November 2019

SARI CRITICAL CARE TRAINING

DESIGNING AND OPERATING A SARI TREATMENT CENTER [STC]

TO OPTIMIZE STANDARD OF CARE AND STRENGTHENING IPC MEASURES

KEYS PRINCIPLES, DESIGN, BASIC FACILITIES, VENTILATION & FLOWS

World Health Organization

HEALTH EMERGENCIES programme

Where setting up a STC?

- As closed as possible to the outbreak epicenter;
    - Next to existing health facilities (to allow an integrated approach and ease the referral pathways);

    And/or

    - New place chosen according to specific strategic reasons (space, community acceptance, accessibility, etc.)

Construction field requirements:

- Enough space (future extensions) and accessible water source;
- Soil conditions: waste water infiltration, raining water evacuation, stability, etc.
- Take into account prevailing winds for the control of smoke and odours

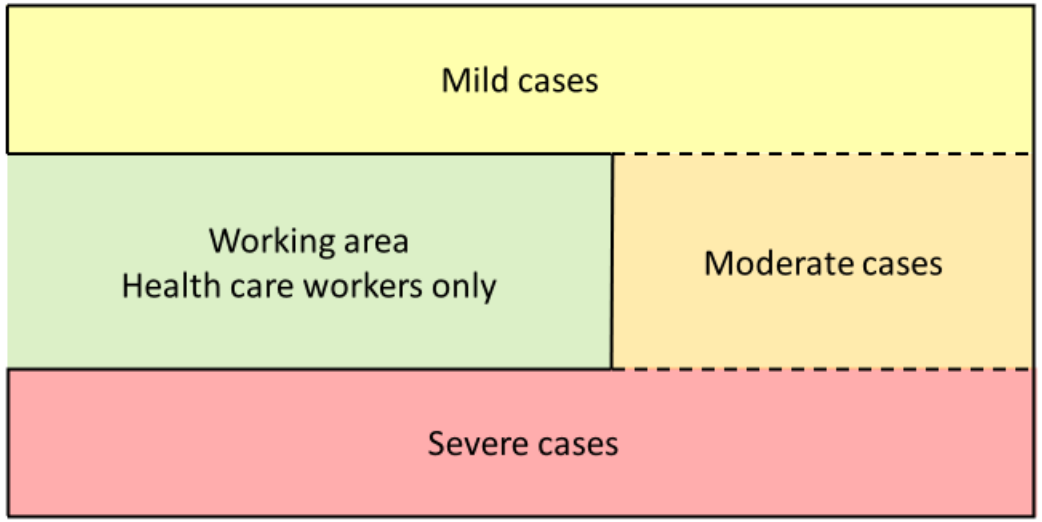
Basic layout principle

The rationales behind this layout are:

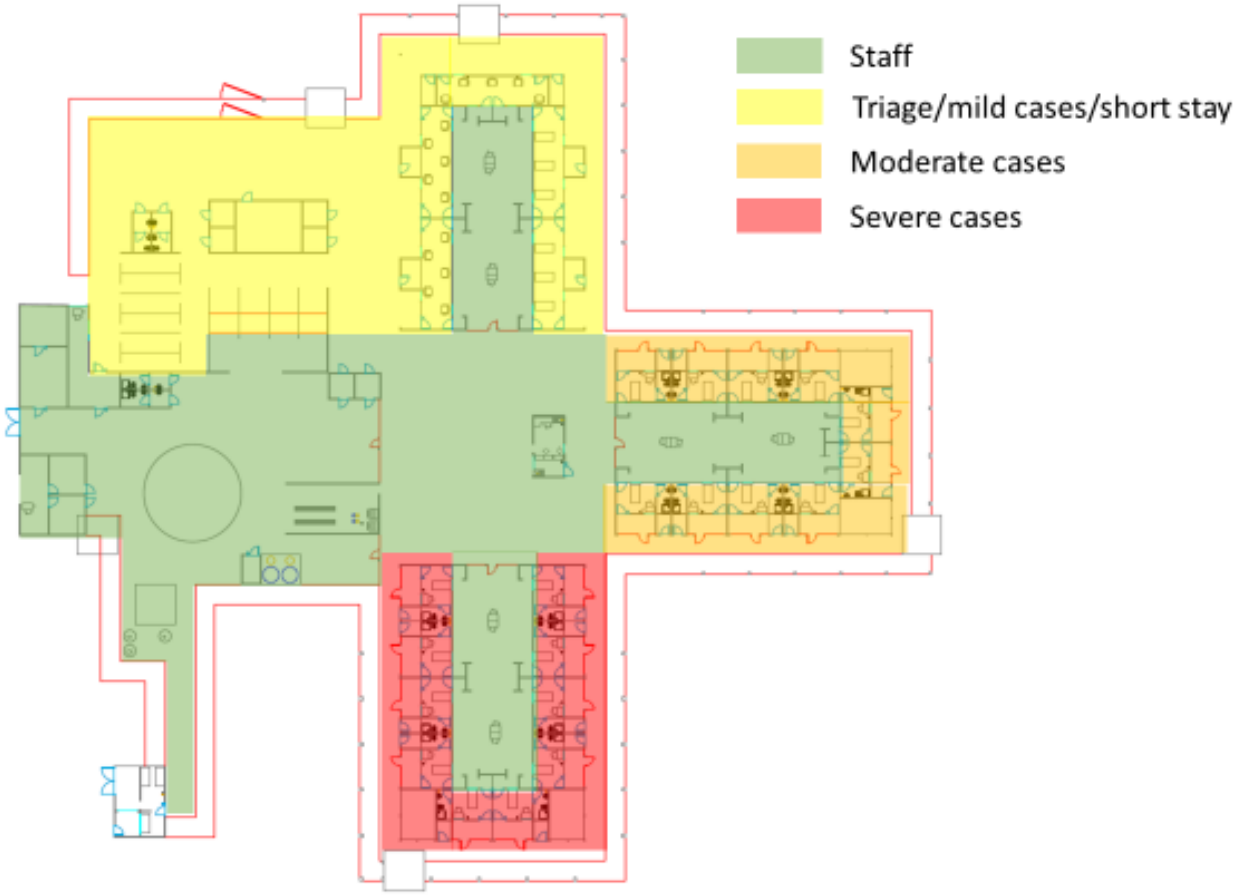
- ✓ Medical care should be provided as soon as possible, even prior the laboratory confirmation, in order to avoid medical conditions worsening.
- ✓ Home care approach might be consider for mild cases, including situations when inpatient care is unavailable or unsafe (i.e. limited capacity and resources unable to meet demand for health care services), or in a case of informed refusal of hospitalization.
- ✓ The different level of risk represented by patients with specific medical condition such as the severe patients who might need an aerosol generating procedure [aspiration, intubation, bronchoscopy, etc.].

Basic layout principle

Based on the **clinical definition** of patient with SARI, suspected of COVID-19, the clinical syndromes associated with COVID-19 infection and related medical conditions: mild, moderate and severe illness



Basic layout principle



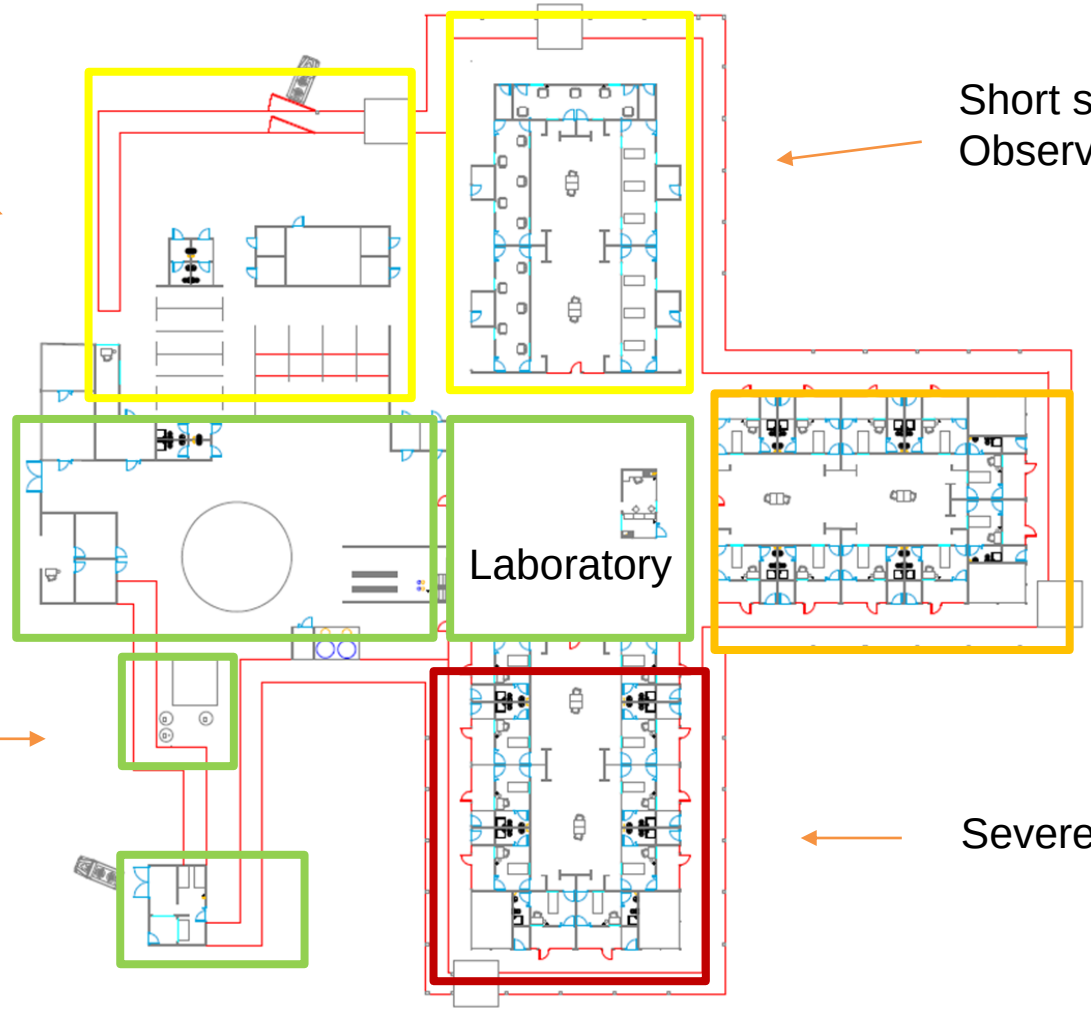
Key elements

Patient entry
Waiting room
Triage [patient]
Sampling room
X-Ray??

Staff entry
Changing room
Laundry
Triage [staff]

