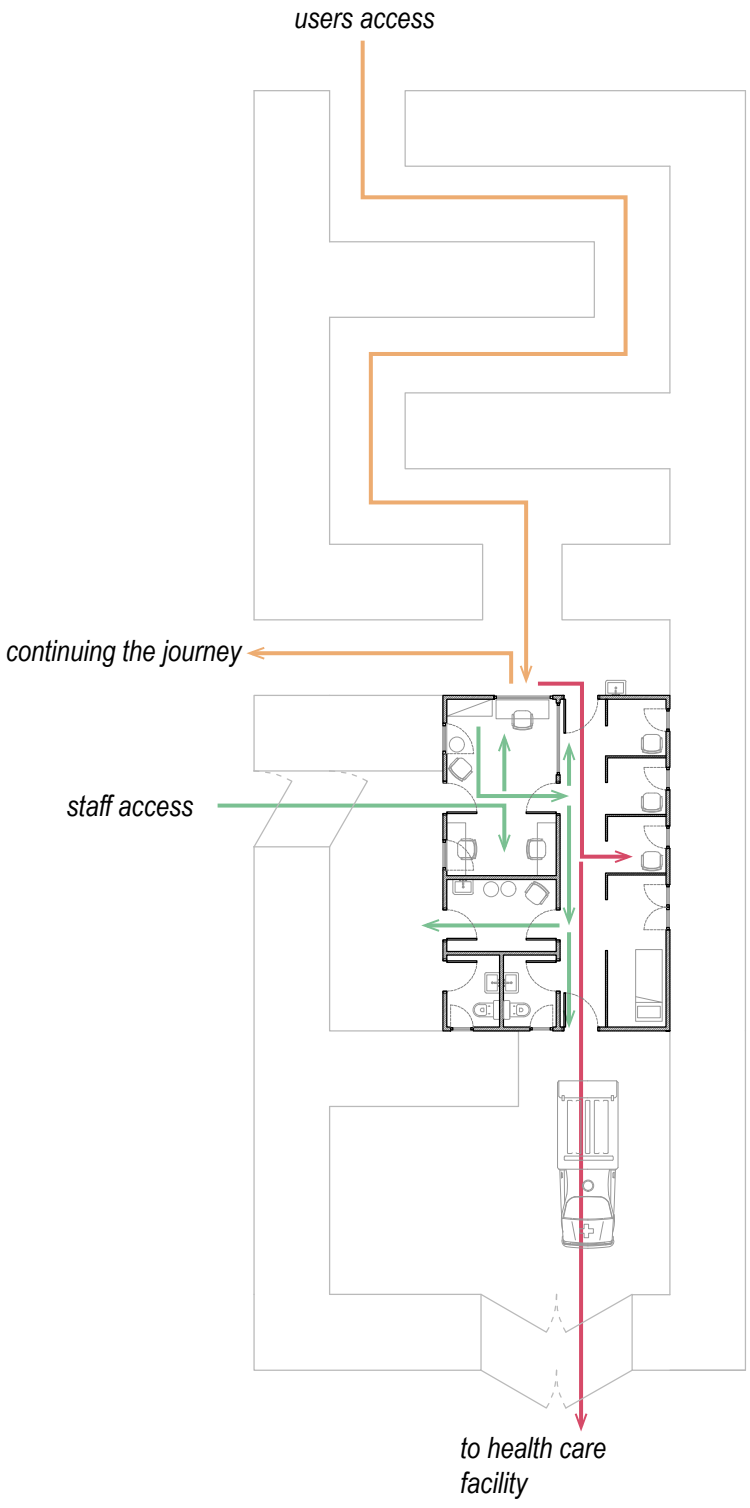


1. crowd management area
2. screening
3. temporary isolation
4. donning
5. doffing
6. ambulance bay

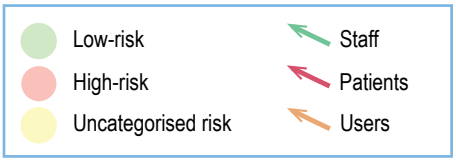
Low-risk
High-risk
Uncategorised risk

Staff
Patients
Users

0 1 2 5 10m



Site minimum dimensions: 13x34 m
Main building dimensions: 9 x6 m



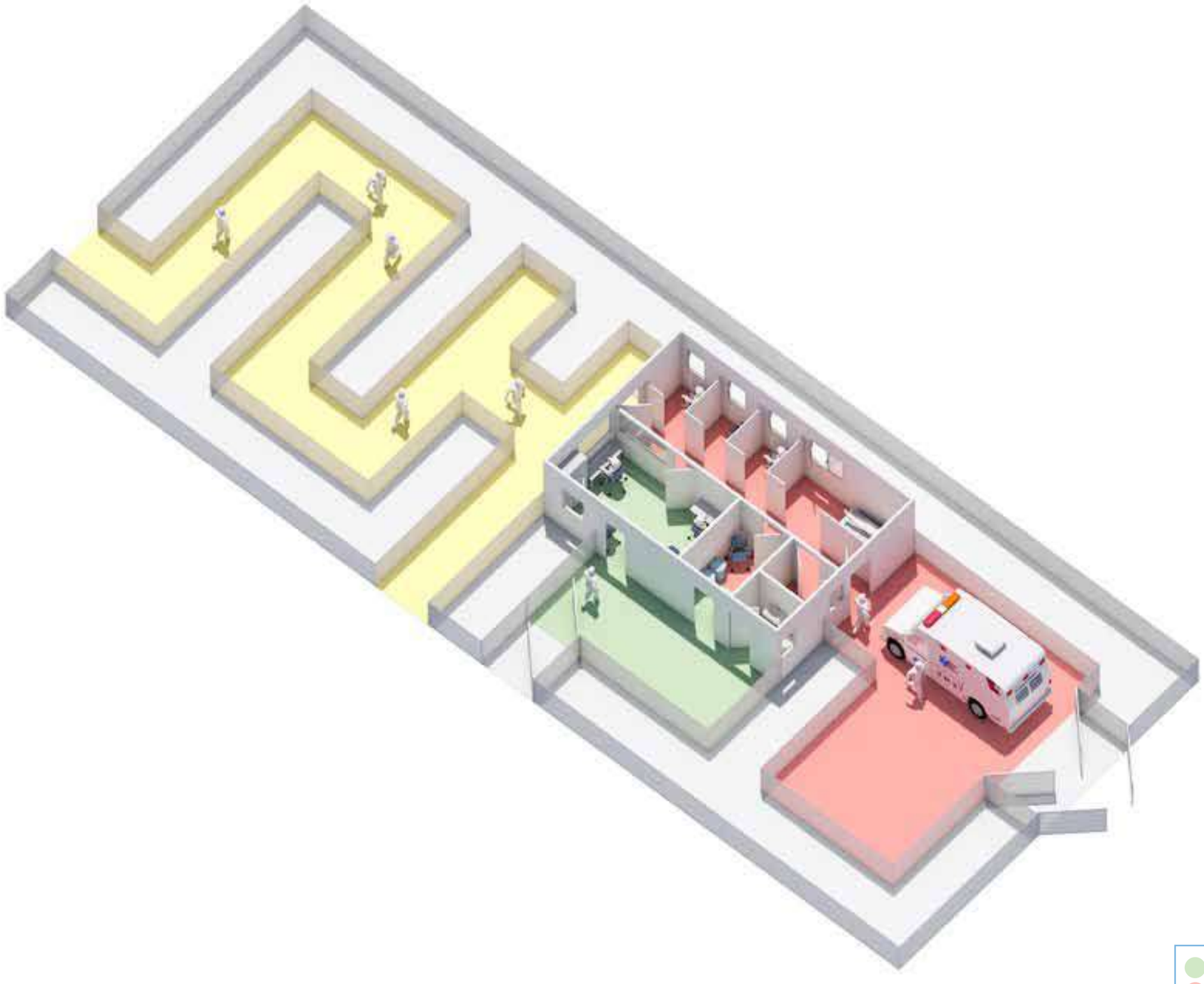
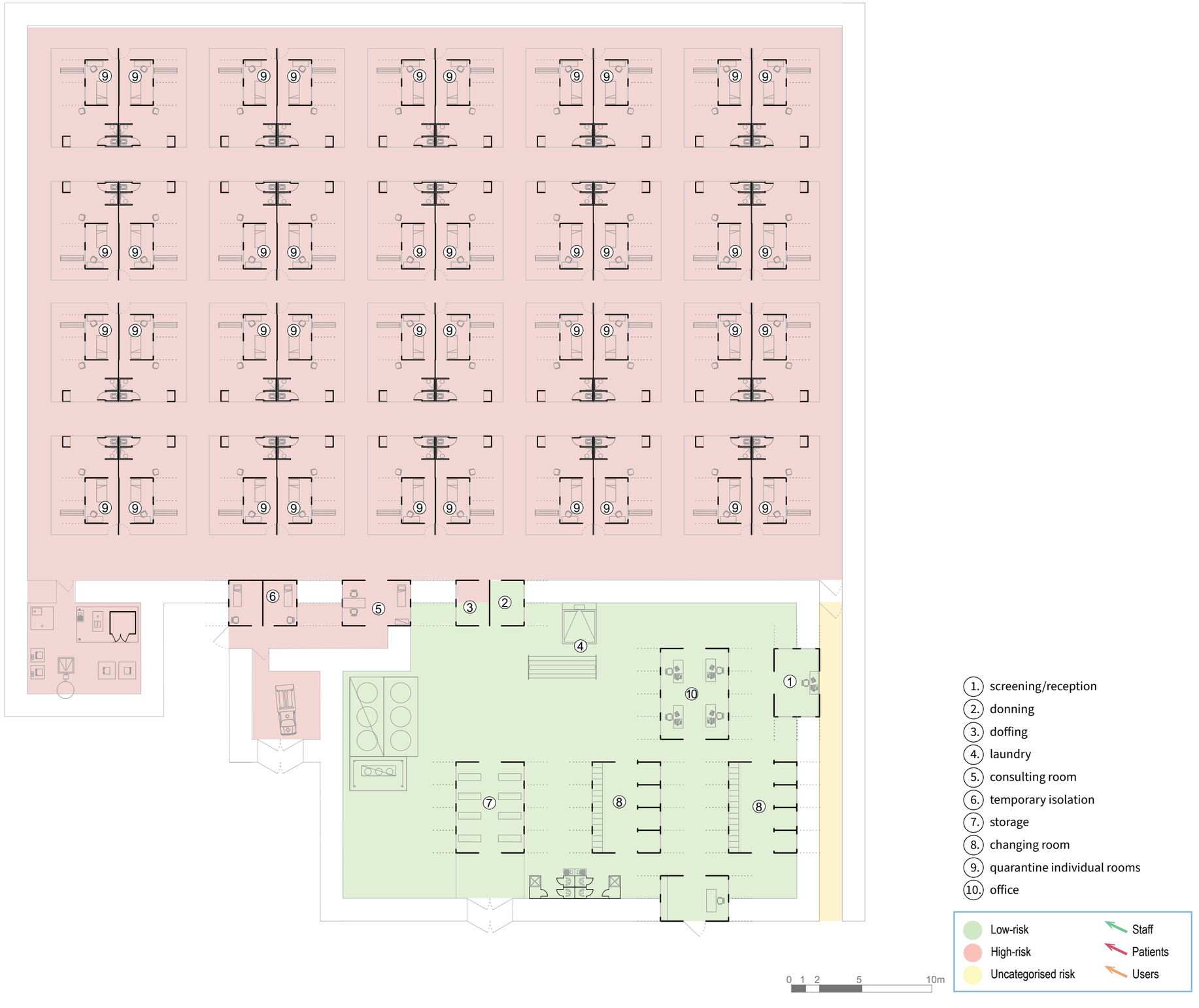


Fig. 23. 3D representation

8.2 Quarantine facilities

8.2.1 Temporary solution in tents



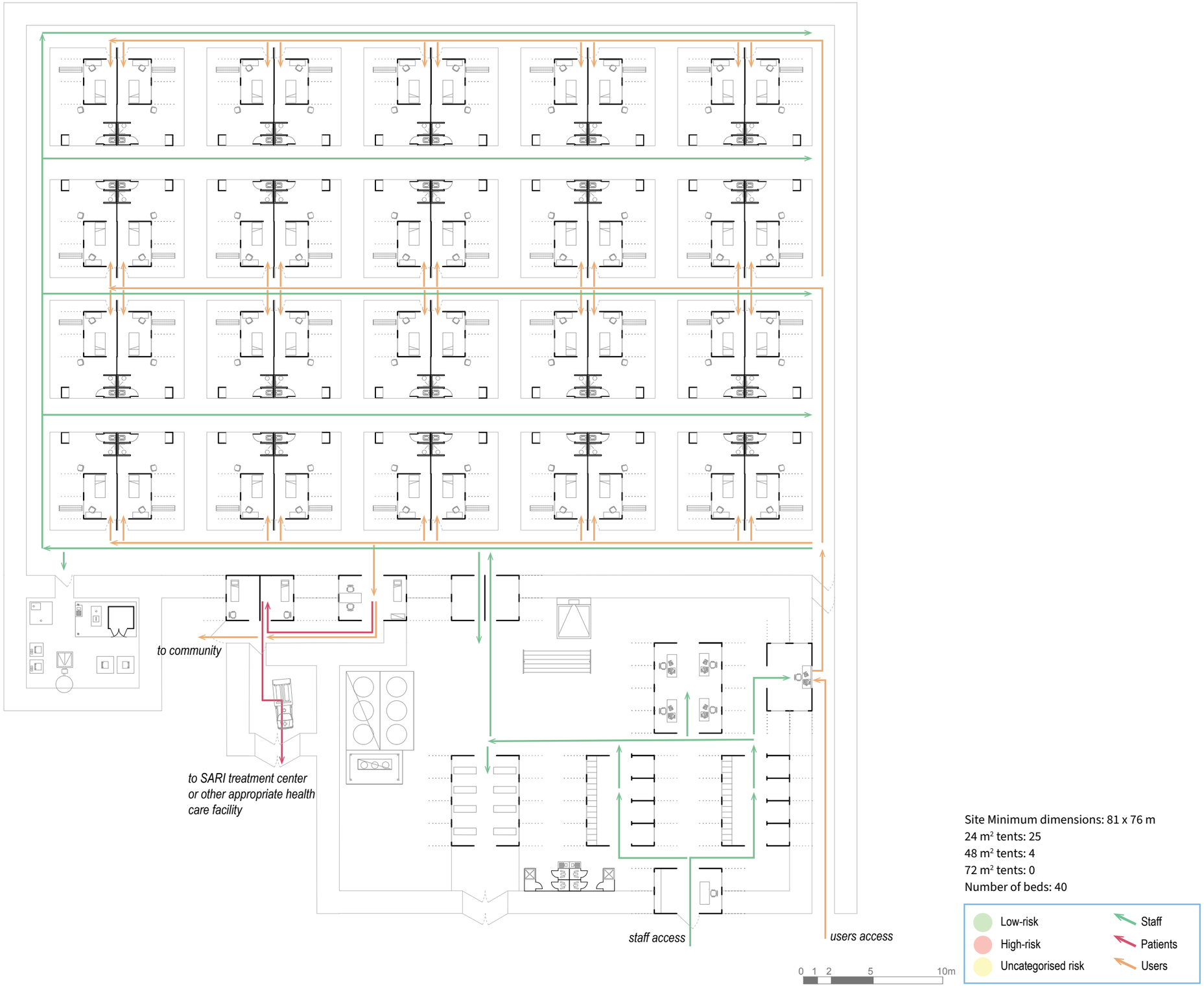
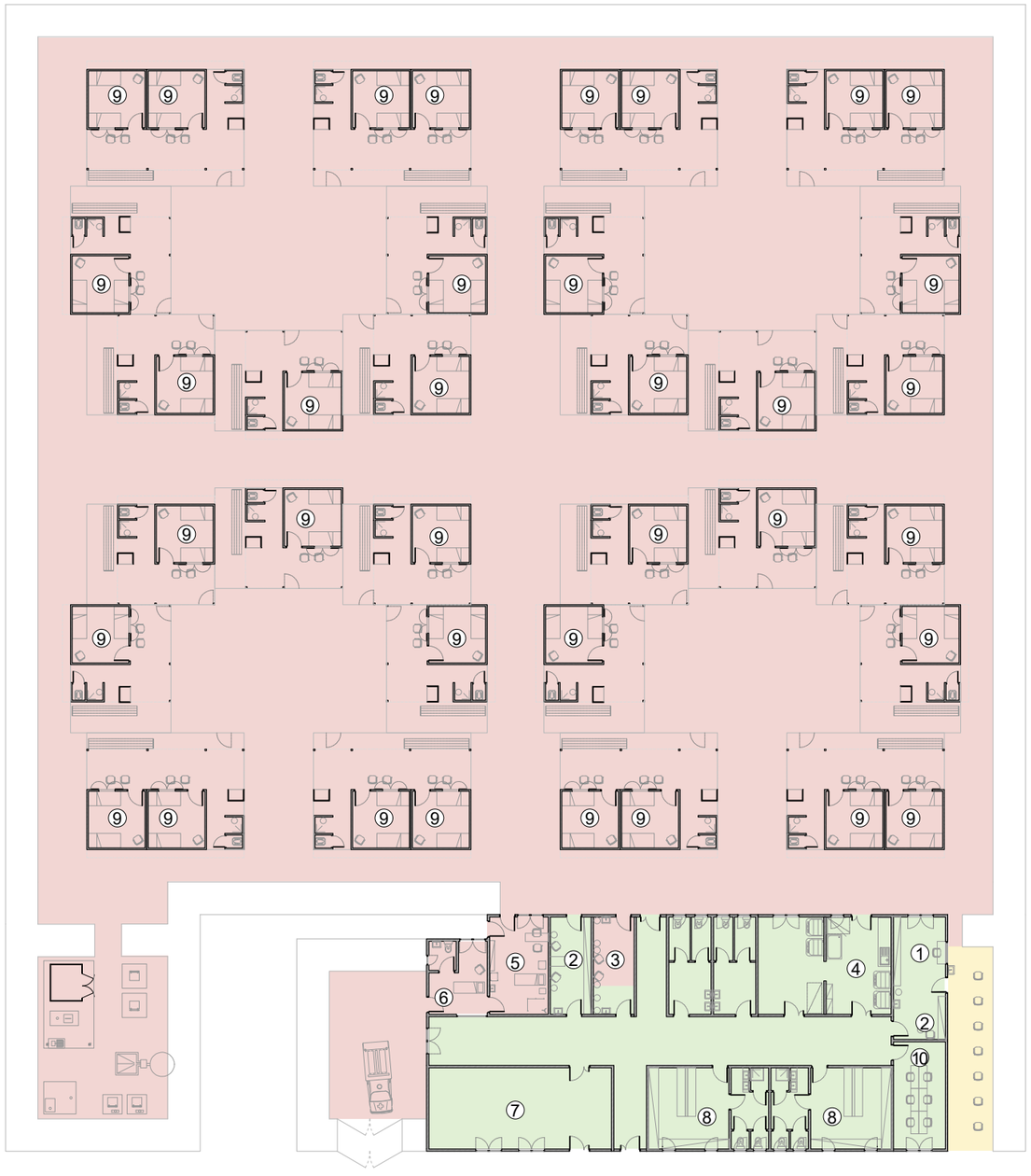
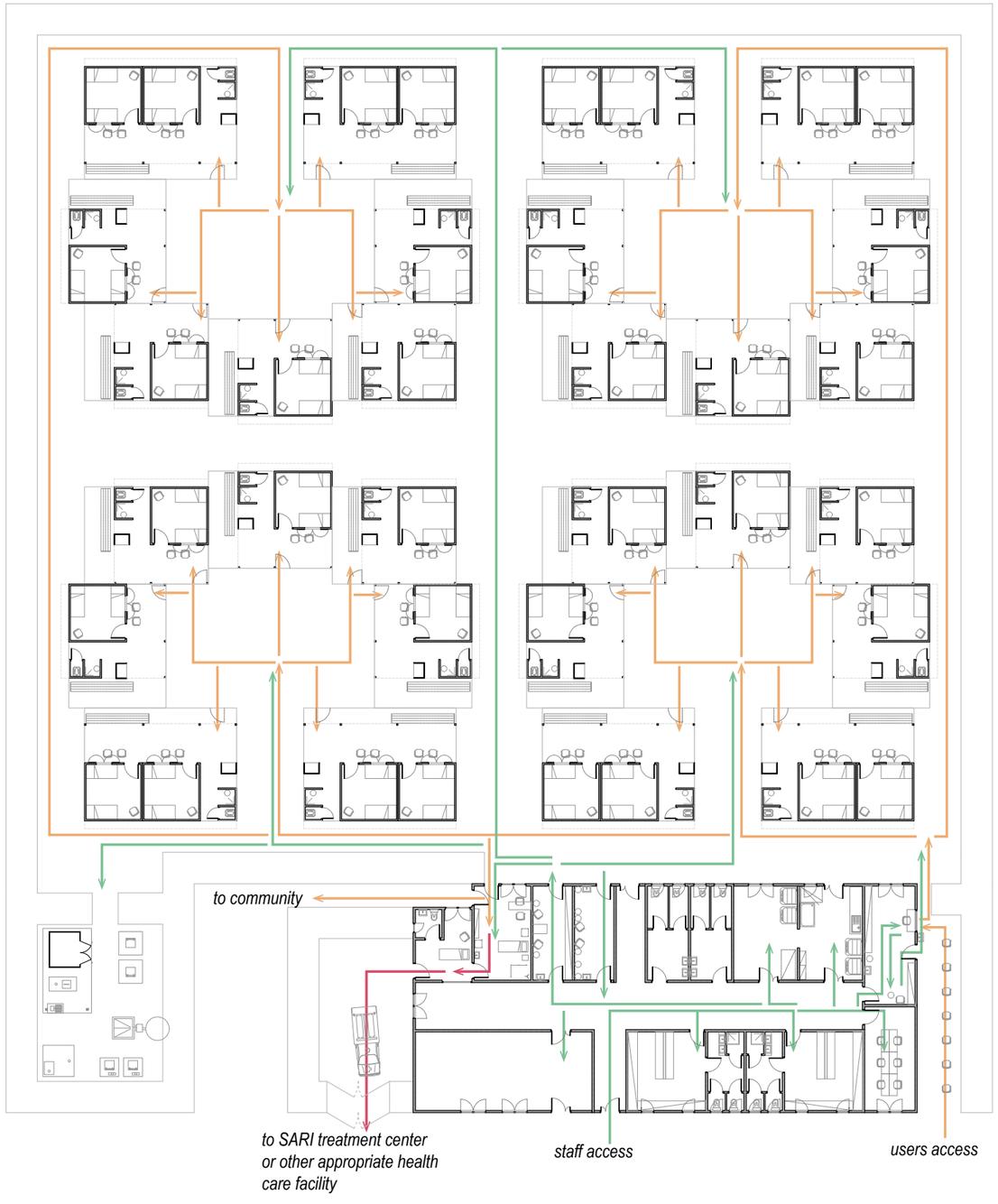

to community
to SARI treatment center
or other appropriate health
care facility
staff access
users access
0 1 2 5 10m
Site Minimum dimensions: 81 x 76 m
24 m² tents: 25
48 m² tents: 4
72 m² tents: 0
Number of beds: 40
Low-risk
High-risk
Uncategorised risk
Staff
Patients
Users