Waste zone

Morgue

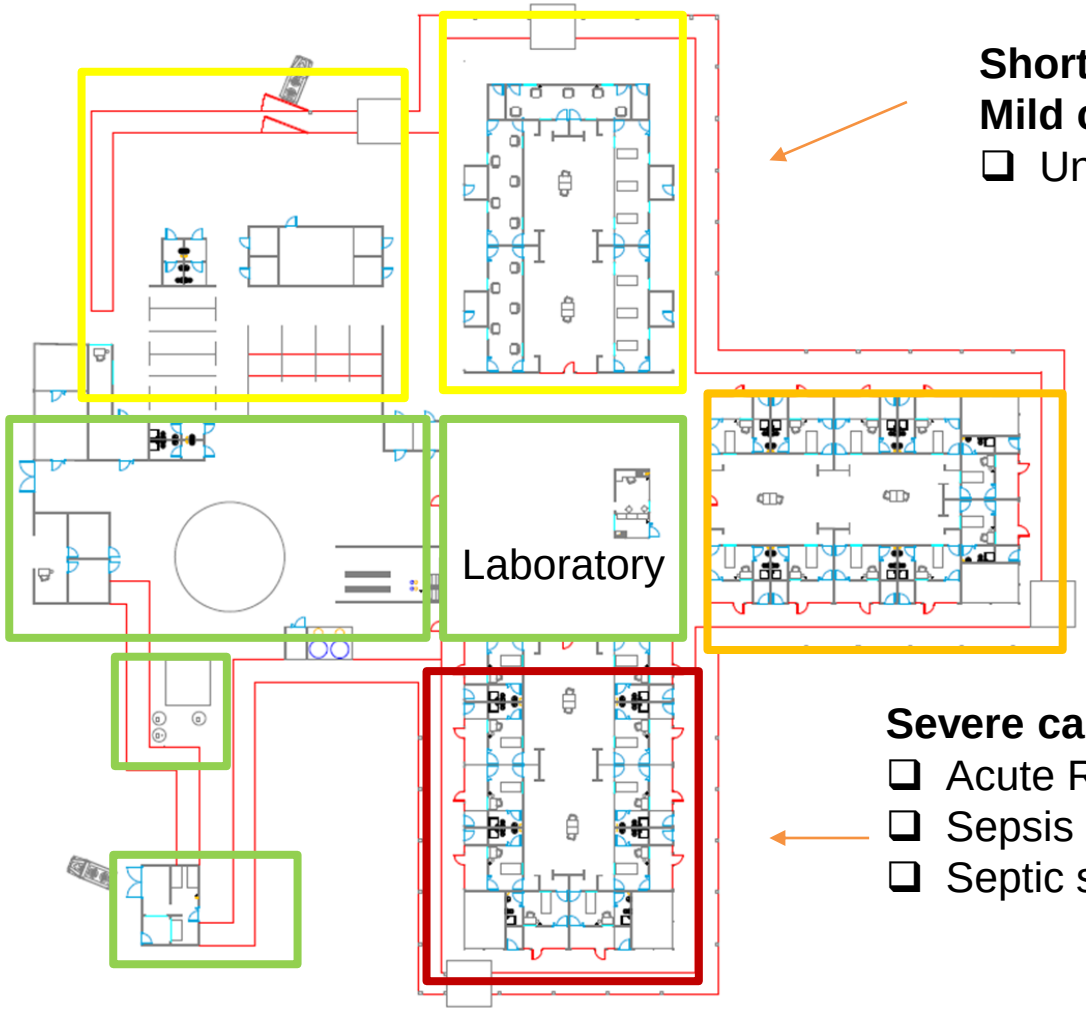


Short stay ward
Observation

Moderate case ward

Severe case ward

Key elements – Clinical categorization

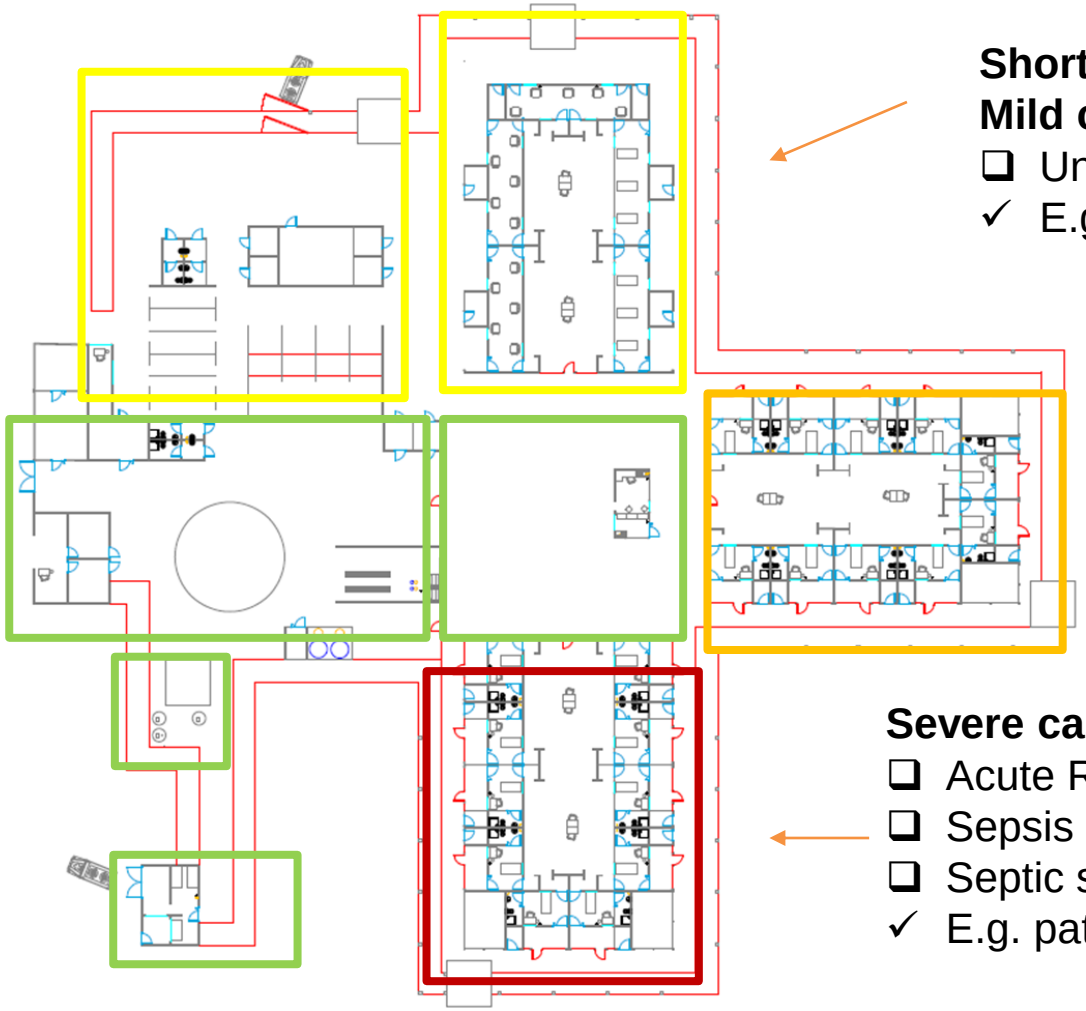


Short stay ward
Mild cases
- ❑ Uncomplicated illness

Moderate case ward
- ❑ Severe pneumonia

Severe case ward
- ❑ Acute Respiratory Distress Syndrome [ARDS]
- ❑ Sepsis
- ❑ Septic shock

Key elements – Case management

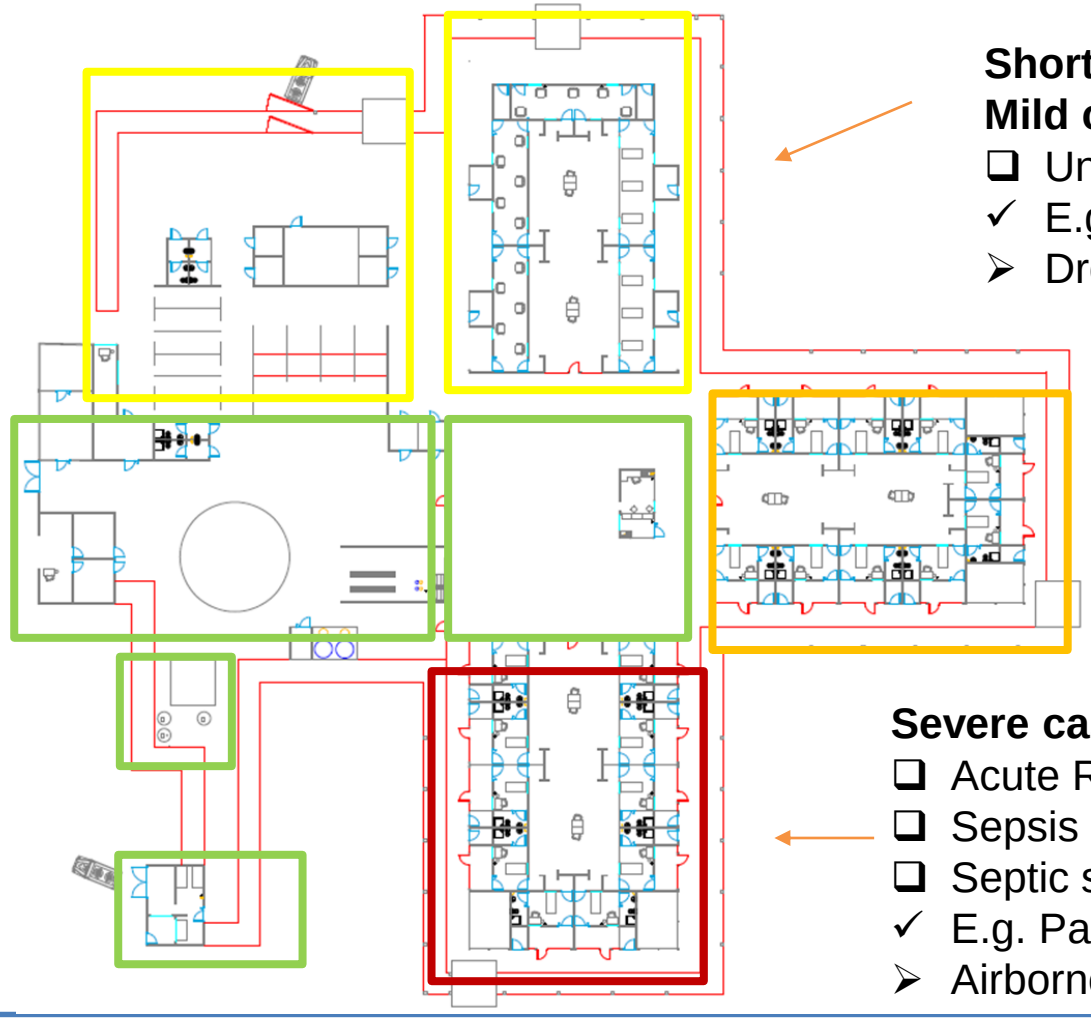


Short stay ward
Mild cases
- ❑ Uncomplicated illness
- ✓ E.g. Home care

Moderate case ward
- ❑ Severe pneumonia
- ✓ E.g. Oxygen

Severe case ward
- ❑ Acute Respiratory Distress Syndrome [ARDS]
- ❑ Sepsis
- ❑ Septic shock
- ✓ E.g. patient ventilation

Key elements – IPC measures /PPE



Short stay ward
Mild cases
- ❑ Uncomplicated illness
- ✓ E.g. Home care
- ➢ Droplet & Contact precautions

Moderate case ward
- ❑ Severe pneumonia
- ✓ E.g. Oxygen
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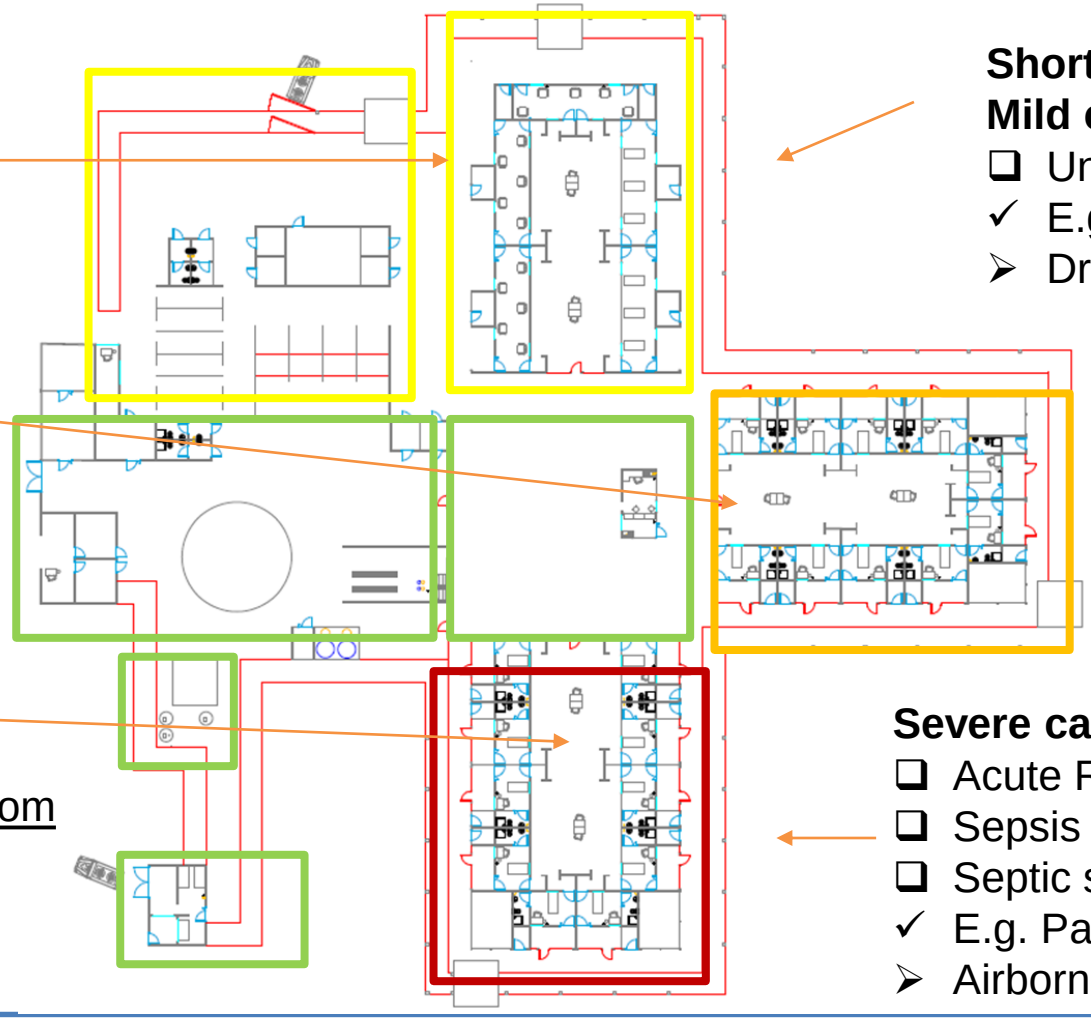
Severe case ward
- ❑ Acute Respiratory Distress Syndrome [ARDS]
- ❑ Sepsis
- ❑ Septic shock
- ✓ E.g. Patient ventilation
- ➢ Airborne & Contact precautions