Fig. 24. 3D representation

8.2.2 Semi-permanent solution with local materials





Site Minimum dimensions: 71 x 63 m
Staff/Entrance building dimensions: 15 x 32 m
Quarantine module 1/2 beds: 8 x 6 m
Quarantine module 2/4 beds: 10 x 8 m
Number of beds: 36 / 72

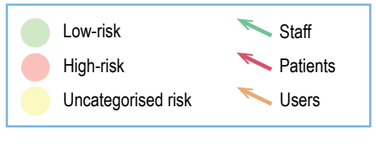
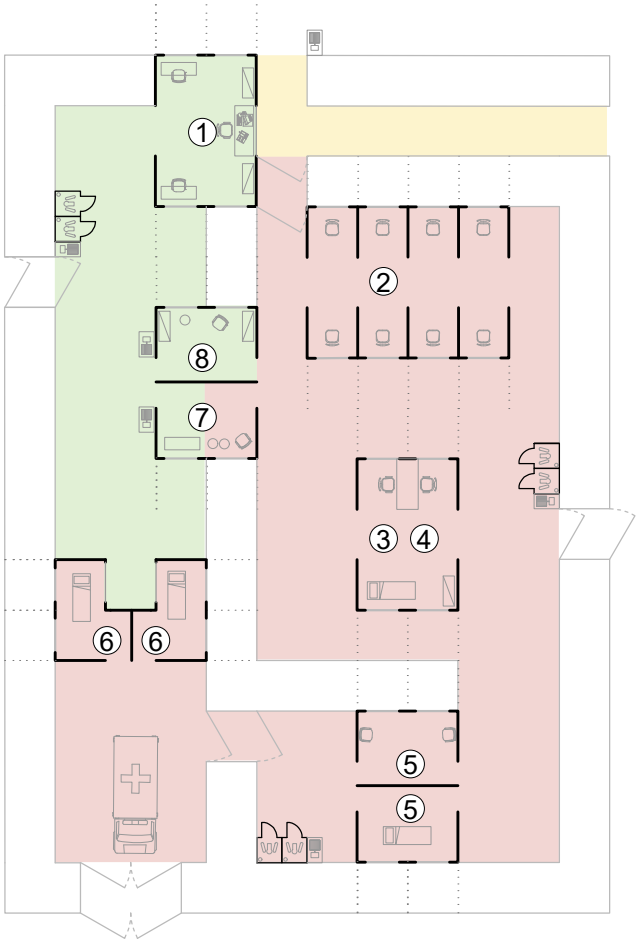


Fig. 25. 3D representation

8.3 Entry to health system

8.3.1 Temporary solution in tents

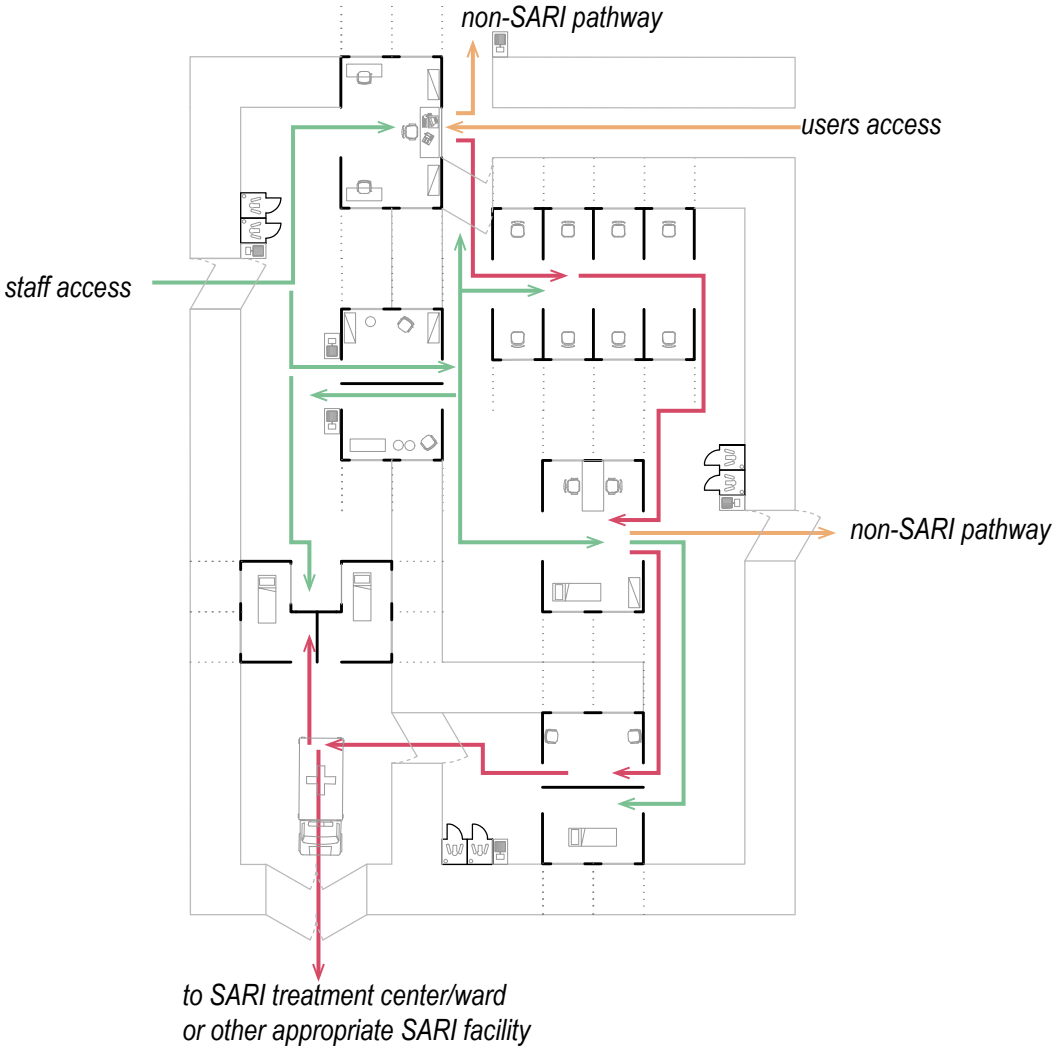


1. screening
2. waiting room
3. triage
4. consulting room
5. temporary isolation room
6. resuscitation room
7. doffing
8. donning

Low-risk
High-risk
Uncategorised risk

Staff
Patients
Users

0 1 2 5 10m



Site Minimum dimensions: 34 x 24 m
24 m² tents: 5
48 m² tents: 1
72 m² tents: 0

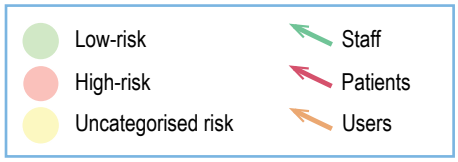


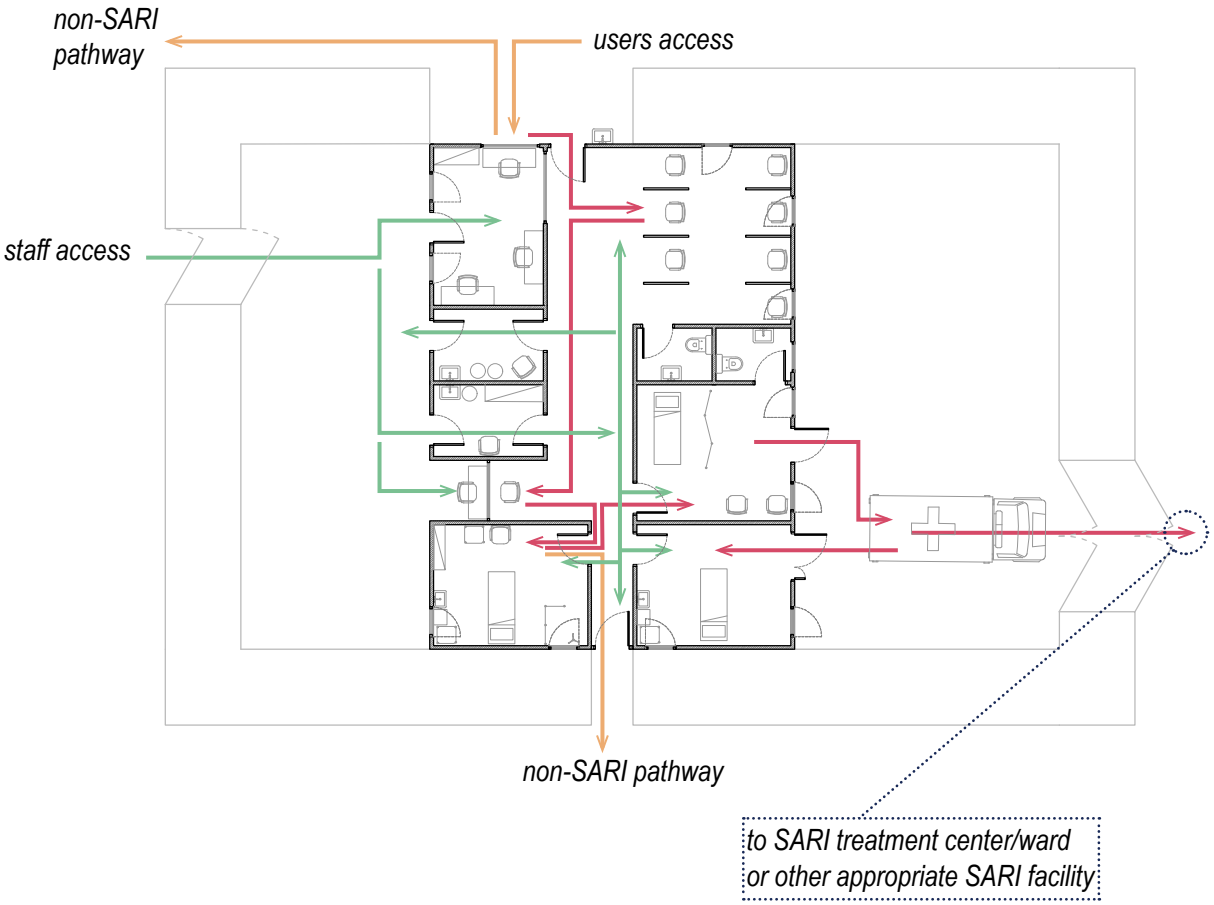
Fig. 26. 3D representation

8.3.2 Semi-permanent solution with local materials

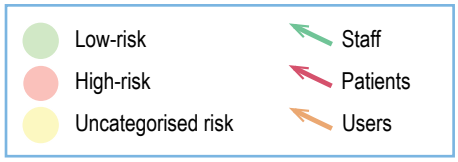
1. screening
2. waiting room
3. triage
4. consulting room
5. temporary isolation room
6. resuscitation room
7. doffing
8. donning

Low-risk
High-risk
Uncategorised risk
Staff
Patients
Users

0 1 2 5 10m



Site Minimum dimensions: 17 x 26 m
Main building dimensions: 13 x 10 m



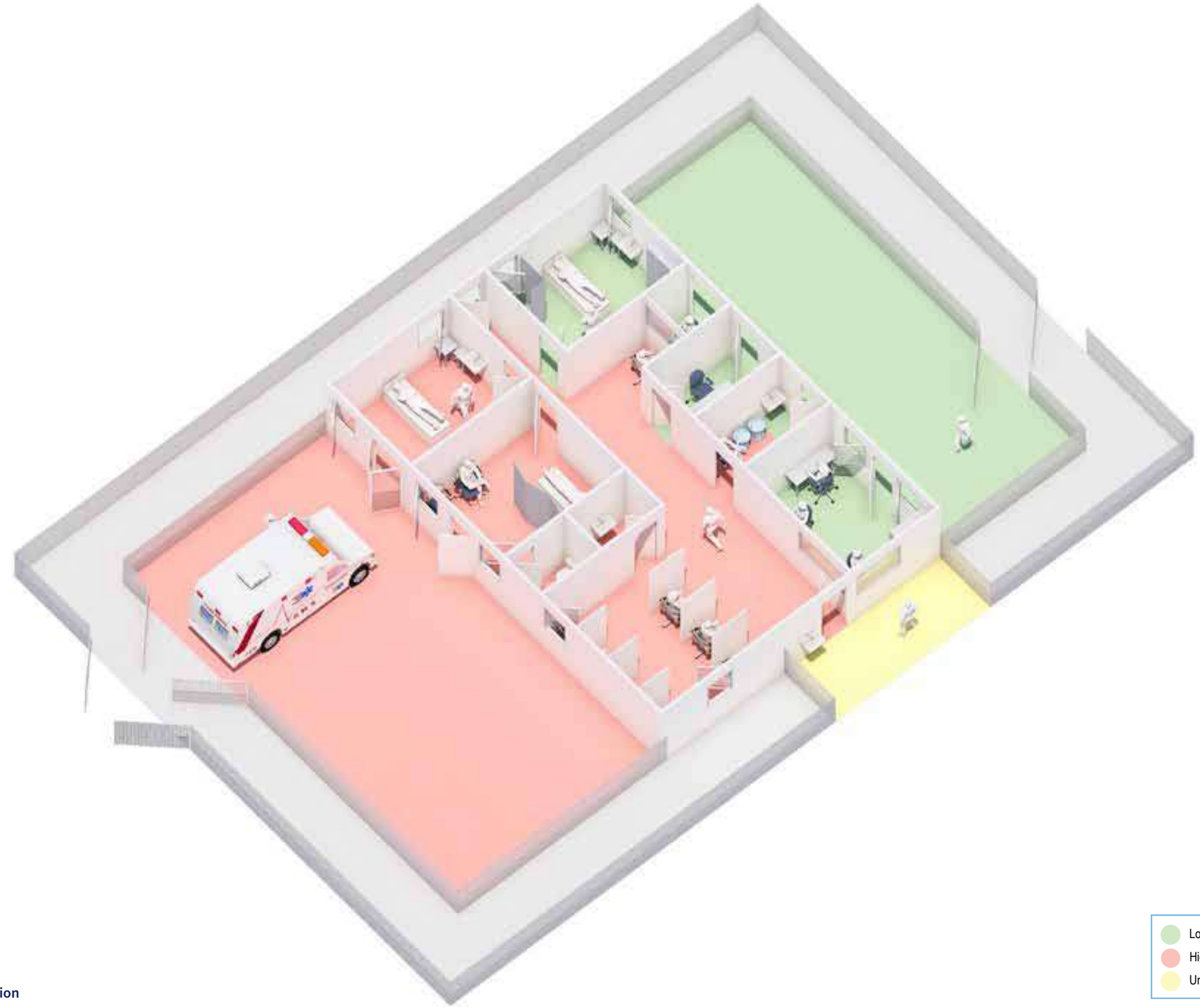


Fig. 27. 3D representation

8.4 Treatment centre

8.4.1 Temporary solution in tents

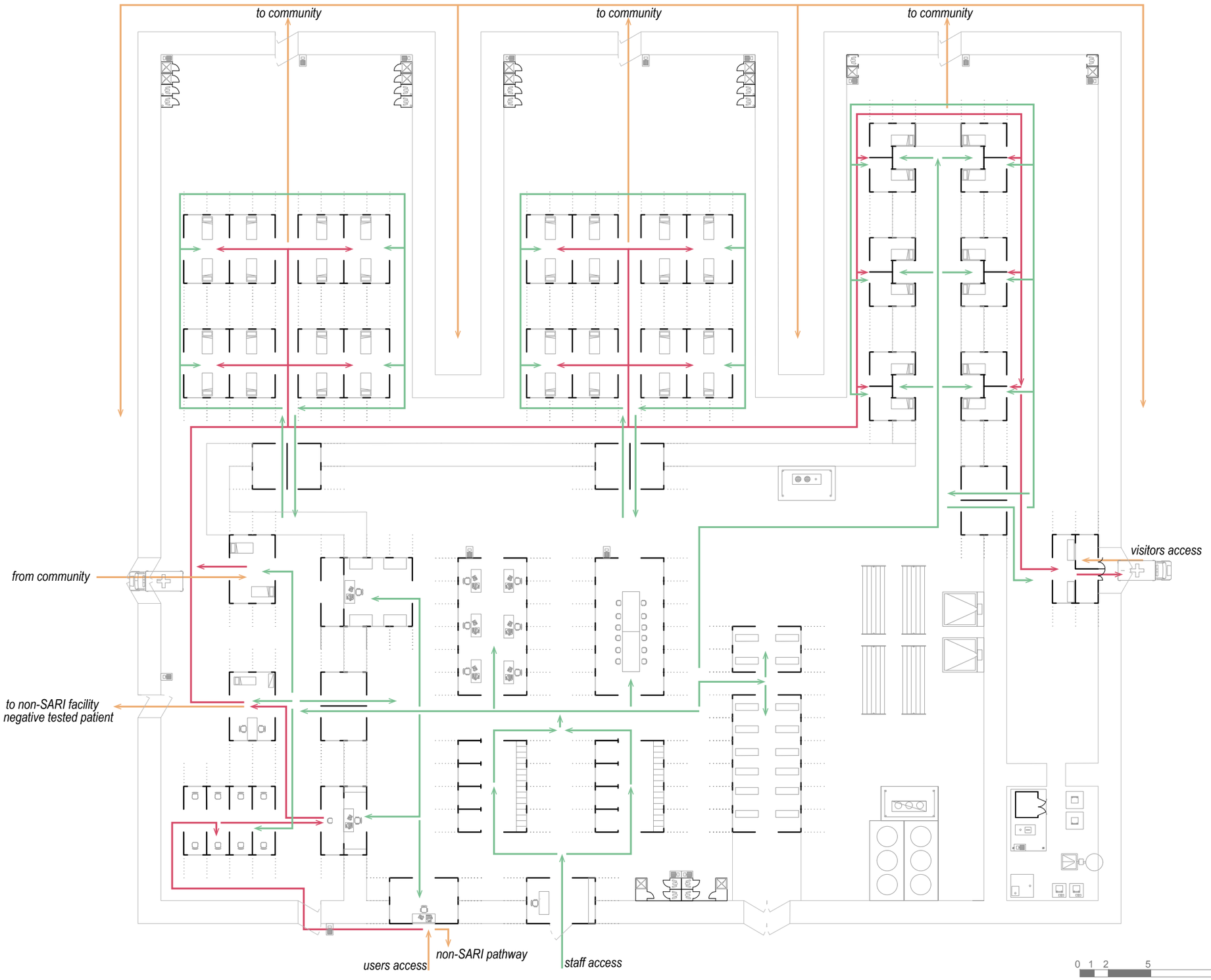
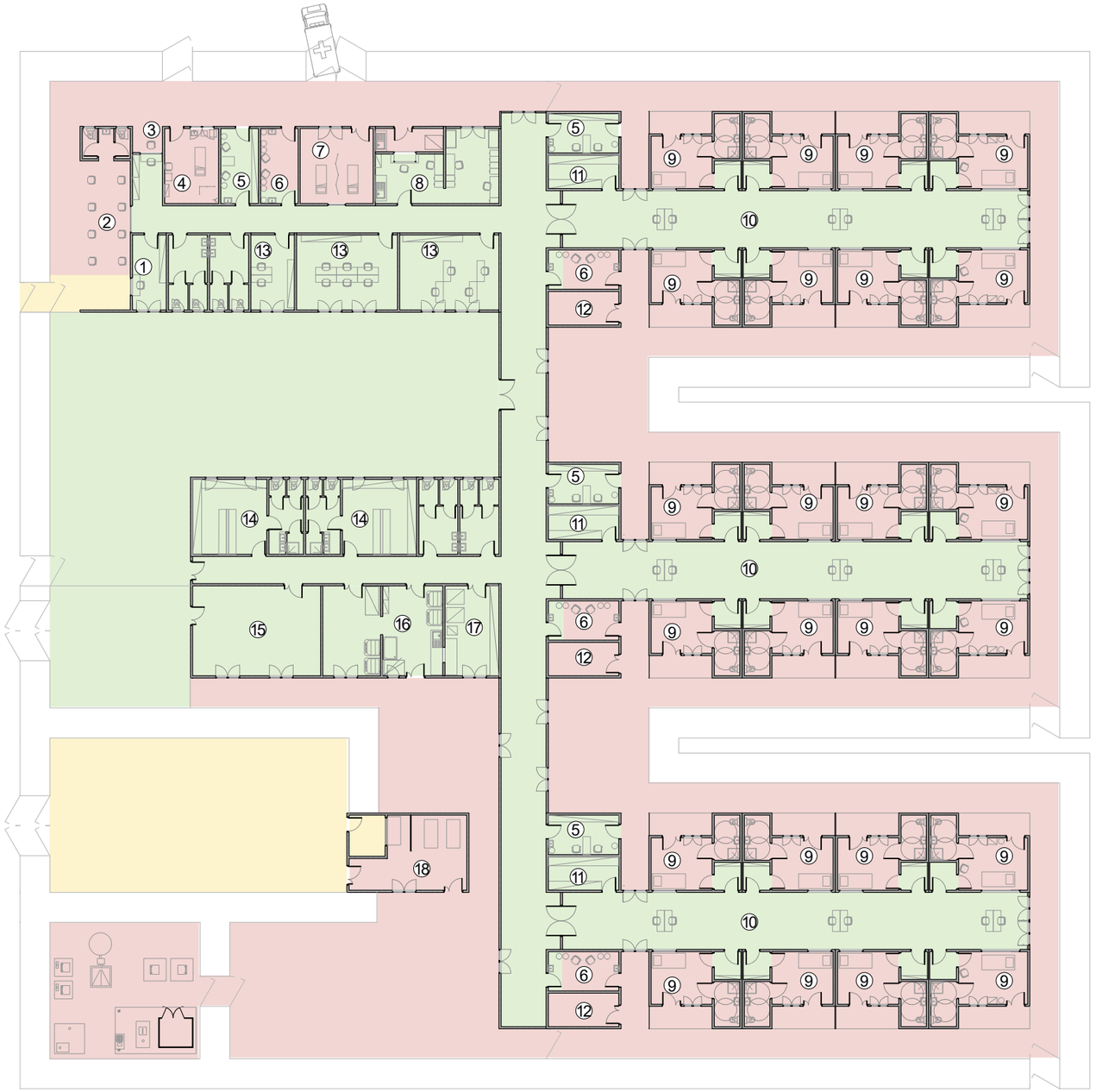

to community
to community
to community
from community
visitors access
to non-SARI facility
negative tested patient
users access
non-SARI pathway
staff access
0 1 2 5 10m
Site Minimum dimensions: 78 x 86 m
24 m² tents: 17
48 m² tents: 12
72 m² tents: 3
Number of beds: 44
Low-risk
High-risk
Uncategorised risk
Staff
Patients
Users