Key elements – IPC measures / engineering

Short stay ward
Mild cases
Ward: spatial separation
Ventilation: Natural ventilation

Moderate cases
Ward or individual self-contained room
Ventilation: Natural ventilation or Hybrid ventilation

Severe cases
Individual self-contained room
Ventilation: **negative pressure** room or hybrid ventilation



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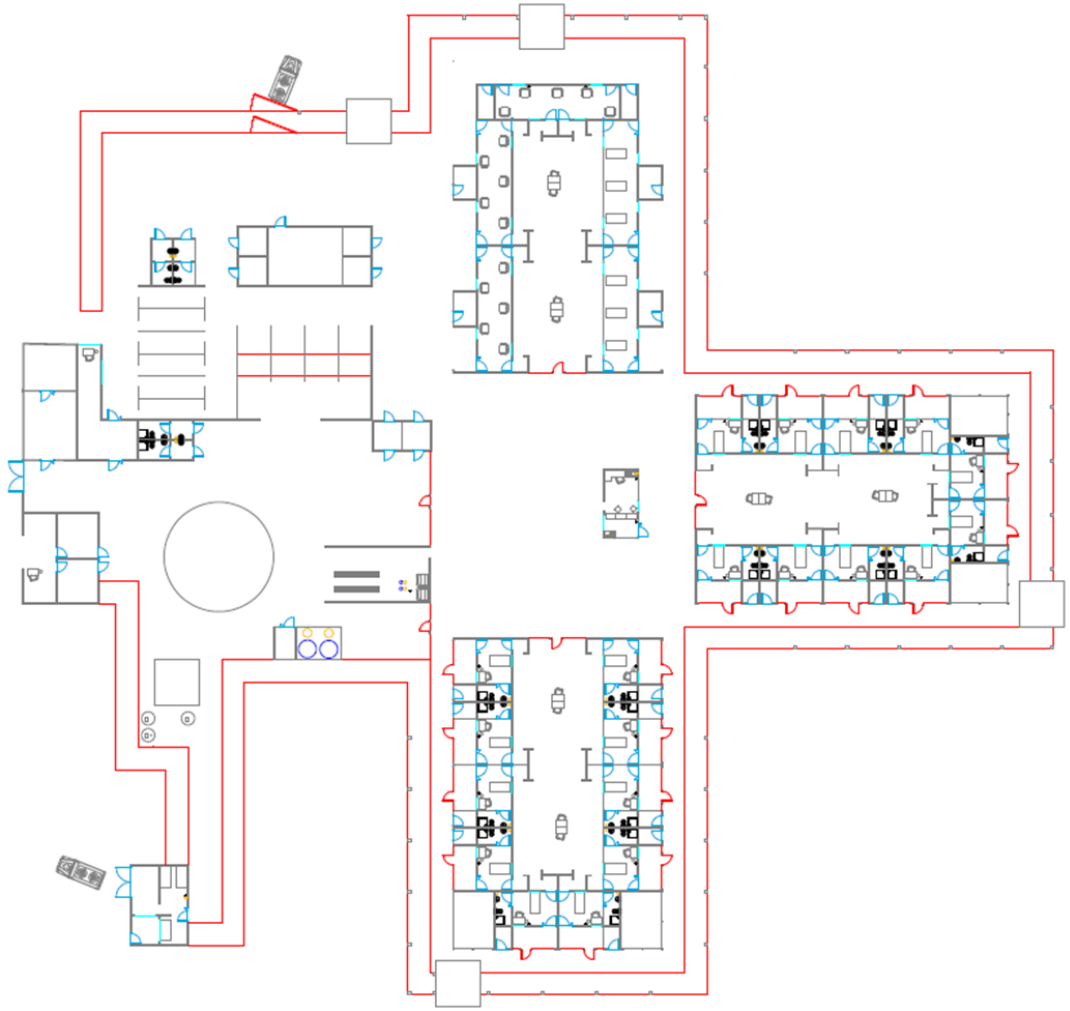
Patient’s flow



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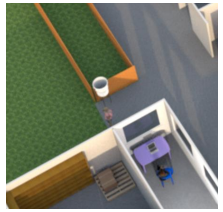
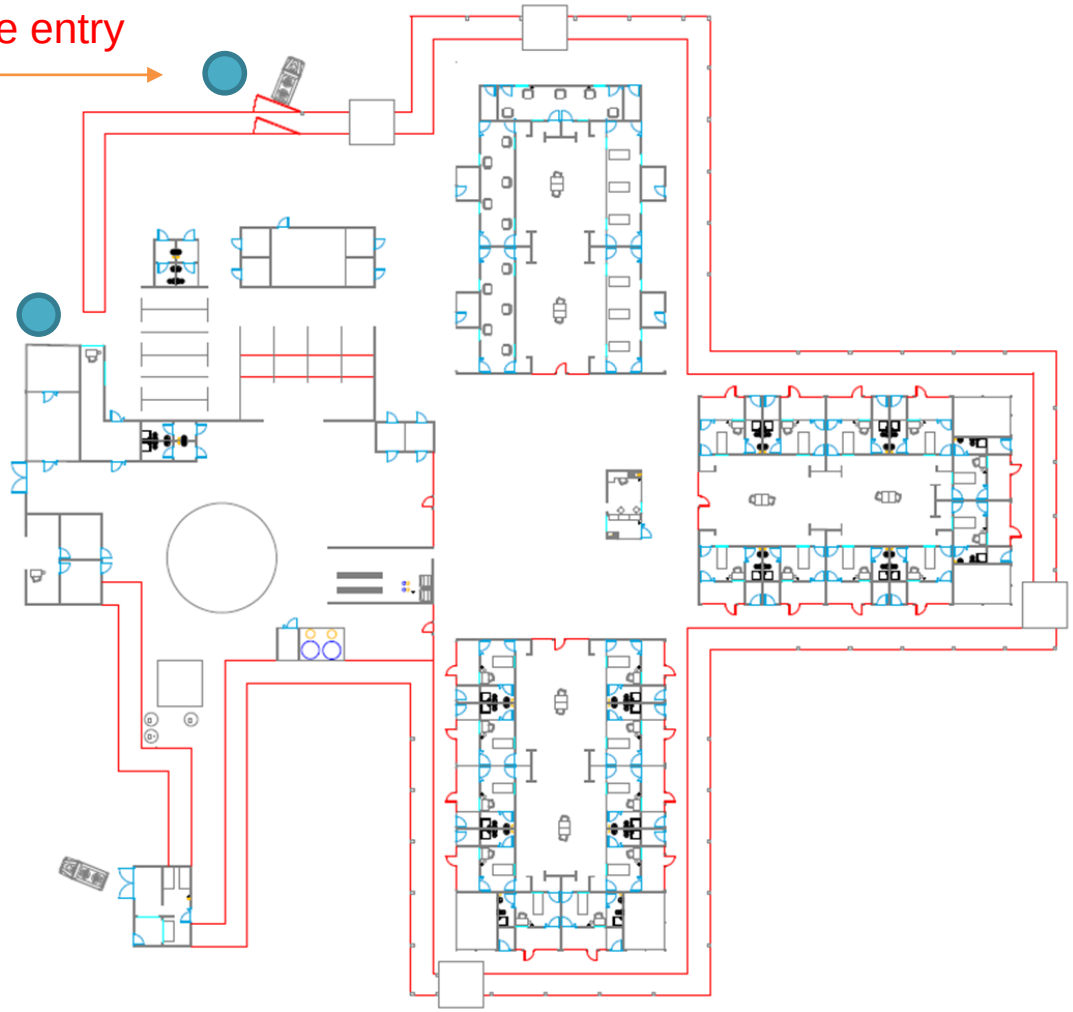


1: Patient entry

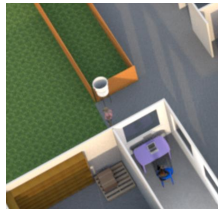
1: Ambulance entry



NOTE: patients have already been triage in another medical facility and being referred to the SARI treatment center.

- At this point all patients: Receive a mask,
- Hand washing,
- Addressed to a dedicate individual booth in the waiting room

Patient's flow



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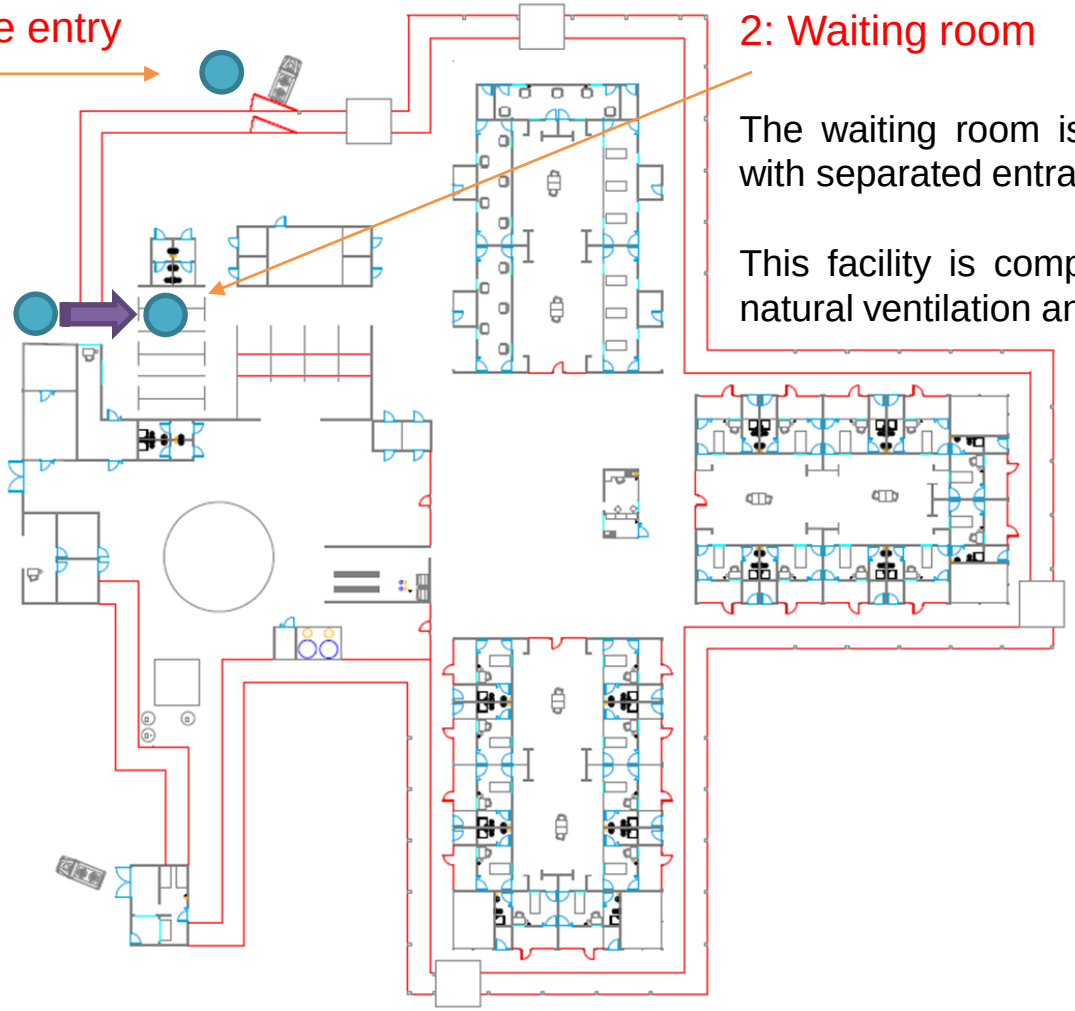
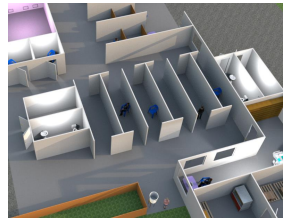
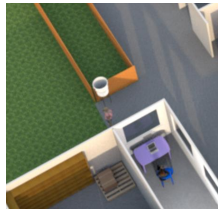


The waiting room is composed of different individual booths with separated entrance and exit.

This facility is completely open [no doors] to allow a proper natural ventilation and equipped with dedicate toilets



Patient's flow



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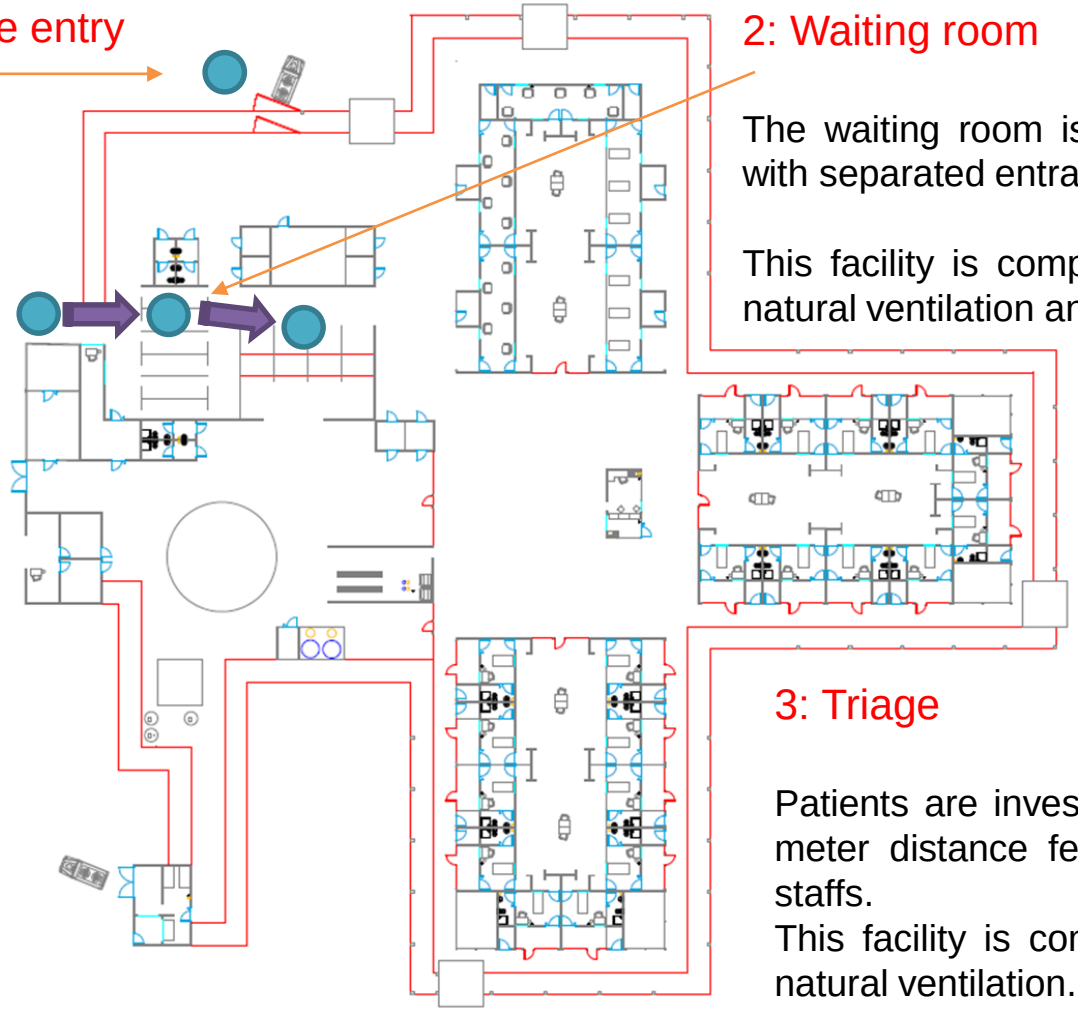

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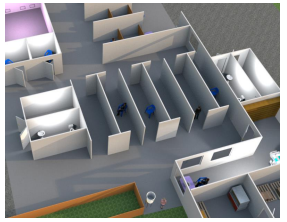
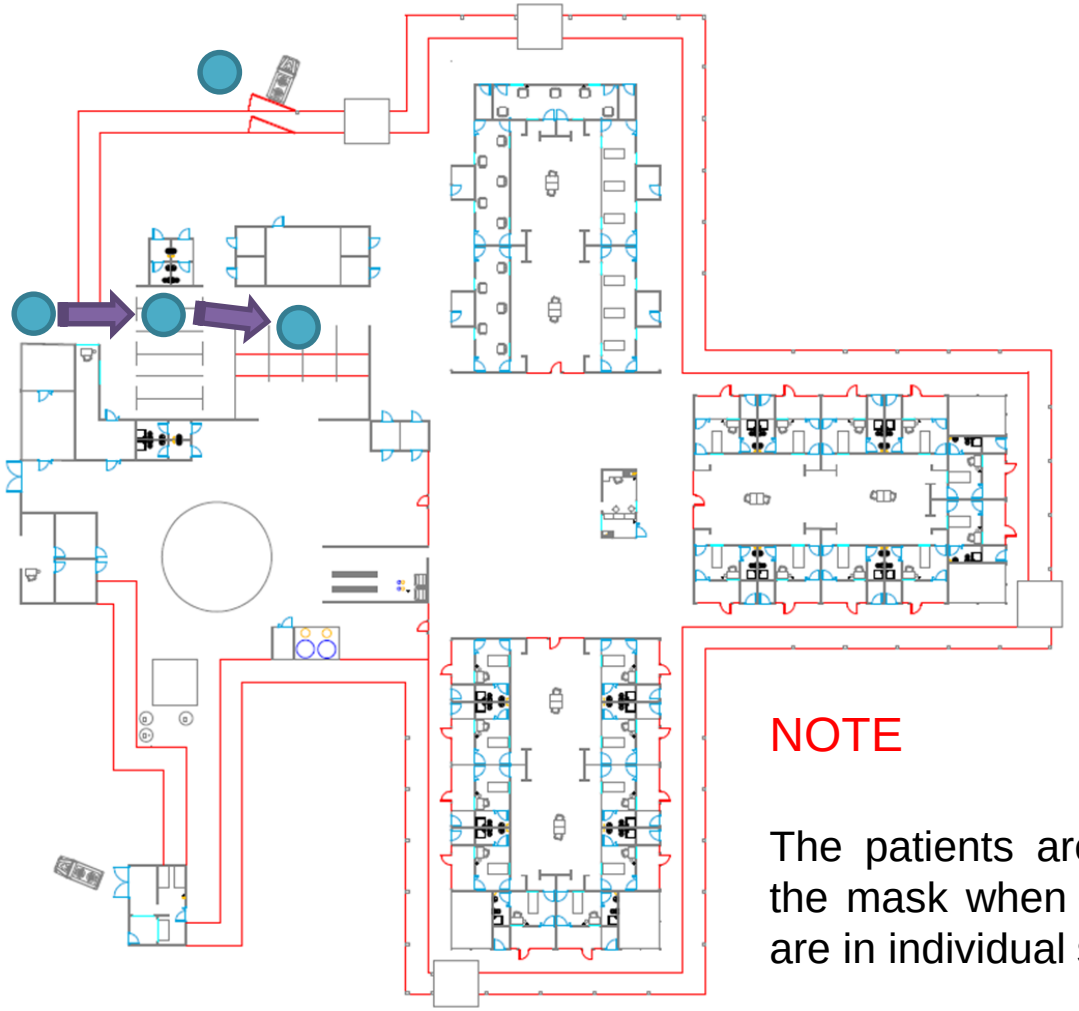


3: Triage

Patients are investigated in the individual triage booth. A two meter distance fence [1,2 m height] separate patients from staffs.
This facility is completely open [no doors] to allow a proper natural ventilation.

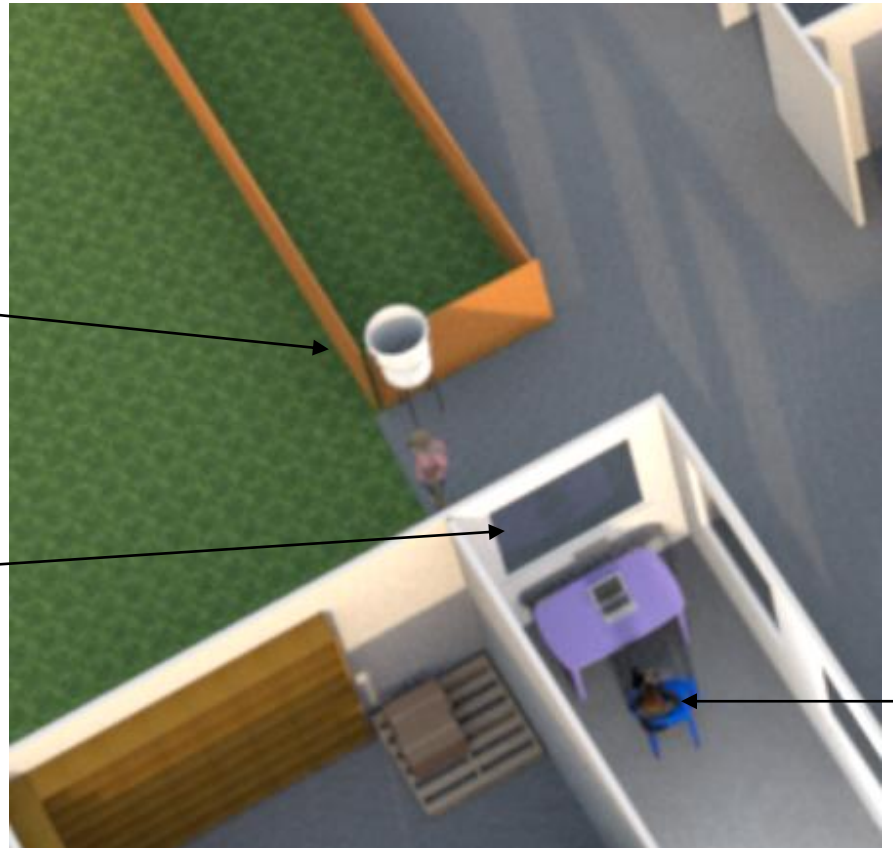
Patient’s flow



NOTE

The patients are supposed to constantly wear the mask when in the center except when they are in individual self-contained room.