Fig. 28. 3D representation

8.4.2 Semi-permanent solution with local materials

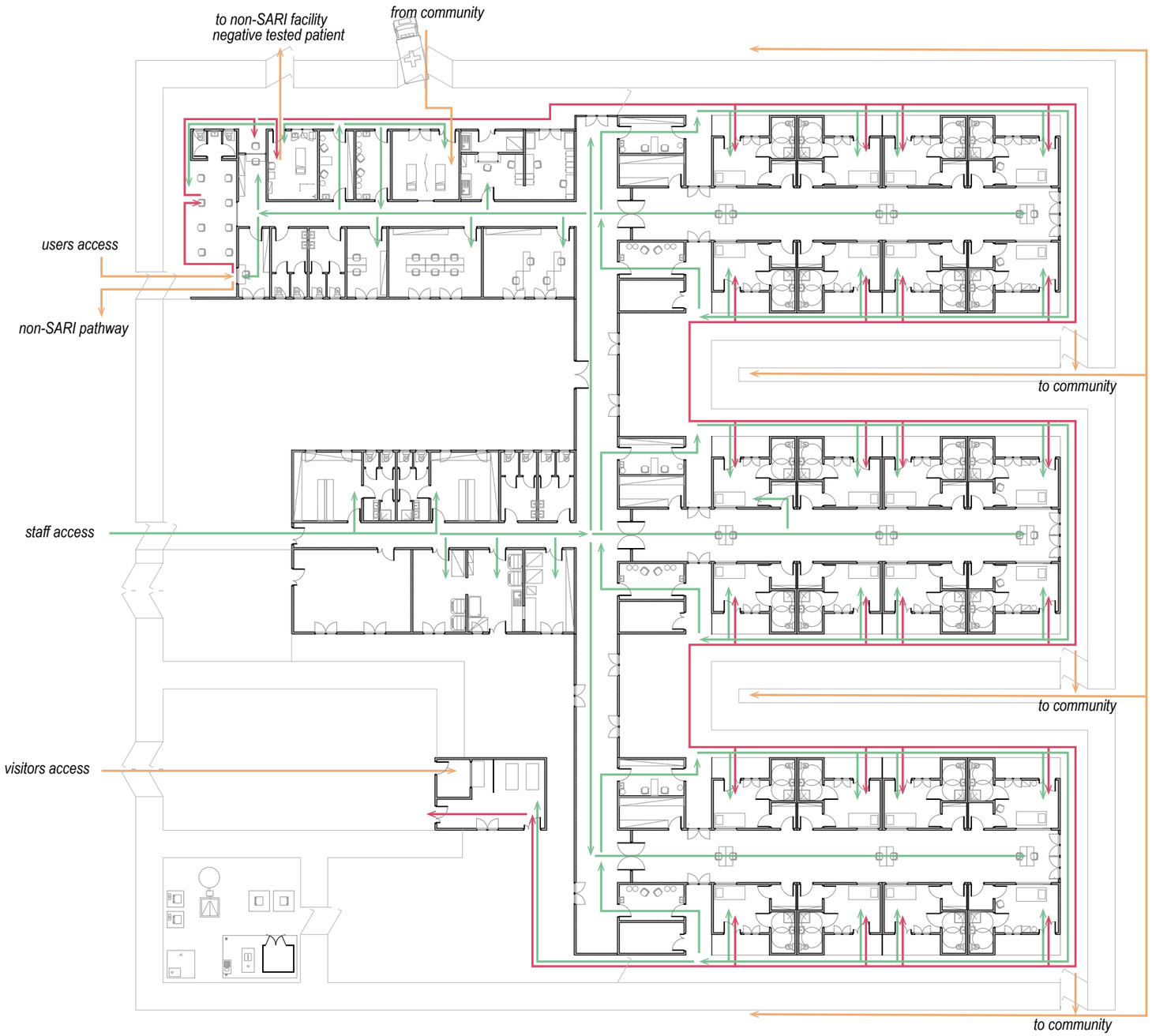


1. screening
2. waiting area
3. triage
4. consulting room
5. donning
6. doffing
7. resuscitation room
8. laboratory
9. patient room
10. nursing station
11. clean utility
12. soiled utility
13. office
14. changing room
15. storage/pharmacy
16. laundry
17. reprocessing equipment
18. morgue
19. staff entrance

Low-risk
High-risk
Uncategorised risk

Staff
Patients
Users

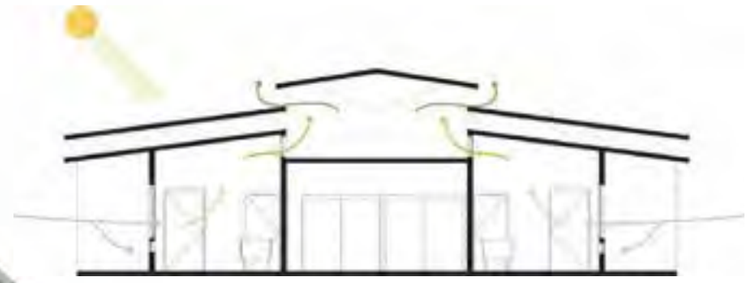
0 1 2 5 10m



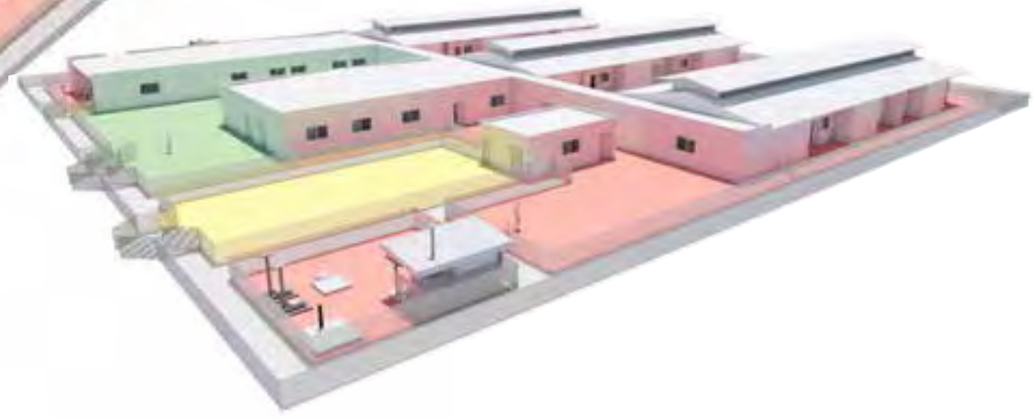
Site Minimum dimensions: 69 x 72 m
Ward dimensions : 14 x 32 m
Staff/entrance : 13 x 28 m
Staff/services : 13 x 21 m
Number of beds: 24

Low-risk
High-risk
Uncategorised risk
Staff
Patients
Users

0 1 2 5 10m



The design of openings towards the roof can create cross ventilation and increase the airflow rate in the patient room if the building rely on natural ventilation. This strategy can be adopted in 1-storey buildings.



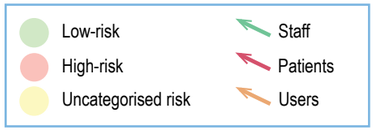
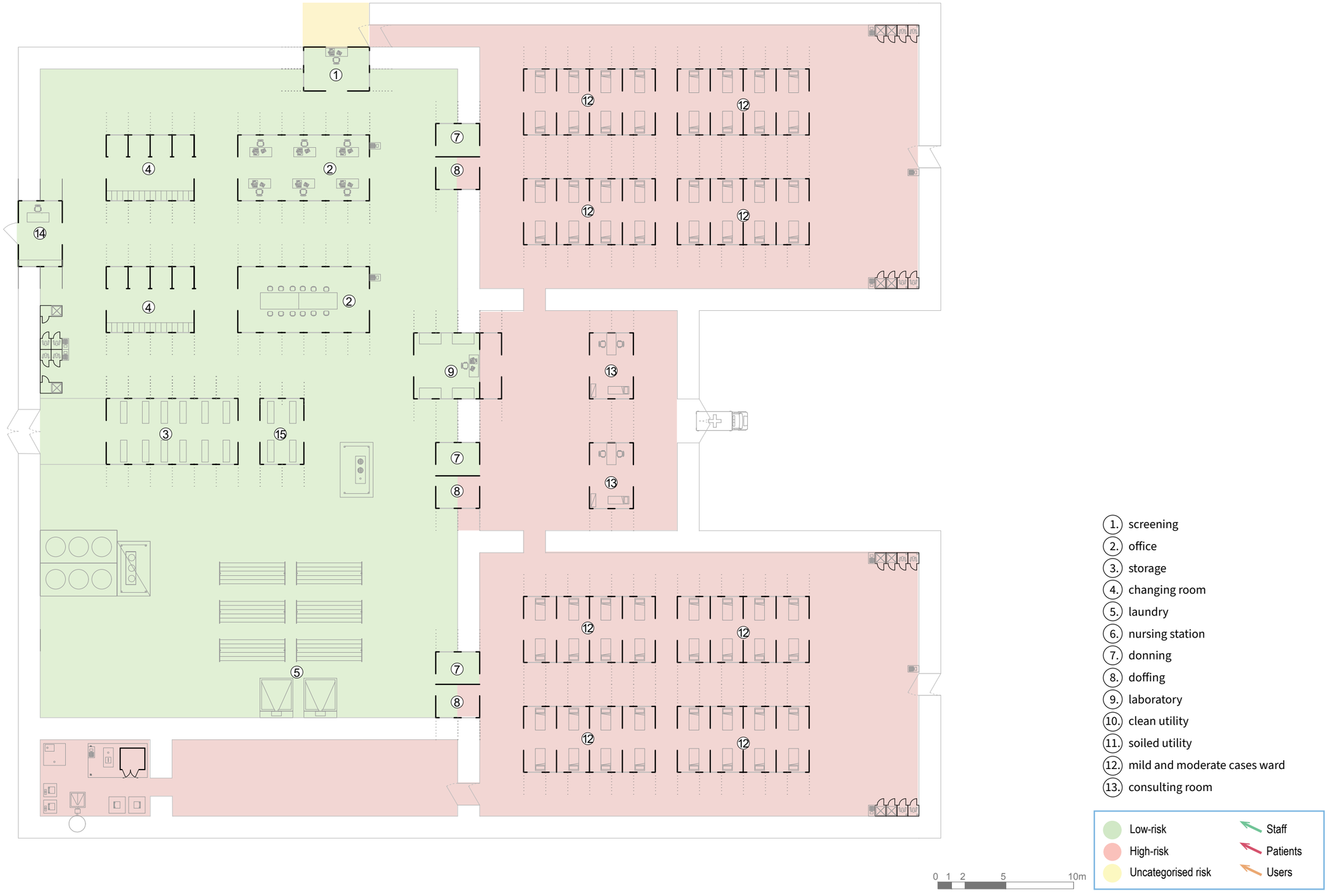
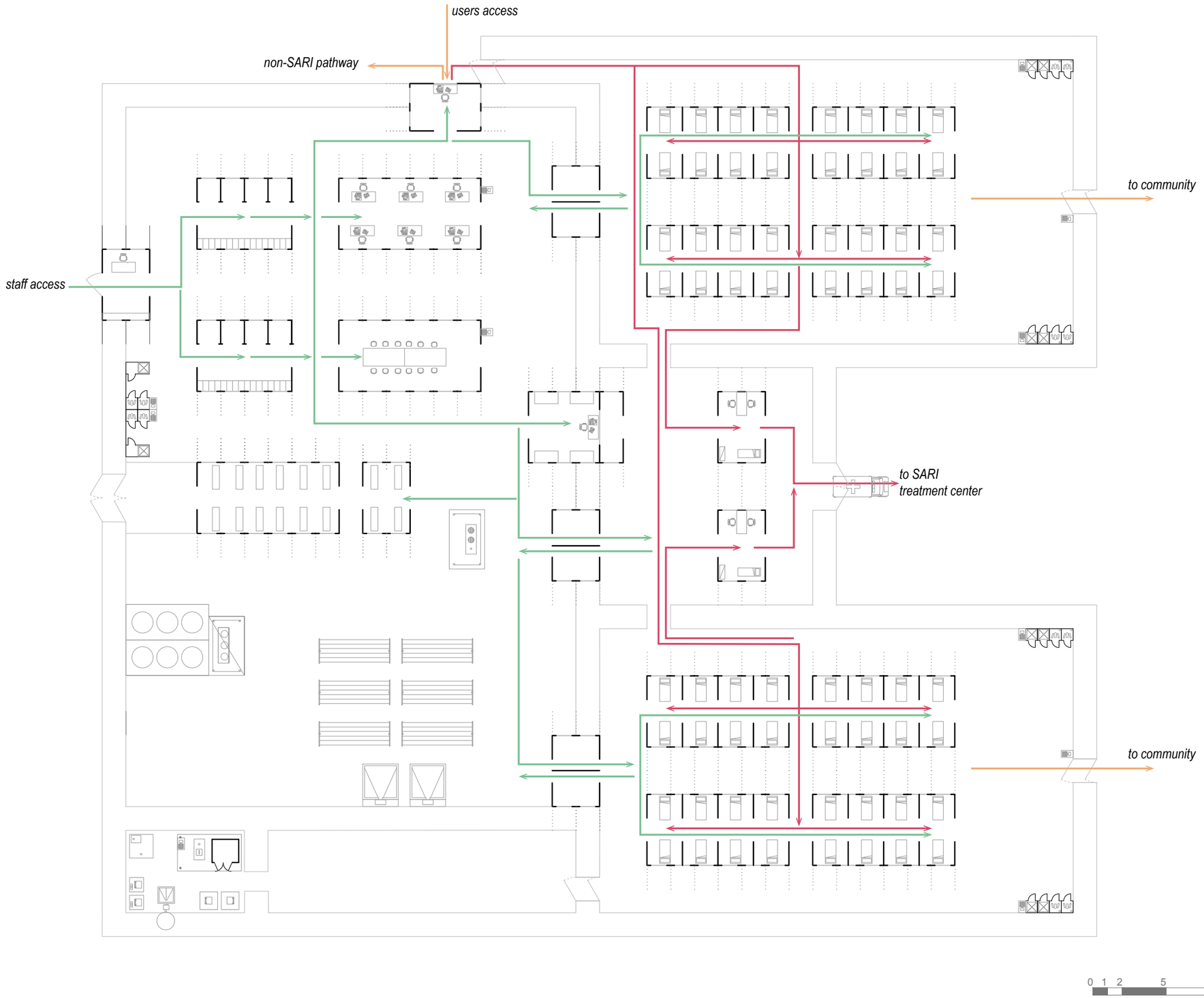