Patient's flow / patient entrance



Hand washing point

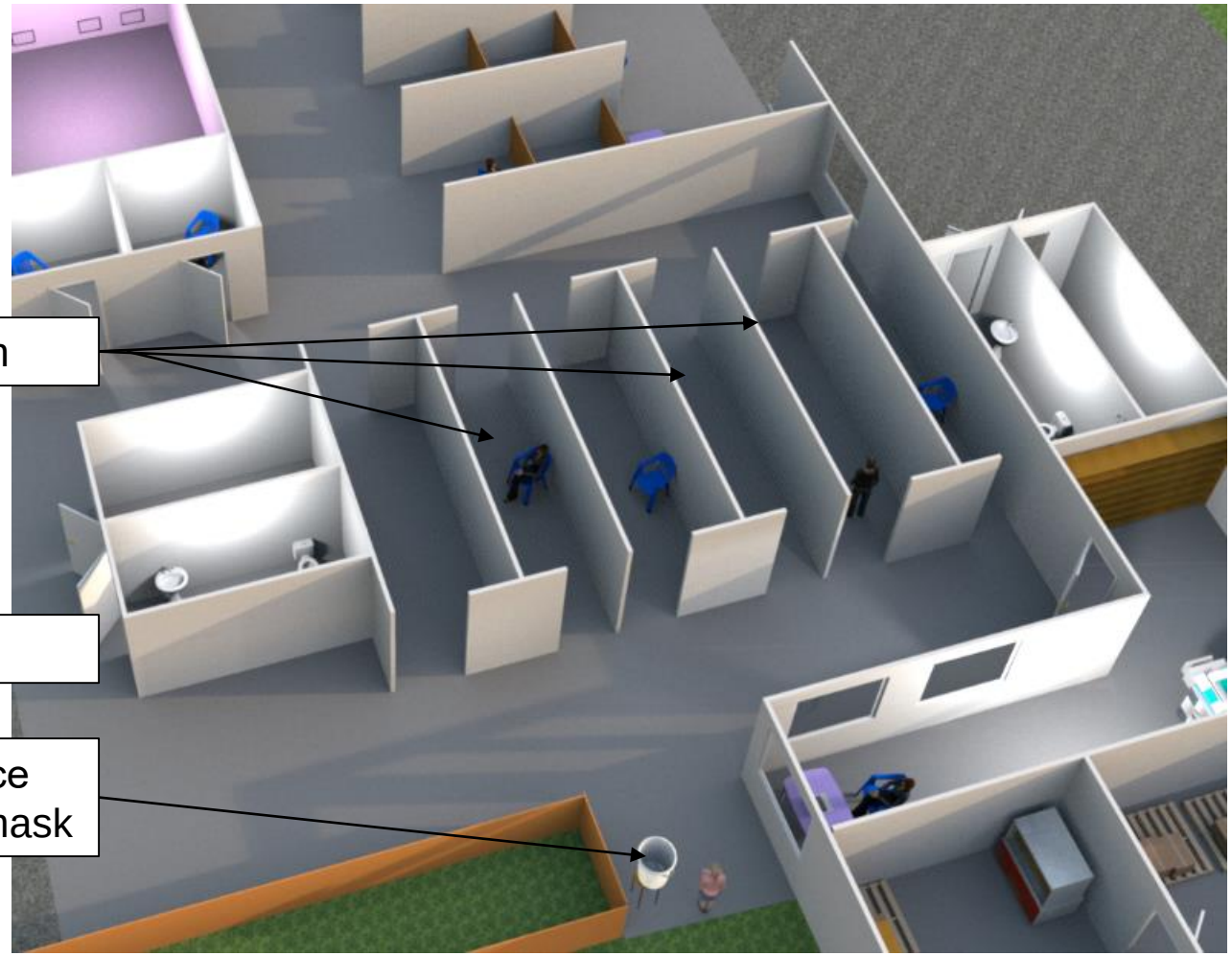
Reception
Patient receive a mask

Reception is a key service as the receptionist will have to address the patient to the correct waiting booth [empty, cleaned and disinfected]. A strong communication in between receptionist and triage staff is needed to assure a proper patient's flow

Receptionist

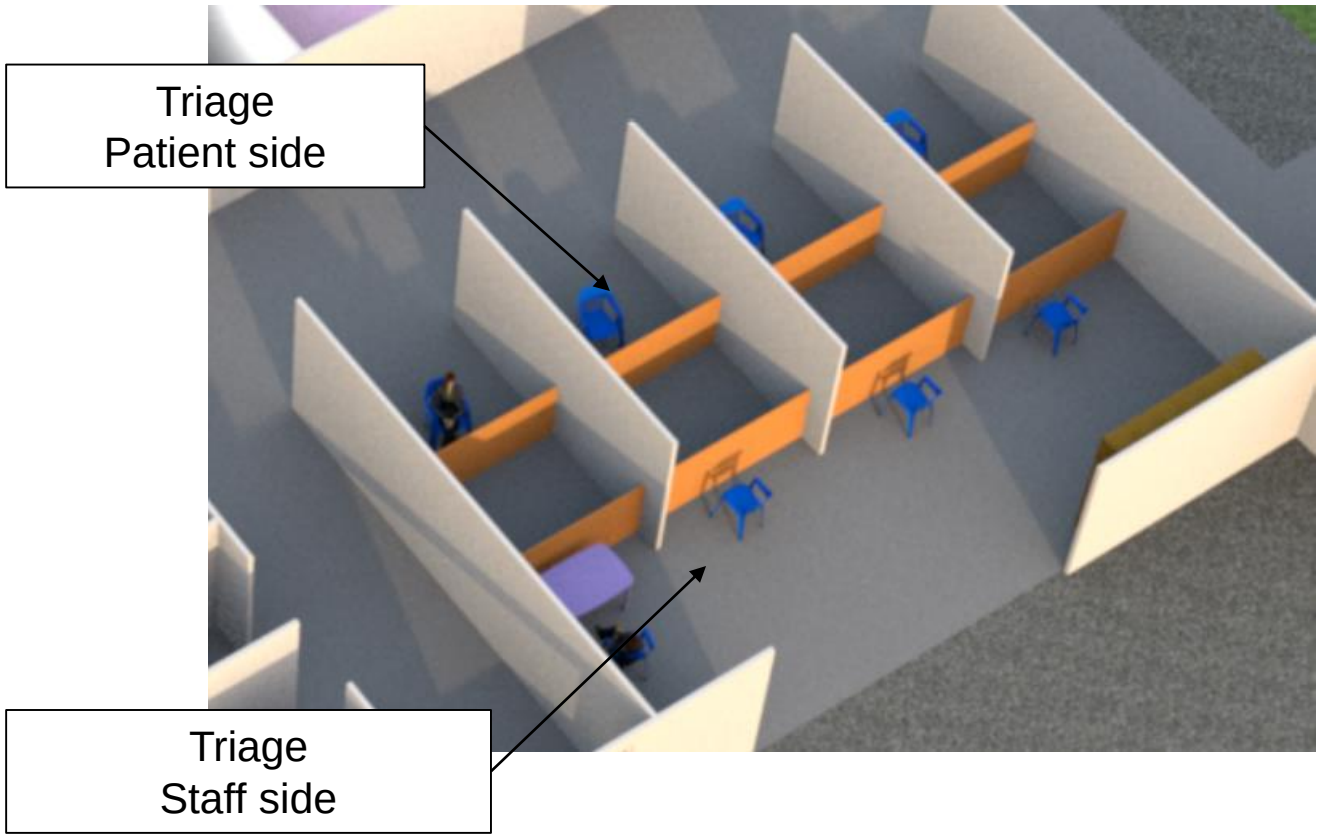
To address the patient to a specific individual booth in the waiting room

Patient's flow / Waiting room



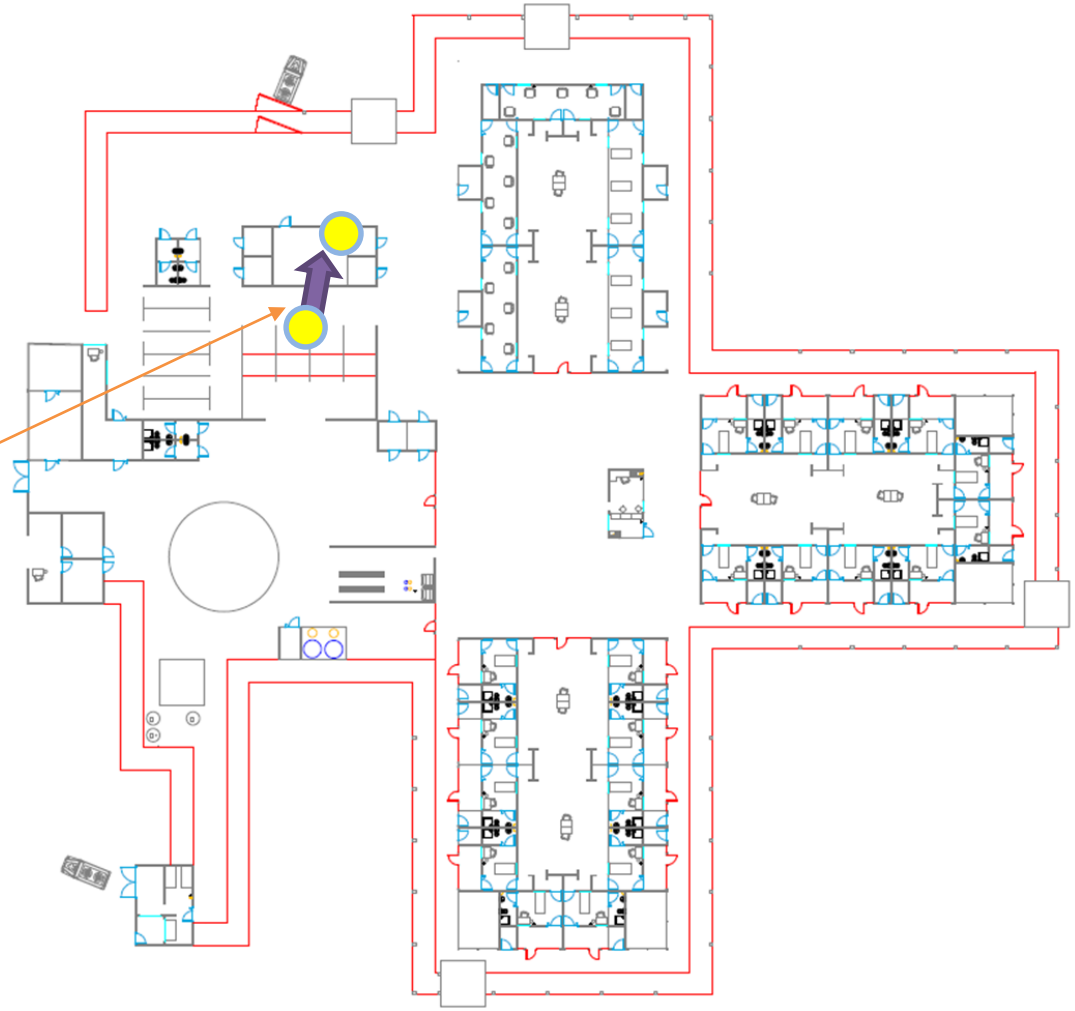
The waiting room is composed of individual booths open on both sides to assure a proper natural ventilation. Each booth should be clearly identified and labelled to avoid any mistake and allow a proper patient's flow. Booths should be cleaned and disinfected after each patient to avoid nosocomial infections

Patient's flow / Triage



Triage is divided in 2 distinctive zones: low risk zone for staff and high-risk zone for patients. A 2-meter distance between the staff and patient is required. Double fencing can be used for the separation or Plexiglas barrier. Separate hand washing points (soap/water) are available for patients and staff. A sloped board ('slide') can be placed between staff and patient zones to pass items (ORS, thermometer, etc.) from low to high risk zones

Patient’s flow / mild cases

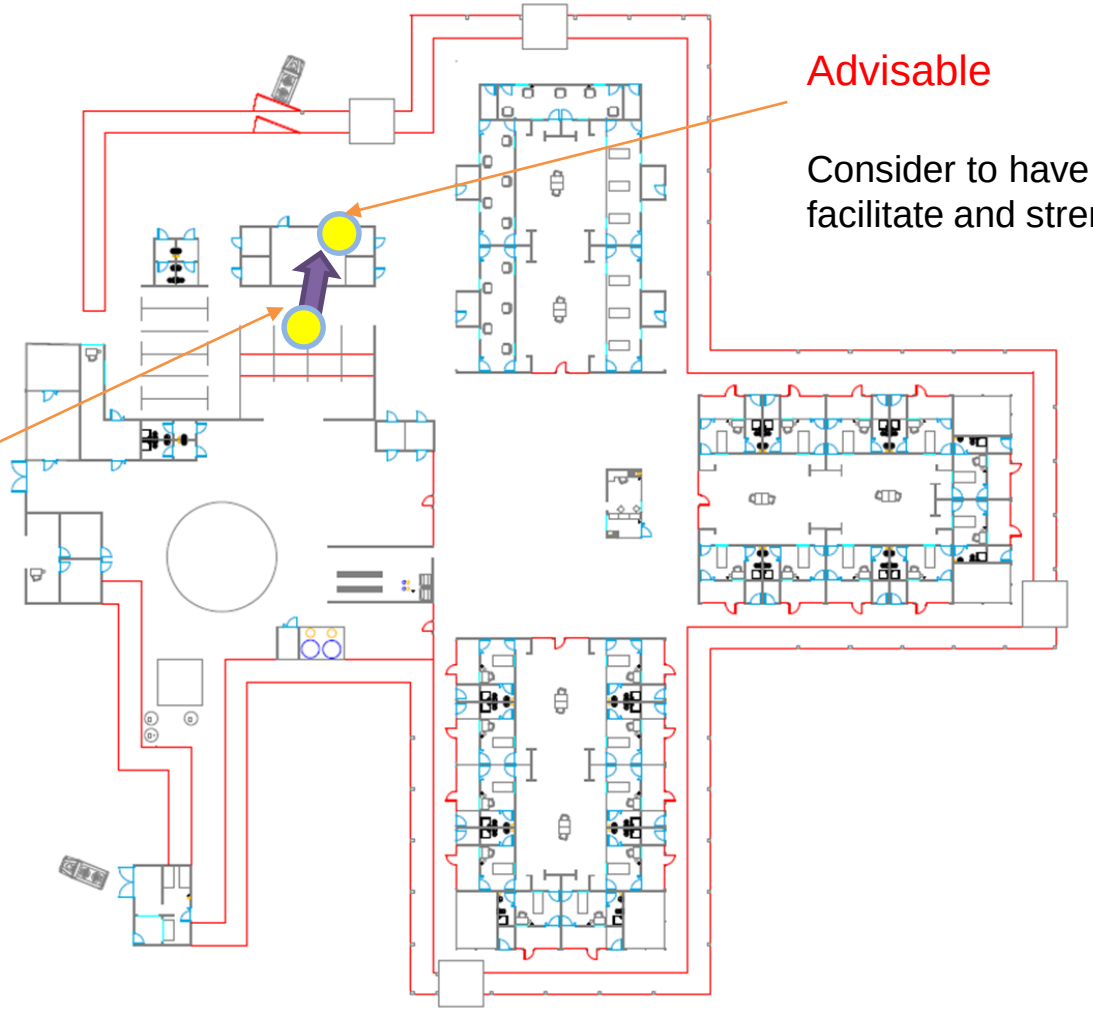


4: Sampling

NOTE: Not all the patients have to be tested, it’s according to medical decision

The sampling room is a 4 individual booth with hybrid ventilation

Patient’s flow / mild cases



Advisable

Consider to have an X-ray portable or not to facilitate and strengthen use of imaging.

4: Sampling

NOTE: Not all the patients have to be tested, it’s according to medical decision

The sampling room is a 4 individual booth with hybrid ventilation

Patient's flow / mild cases

5: Short stay ward

Patients are moved to the short stay ward where distances and hybrid ventilation assure IPC standards.

Patients can wait few hours for the laboratory results, receiving health promotion sessions and treatment

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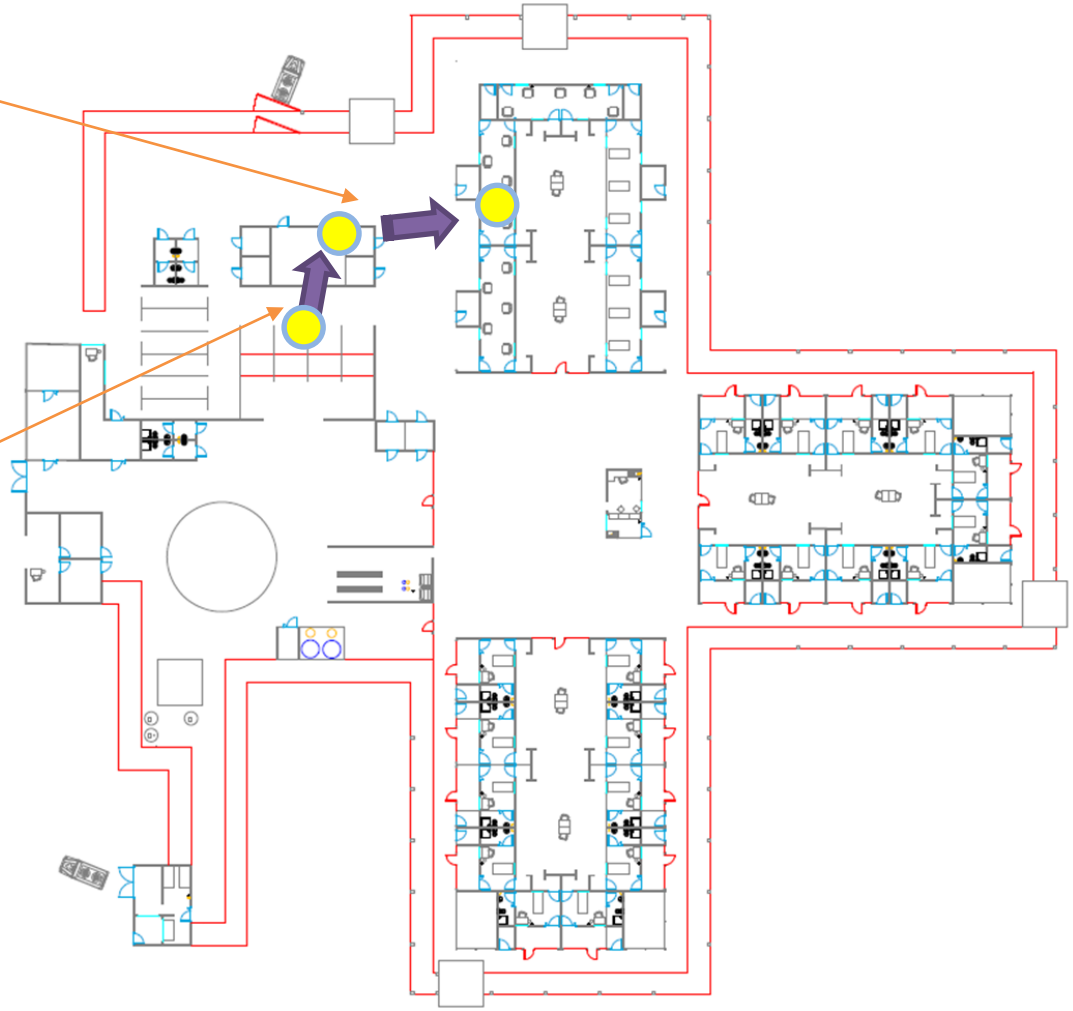

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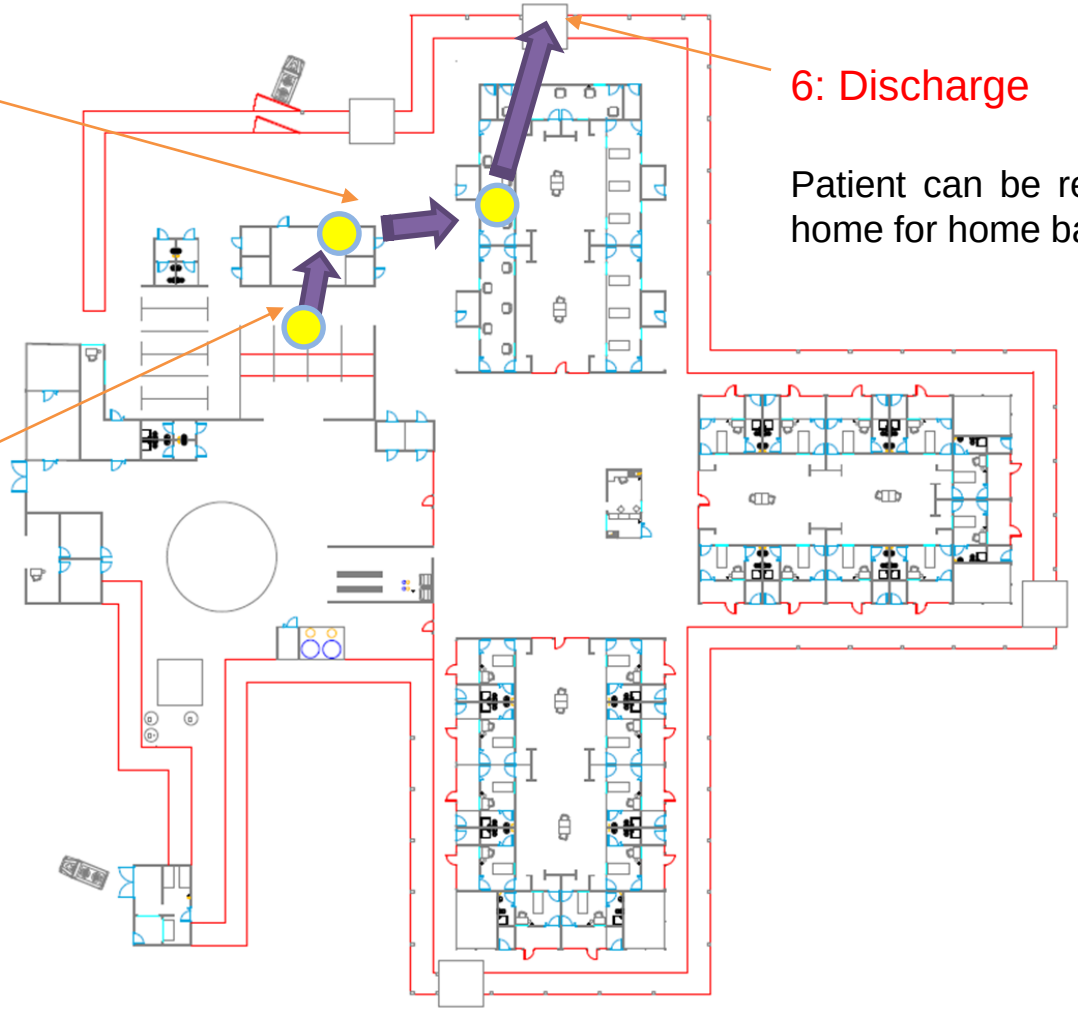

6: Discharge

Patient can be referred to another health facility or at home for home based care

Patient's flow / mild cases

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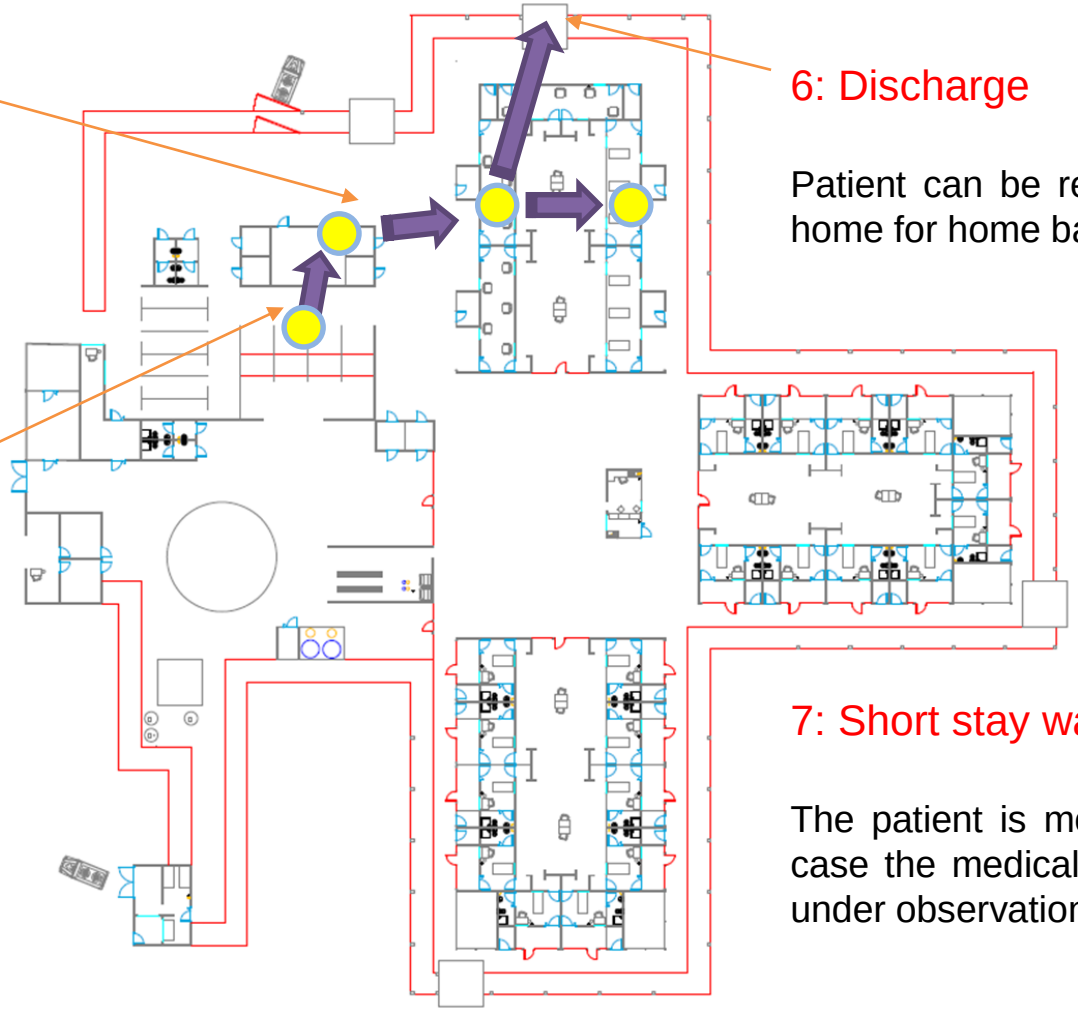