Fig. 29. 3D representation

8.5 Community facilities

8.5.1 Temporary solution in tents





Site Minimum dimensions: 76 x 84 m
24 m² tents: 7
48 m² tents: 3
72 m² tents: 11
Number of beds: 64

Fig. 30. 3D representation

8.5.2 Semi-permanent solution with local materials

1. screening
2. office
3. storage
4. changing room
5. laundry
6. nursing station
7. donning
8. doffing
9. laboratory
10. clean utility
11. soiled utility
12. mild and moderate cases ward
13. consulting room

Low-risk
High-risk
Uncategorised risk

Staff
Patients
Users

0 1 2 5 10m


non-SARI pathway
users access
staff access
to SARI
treatment center
to community
Site Minimum dimensions: 74 x 55 m
Main Building dimensions : 45 x 40 m
Number of beds: 60
Low-risk
High-risk
Uncategorised risk
Staff
Patients
Users
0 1 2 5 10m

The design of openings towards the roof can create cross ventilation and increase the airflow rate in the patient room if the building rely on natural ventilation. This strategy can be adopted in 1-storey buildings.

Fig. 31. 3D representation

9. Focus on the key elements

9.1 Patient wards and rooms

Hereby three potential layouts of patient wards are proposed. The decision to adopt one or the other should be guided by the testing capacity, the patient categorization, and the available treatment at facility level.

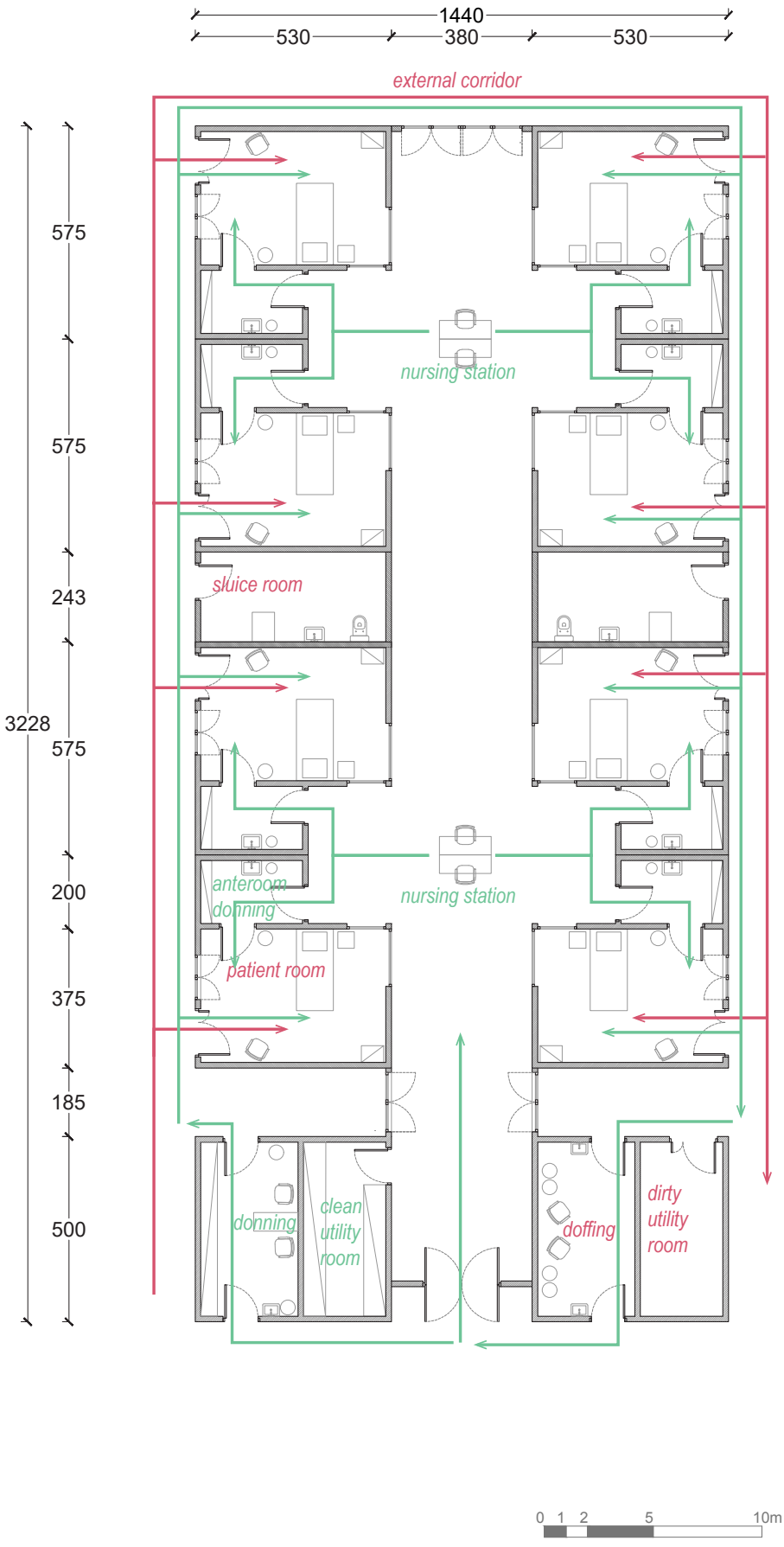
As presented in this manual, individual rooms should be preferred when the capacity of testing is not in place or when the test results may be available with delay, while confirmed cases could be cohorted in shared rooms. Intensive care wards do not require the presence of toilets at room level, but a sluice room should be foreseen in each ward. The rooms and toilets are designed to be accessible for patients in wheelchairs. Patients access the rooms from the outside corridor through a door that is wide enough to allow the passage of a hospital bed or stretcher.

Fig. 32. The transparent screen

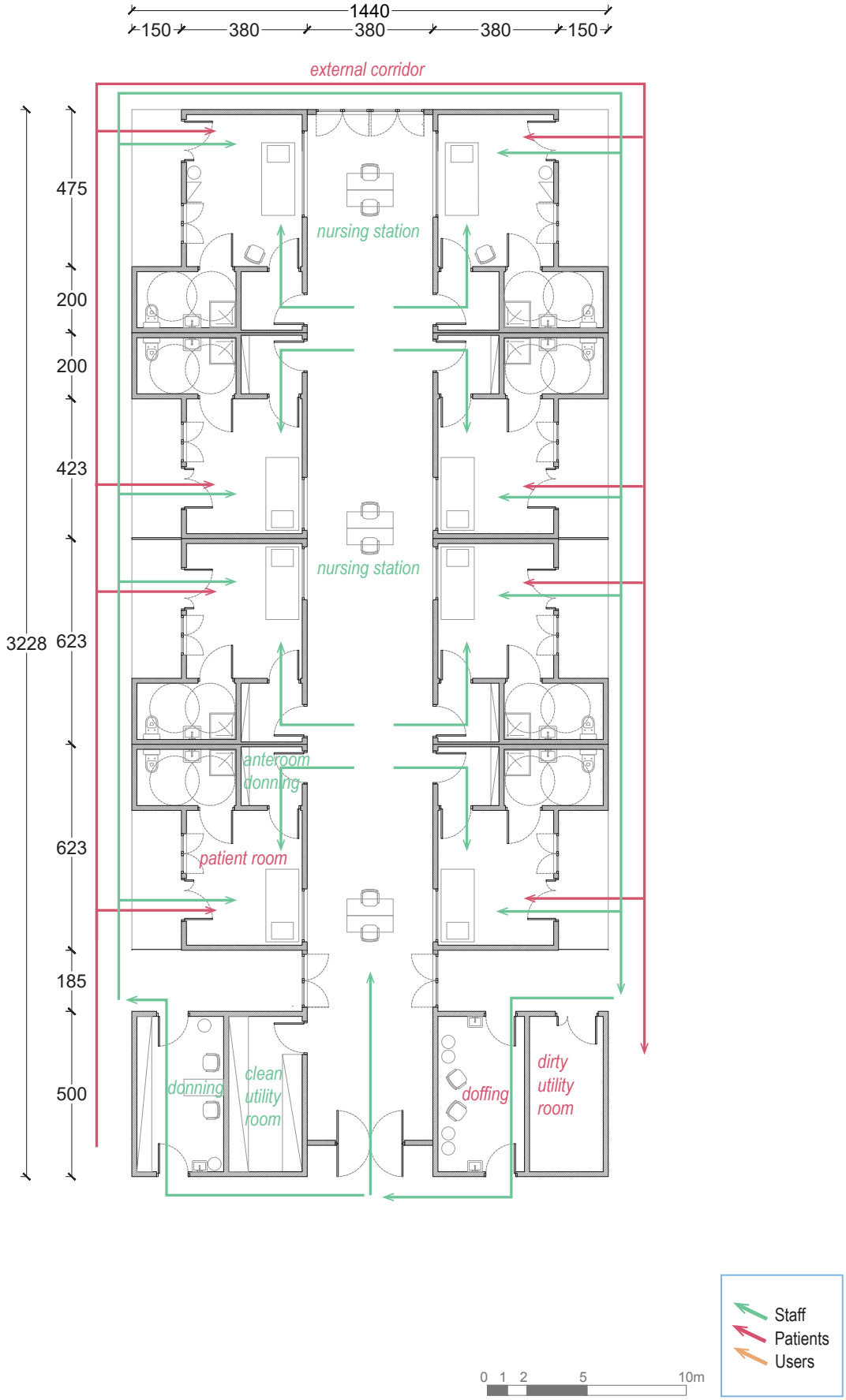
The central corridor serves as a medical office and nursing station. The transparent screens between nursing station and patient rooms allow visibility (Fig. 32) to better monitor patients' conditions and improve the quality of care. The visibility may reduce the PPE consumption.