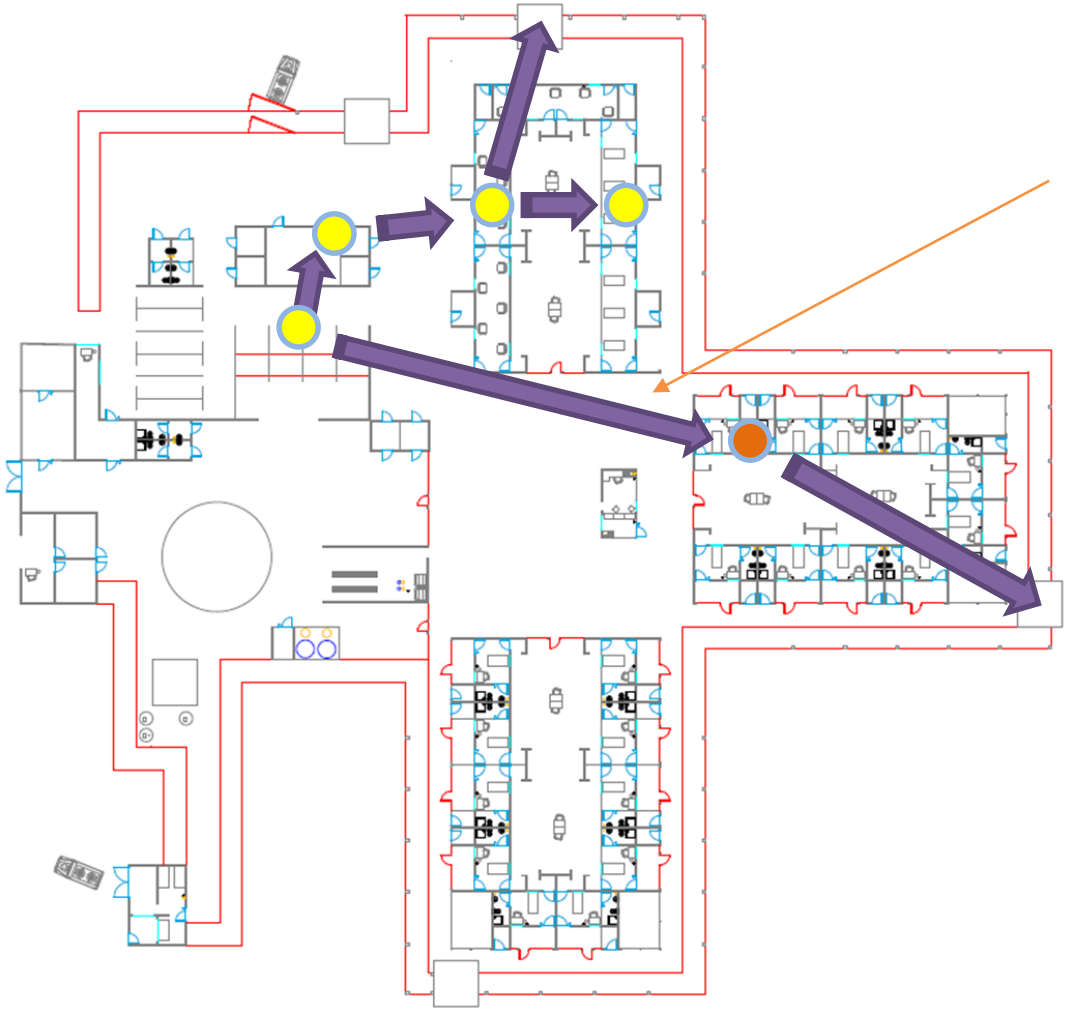
6: Discharge

Patient can be referred to another health facility or at home for home based care

7: Short stay ward - observation

The patient is moved to the observation room only in case the medical department want to keep the patient under observation for few hour more.

Patient's flow / moderate & severe cases



8: Moderate case

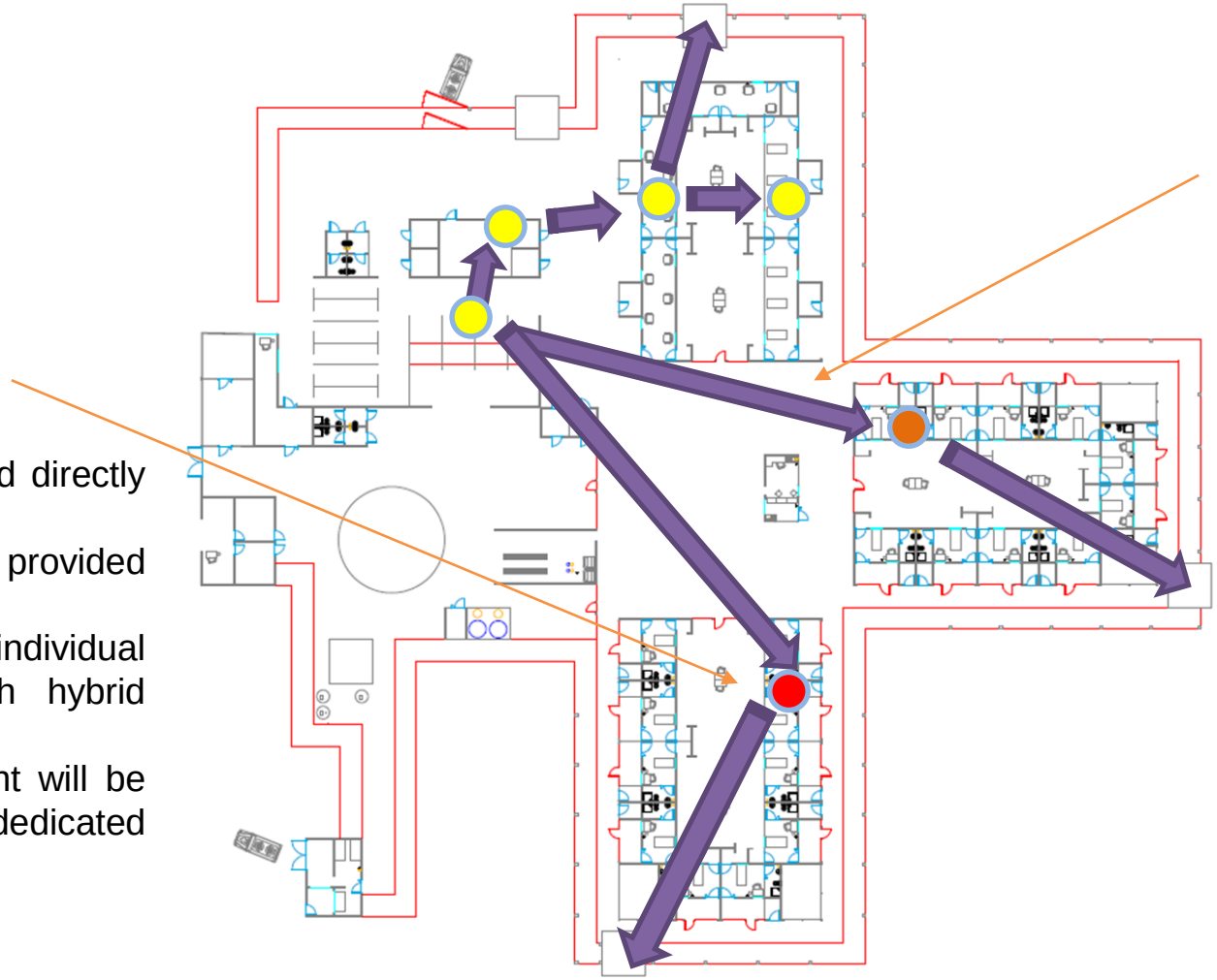
Moderate cases are moved directly to the moderate case ward.
Medical care will then be provided and the sample taken.
This ward is composed of individual self-contained rooms with hybrid ventilation.

Once recovered the patient will be discharged through the dedicated discharge room

Patient's flow / moderate & severe cases

9: Severe case

Moderate cases are moved directly to the moderate case ward.
Medical care will then be provided and the sample taken.
This ward is composed of individual self-contained rooms with hybrid ventilation.
Once recovered the patient will be discharged through the dedicated discharge room



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Medical care will then be provided and the sample taken.
This ward is composed of individual self-contained rooms with hybrid ventilation.

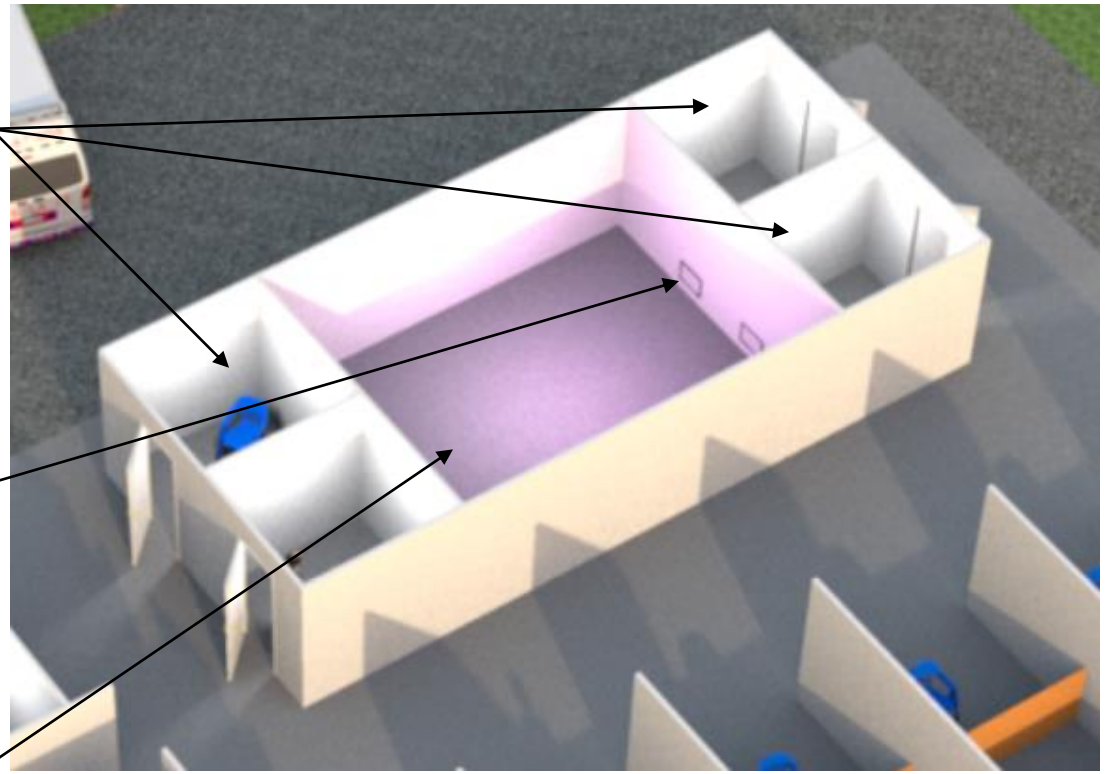
Once recovered the patient will be discharged through the dedicated discharge room