To ensure Infection Prevention and Control, staff can access patients' room from the outside corridor after a mandatory passage in the donning room, or in case of emergency through the anteroom. The anteroom allows for better control of the airflow direction and can be used as a donning area. A doffing area is available at the end of the circuit, on the opposite side of the donning area. One clean and one dirty utility room are available for each ward, the first for medications, linen and other clean goods storage, and the second for temporary storing of waste or dirty goods produced in the ward, before moving them to the laundry, reprocessing equipment and waste areas.

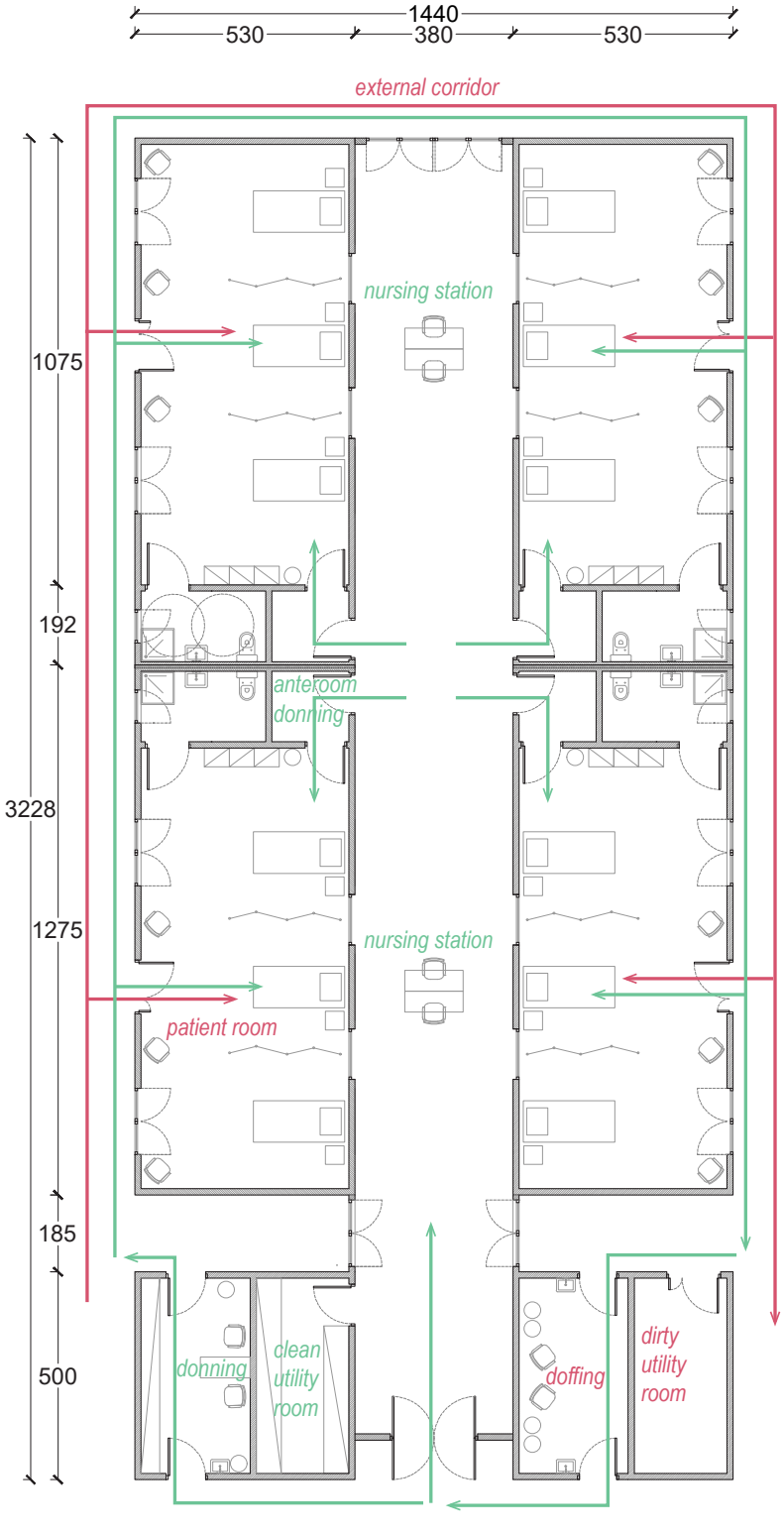
9.1.1 Individual room, critical cases



9.1.2 Individual room, mild and moderate cases



9.1.3 Shared room for confirmed cases



9.2 Patient entrance area

Staff and patient entrances are located in different areas of the site. In patient entrance area, the patients and health professionals can be in direct contact. These areas are designed with transparent screens, which allow for protected verbal and visual contacts in order to safeguard health professionals and patient safety and reduce the PPE consumption.

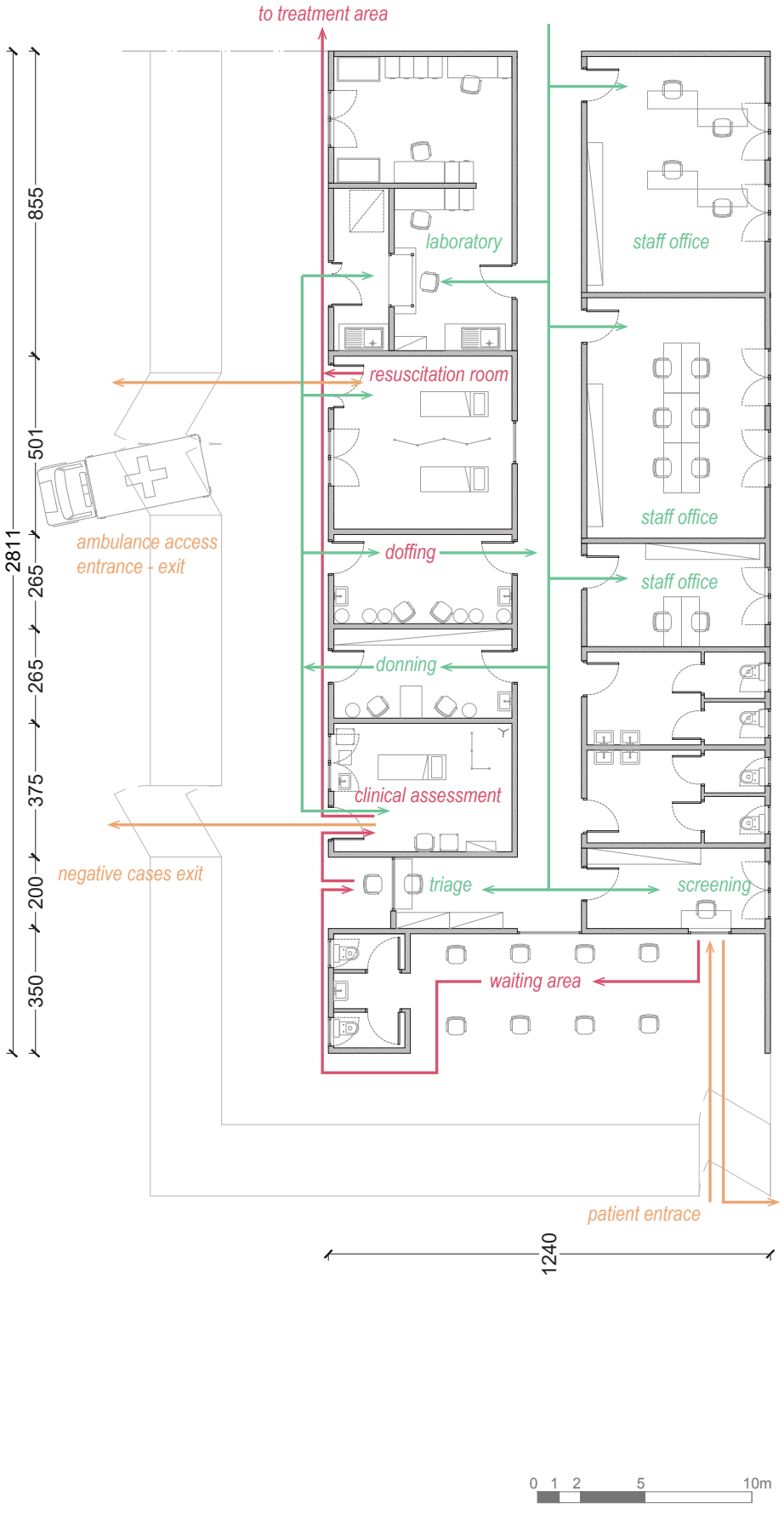
The screening area is located at the entrance of the site and is characterized by the presence of the transparent screen. Patients who meet the case definition for access to the treatment centre are directed to the waiting room. The triage station is equipped with a transparent screen between patients and health professionals for no-touch procedures, and an examination room available nearby for procedures requiring direct contact, such as clinical assessments or sample collection.

Patients who are identified as confirmed cases are directed to the treatment wards. Negative cases exit the centre and, if needed, they are referred to other health facilities.

A resuscitation room is available for high-acuity patients and located near the ambulance entrance. Patients in the resuscitation room can be monitored from a low-risk staff corridor thanks to the installation of transparent screens.

The laboratory is characterized by a sample reception area equipped with a glove box. Here, the samples are safely handled and deactivated before being brought into the laboratory. Laboratory staff work in the processing area where working stations, sinks and shelves are available. A second room is available with a controlled environment for special procedures, and a storage area completes the lab zone. For more information, refer to "World Health Organization. Laboratory Design and Maintenance. (2020)".

A donning and a doffing space complete the patient entrance area, allowing staff to put on and take off PPE and move more safely through zones with different levels of risk.


to treatment area
laboratory
staff office
resuscitation room
staff office
ambulance access
entrance - exit
doffing
staff office
donning
clinical assessment
negative cases exit
triage
screening
waiting area
patient entrace
2811
855
501
265
265
375
200
350
1240
Staff
Patients
Users
0 1 2 5 10m

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Annexes

Annex 1. The SARI pathway

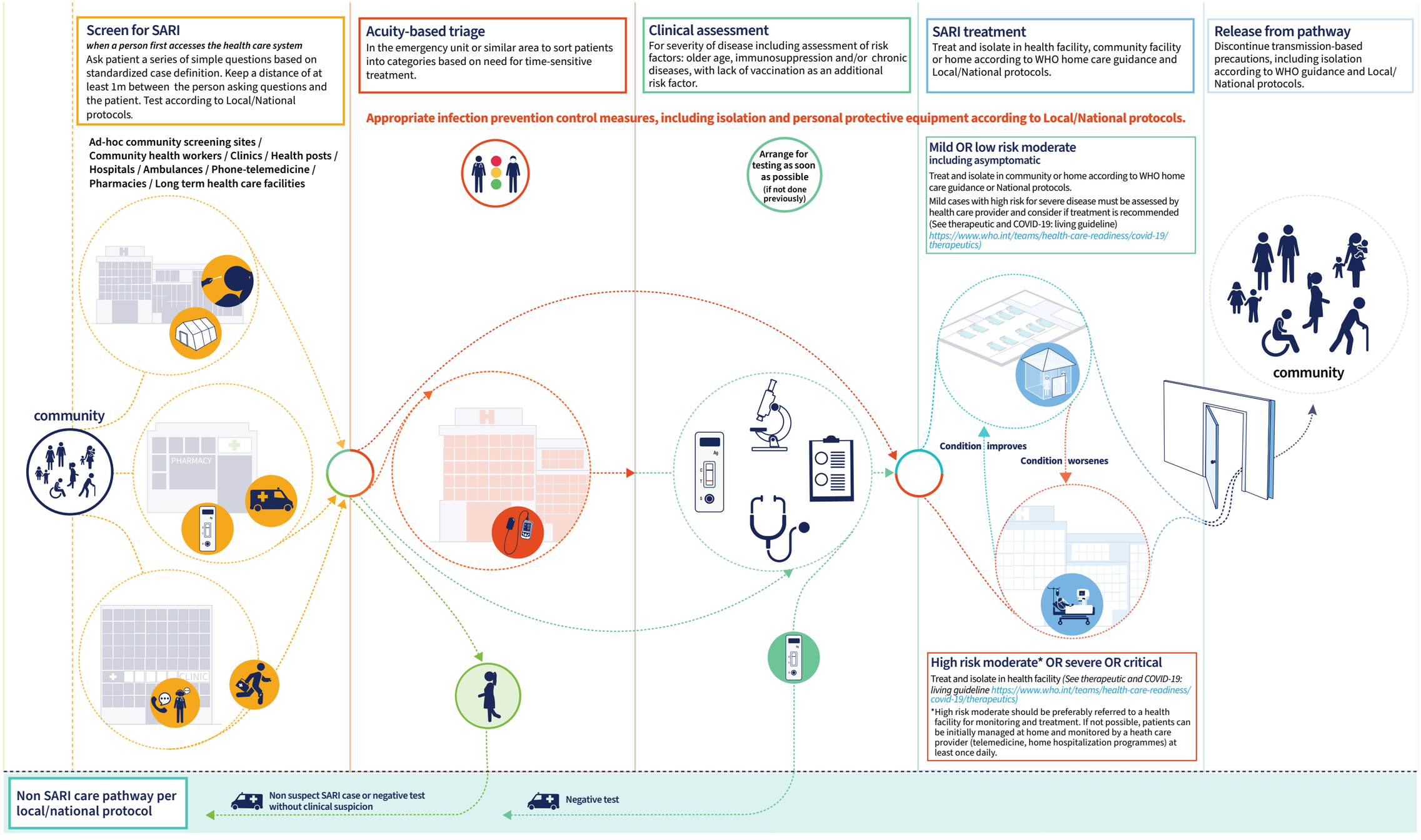

Fig. A1. The SARI Pathway.

Source: Adaptation from WHO/ Clinical management of COVID-19: living guideline

Annex 2. Medical Devices for Severe Acute Respiratory Infection treatment

Further information could be find in the WHO publication "Priority medical devices list for the COVID-19 response and associated technical specifications".

1. **Monitor:** The screen displays vital signs parameters such as such as blood pressure measurements and heart rate. An alarm is activated when abnormal vital signs develop.
2. **Suction device:** Excess secretions are regularly removed from the airways using suction.
3. **Oxygen supply:** Every bed area should have an oxygen supply available at all times.
4. **Pulse oximeter sensor:** The level of oxygen saturation in the blood (SpO_2) is measured painlessly with probe on the finger or earlobe.
5. **Ventilator tubing and face mask:** These consumables are the interface between equipment and patient.
6. **Ventilator:** This equipment provides respiratory support by inflating the lungs with a mixture of oxygen and air.

Fig. A2.1. Medical devices related to oxygen therapy used in an intensive care unit. Foundations of medical oxygen systems, 2023

Table 3. Items for severe acute respiratory infections (SARI) ICU

The listed items can be available for each patient bed, and in some cases for all the facility (e.g., defibrillator).

The selection of medical equipment, especially patient ventilators, will be depending on the context, clinical needs and technical and clinical skills capacity and availability; as well as the capacity for cleaning, disinfection and sterilization at facility level for some accessories.

The medical equipment requires a continuous and reliable source of energy. Therefore, planning for emergency energy supply for ICU is a must.

The medical equipment requires maintenance for long term sustainability and acquisition of accessories, consumables and spare parts for proper operation.

The selection and quantification of accessories, consumables and spare parts will vary depending on the number of patients, treatments and capability of maintenance. Some items, like consumables and batteries, require specific decommissioning processes.

The location of the medical equipment should allow movement of the medical staff and avoid tangled cabling and hoses.

For the ICU		**Quantity**	**Patient Group** *Note: Different patient groups may require different models or sizing for accessories and consumable*		
Biomedical Equipment	**Use**	**Per bed/ICU**	**Adult**	**Paediatric**	**Neonate**
Essential Items • **Specifically for oxygen supply, it is recommended to have the primary source and back up -supply (e.g., bedside oxygen concentrators and/or high-pressure cylinders).**					
Patient monitor multiparametric, basic with accessories (e.g., pulse oximeter, blood pressure cuff, cables, batteries)	To monitor vital signs: ECG, respiration rate, temperature, blood oxygen saturation (SpO2), non-invasive blood pressure; optional invasive blood pressure, capnography EtCO2.	1 per bed	✓	✓	✓
Defibrillator external, with accessories	To select between manual, semiautomatic or automatic.	1 per ICU/area	✓	✓	✓
Electrocardiograph, with accessories	To have the most accurate indication of the functioning of the heart.	1 per bed	✓	✓	✓
Gas pressure regulators and flowmeters	To adjust flow rate and pressure required, depending on the oxygen supply source (i.e., cylinders, pipe network or concentrators).	2 per bed (2X O2, 2XVacuum and 2X Medical Air)	✓	✓	✓
Oxygen high-pressure cylinders	Different sizes could be needed. Could be used also to transfer patients from another hospital/ambulatory to the current ICU. Could be used as back-up supply if the facility is piped with medical oxygen.	1-2 (per ICU as back-up supply)	✓	✓	✓
Bedside oxygen concentrators	Useful in the absence of piped medical oxygen outlet in the facility, or high-pressure cylinders. Consider the out pressure and flow parameters.	1 per bed (in the absence of medical oxygen outlet) Or 1-2 per ICU as back-up	✓	✓	✓
Hospital bed (mechanical)	For hospitalized patients in need of health care.	1 per bed	✓	✓	✓
Basic thermometer	For body temperature measurement.	1-3 per ICU	✓	✓	✓
Suction device with accessories (manual)	Used to remove fluids — like mucus, blood, saliva, or phlegm — that are causing obstructions on the airway or respiratory system and infectious materials from wounds. The accessories should be for single use only.	1 per bed	✓	✓	✓
Resuscitator bag with accessories	Used to inflate the lungs during procedures including intubation. The accessories should be for single use only.	1-3 per ICU	✓	✓	✓
Nasogastric tubes	1. To remove bodily fluids from the stomach to prevent vomiting and possible aspiration. 2. To give medication or food when the patient is ventilated and/or is having trouble swallowing.	Single use only	✓	✓	✓
Advanced items • **The selection of this equipment will depend on the context and clinical skills capacity and availability.**					
Syringe pump with accessories	Sophisticated pump used to deliver small quantities of intravenous medications and fluids.	1-5 per bed	✓	✓	✓
Infusion pump with accessories (e.g., intravenous bag, tubing set and support pole)	For higher volumes, consider infusion pumps instead of syringe pumps.	1-5 per bed	✓	✓	✓
Enteral feeding pump	To assist intake of food via the gastrointestinal (GI) tract.	1 per bed	✓	✓	✓

For the ICU		Quantity	Patient Group *Note: Different patient groups may require different models or sizing for accessories and consumable*		
Biomedical Equipment	**Use**	**Per bed/ICU**	**Adult**	**Paediatric**	**Neonate**
Indwelling urinary catheter	To measure the amount of urine produced and to control bladder function.	Single use only	✓	✓	✓
Electric hospital bed	To transport critically-ill patients, support the patient comfortably, and provide room to carry portable oxygen cylinders, suction equipment, emergency resuscitation equipment, intravenous infusions and their pumps, as well as transport monitor and ventilator.	1 per bed	✓	✓ Consider additional caregiver and child bed	Incubator Or Newborn cot
Electronic probe thermometer	For the body temperature.	1-3 per ICU	✓	✓	✓
Infrared thermometer		1-3 per ICU	✓	✓	✓
Examination lamp	For local illumination of the patient body during diagnostic procedures and minor procedures.	1 per bed	✓	✓	✓
Suction device with accessories (electric)	Used to remove fluids — like mucus, blood, saliva, or phlegm — that are causing obstructions on the airway or respiratory system and infectious materials from wounds. The accessories should be for single use only.	1 per bed	✓	✓	✓
Laryngoscope or Video laryngoscope with accessories (e.g. blades, handles, tubes, stylets, mask airway)	Intubation assist device. To be able to put the tip of the endotracheal tube into the trachea for ventilation or general anaesthesia. Accessories should be for single use only.	1-3 per ICU	✓	✓	✓
Oto/Ophthalmoscope	Oto (ear), and ophthalmo (eye)	1 per ICU	✓	✓	✓
Blood chemistry analyser, portable with cartridges and solutions	For patient blood chemistry (blood gases – O2 and CO2), electrolytes (sodium, calcium, potassium) and other components (urea, haemoglobin).	This equipment might be needed for some patients. However, it could be borrowed from another department (Radiology & Laboratory). No need to consider purchasing it for the single isolation rooms.	✓	✓	✓
Ultrasound machine with probes and accessories	Certain tissues cannot be visualized well with x-rays and some situations require to avoid x-rays, but visualization of internal tissue is still needed.		✓	✓	✓
Portable x-ray (digital)	For patients who cannot move. Need of radiology technicians and a radiologist. Lead Personal Protective Equipment have to be purchased for the safety of the users.		✓	✓	✓
Phototherapy lamp or light blanket	Used to break down the bilirubin for newborns with jaundice	1-2 per NICU			✓
Ventilator and accessories (e.g., breathing tube)	Support patients to breathe by themselves, or can take over breathing for a patient completely. Accessory tubing should be for single use only.	1 per bed	✓	✓	✓
Continuous positive airway pressure (CPAP) and accessories	To apply continuous positive airway pressure, which helps keeping the lungs inflated. Accessory tubing should be for single use only.	1-2 per ICU	✓	✓	✓
Bilevel positive airway pressure (BiPAP/BPAP) and accessories	To apply BiPAP/BPAP to non-intubated adult or paediatric patients, allowing clinicians to adjust pressures for inspiratory and expiratory phases of a breath. Accessory tubing should be for single use only.	1-2 per ICU	✓	✓	✓
High-flow nasal cannula (HFNC), heated humidified high-flow (HHHF) therapy or high-flow nasal oxygen (HFNO) and accessories	To deliver high-flow rates with heated humidification to non-intubated adult or paediatric patients. Accessory tubing should be for single use only.	1-2 per ICU	✓	✓	✓

For single isolation rooms		Quantity		
Biomedical equipment	**Use**	**Per bed**	**Per area**	**Per hospital**
***Patient monitor multiparametric, basic with accessories**	To monitor vital signs: ECG, respiration rate, temperature, blood oxygen saturation – SpO2, blood pressure Non-Invasive Blood Pressure.	**1**		
External defibrillator, with accessories	Manual		**1**	
Syringe pump with accessories	Spare ones.		**10**	
Electrocardiograph, with accessories	To have the most accurate indication of the functioning of the heart.		**1**	
Electric hospital bed		**1**		
***Electronic probe thermometer**	For the body temperature.		**1 TO 3**	
Infrared thermometer			**1 TO 3**	
Examination lamp		**1**		
Gas pressure regulators and flow meters	To regulate pressure and adjust flow rate as required.	**1 (1 O2, 1 VACUUM, 1 MEDICAL AIR)**		
Glucometer	To measure blood glucose levels.		**1**	
Oto/Laryngo/ Ophthalmoscope	Oto (ear), laryngo (throat) and ophthalmo (eye).		**1**	

Medical gases wall-outlets per bedspace

If the facility has a medical gas piping network, the number of wall-outlets can vary depending on the medical ward and standard followed (e.g., ISO 7396-1, Health Technical Memorandum (HTM 02-01), or National Fire Protection Association (NFPA) 99).

For instance, some standards may recommend more than one wall-outlet for each medical gas (oxygen, air, vacuum). This adds safety measures but may represent an extra cost for investment, including for the medical gas source. Thus, it needs to be carefully assessed.

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