Patient's flow / Sampling room

Individual booth

Air extractor
With HEPA filter
or
UV system

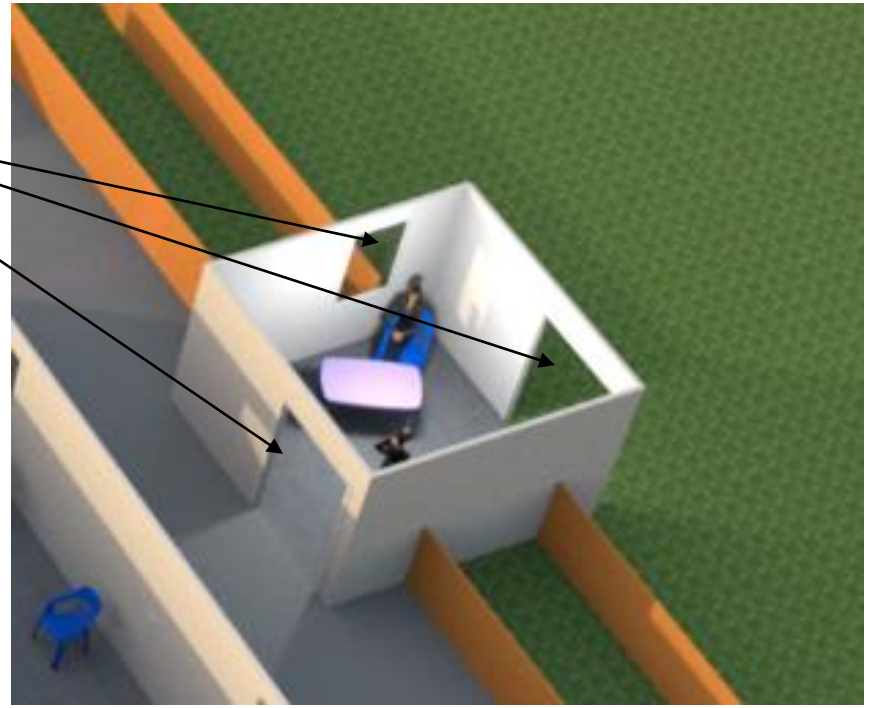
Space for exhausted
air treatment
[only if UV system]



Where samples are taken for mild cases. Individual booth with hybrid ventilation and HEPA filter or UV disinfection for the exhaust air. Each booth should be clearly identified and labelled to avoid any mistake and allow a proper patient's flow. Booths should be cleaned and disinfected after each patient to avoid nosocomial infections

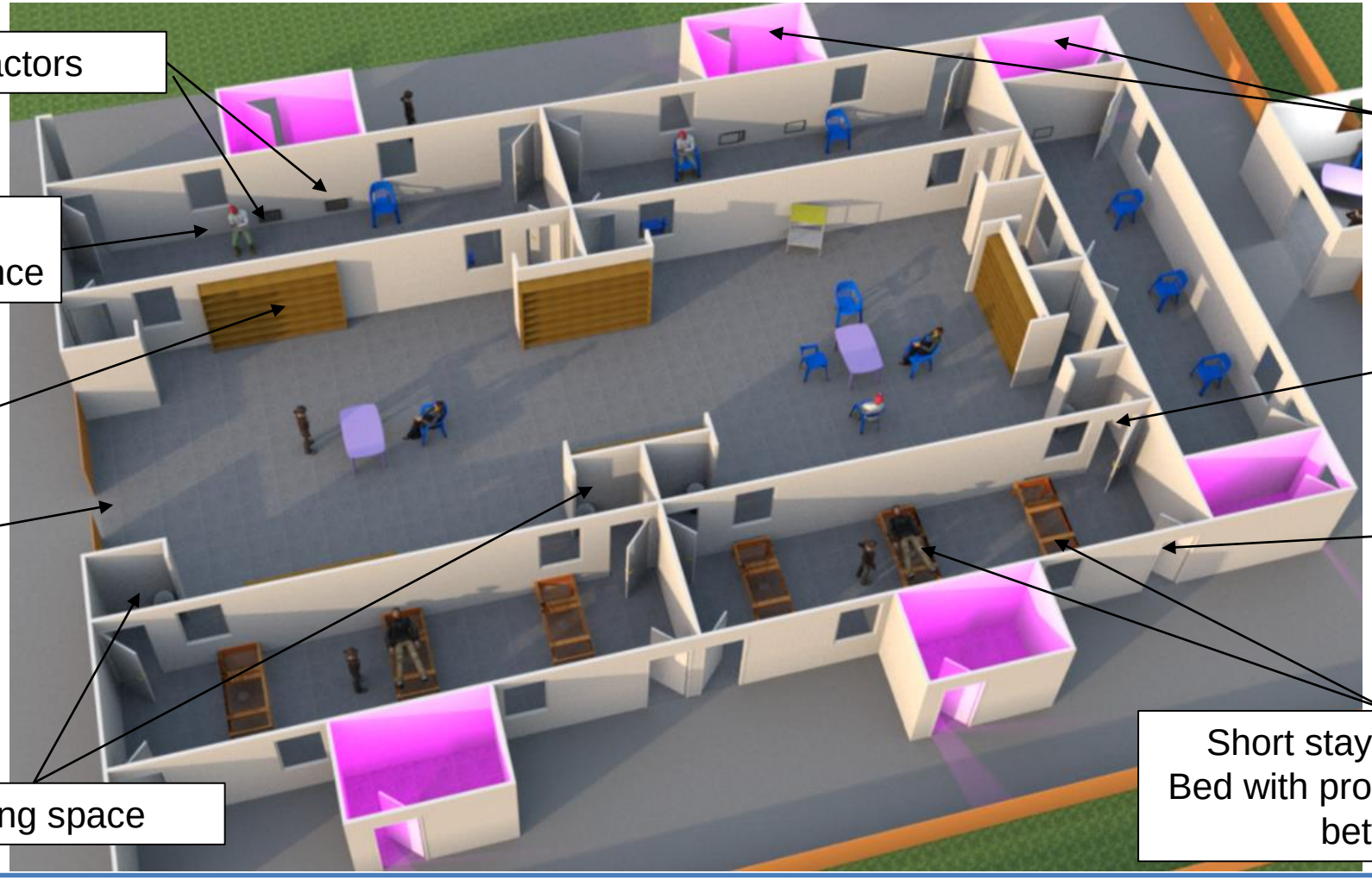
Patient's flow / Dicharge room

Wide opened windows and doors

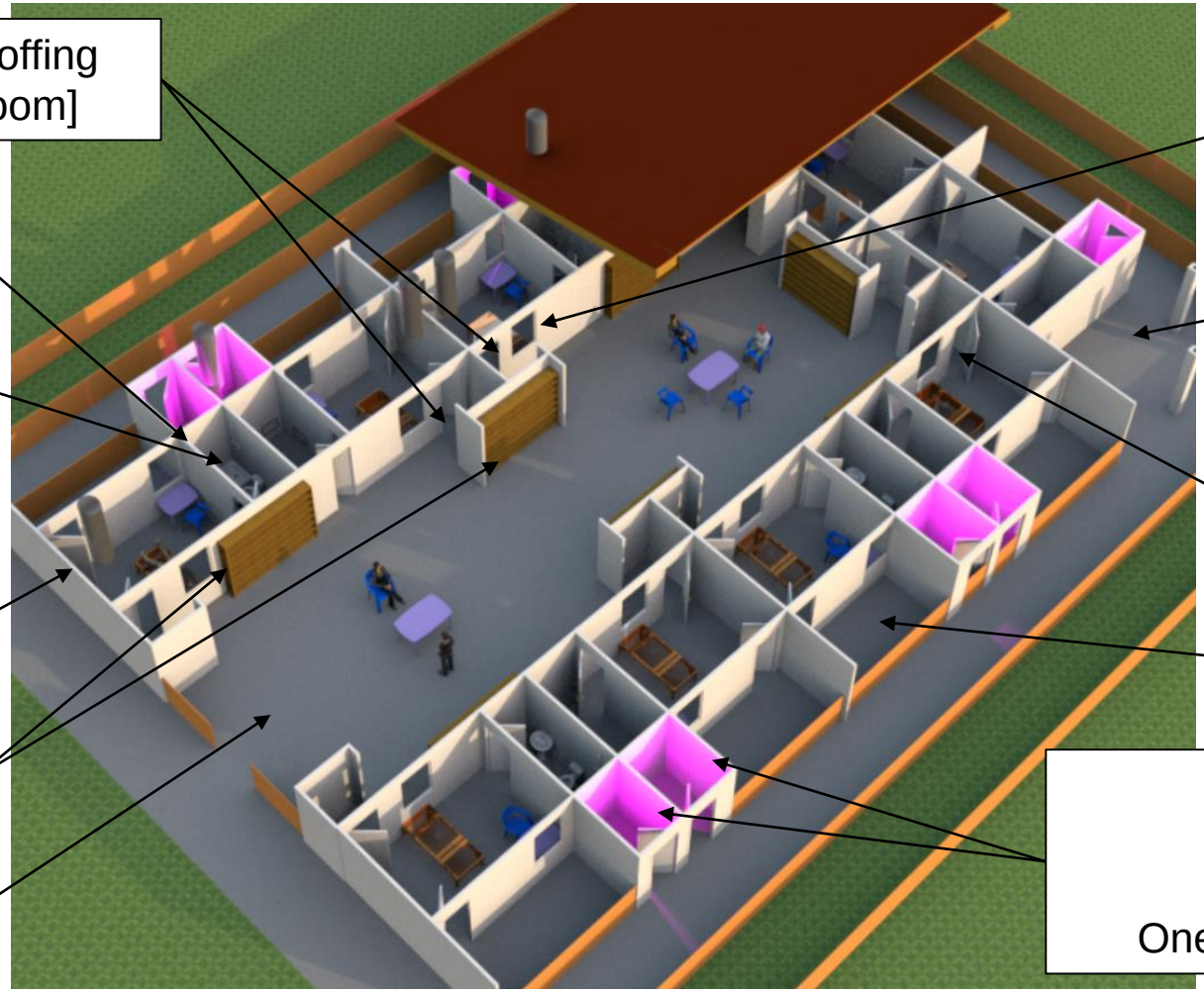


For patients who don't fit the case definition or for mild cases referred to other health facilities or homecare. Wide window on both sides assure adequate natural ventilation and hand washing points are available at entrance and exit. A staff should be always present to control movements.

Patient's flow / Short stay ward – mild cases



Patient's flow / Moderate & Severe cases



Individual doffing [one per room]

Air extractors

Individual toilet/shower

Self-contained room with individual terrace

Shelf for PPE

Working area [staffs only]

Transparent surface for visual contact

Space for items cleaning and disinfection

Staffs entrance [only]

Patient entrance and individual terrace

UV light disinfection
Buffer space
[only if no HEPA filter]
One for each room to avoid risk

Patient's flow / Mild, Moderate & Severe cases

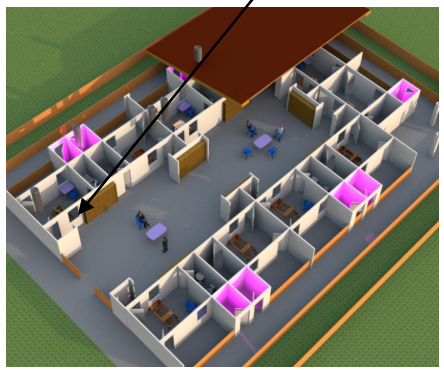
Patient's wards must have closed ceiling to allow proper air flow

Working area
Should have no ceiling to allow proper natural ventilation

Staff working area

Transparent window

- To allow visual contact with patient
- Ease observation and monitoring,
- Oxygen, monitor, pulse oximeter not in the patient's room but place in the working area,
- Less PPE consumption



Ventilation

The purpose of ventilation is to provide healthy air for breathing by both diluting the pollutants originating in the building and removing the pollutants from it.

Building ventilation has three basic elements:

- ✓ Ventilation rate — the amount of outdoor air that is provided into the space, and the quality of the outdoor air;
- ✓ Airflow direction — the overall airflow direction in a building, which should be from clean zones to dirty zones; and
- ✓ air distribution or airflow pattern — the external air should be delivered to each part of the space in an efficient manner and the airborne pollutants generated in each part of the space should also be removed in an efficient manner.

Atkinson, J., Chartier, Y., Pessoa-silva, C. L., Jensen, P. & Li, Y. Natural Ventilation for Infection Control in Health-Care Settings Edited by : *WHO Publ.* (2009).

Ventilation

There are three methods that may be used to ventilate a building:

Natural ventilation

Natural forces (e.g. winds) drive outdoor air through the building openings such as windows, doors, solar chimneys, wind towers and trickle ventilators.

Mechanical ventilation

Mechanical fans drive mechanical ventilation. Fans can either be installed directly in windows or walls, or installed in air ducts for supplying air into, or exhausting air from, a room

Hybrid ventilation

Hybrid (mixed-mode) ventilation relies on natural driving forces to provide the desired (design) flow rate. It uses mechanical ventilation when the natural ventilation flow rate is too low.

Atkinson, J., Chartier, Y., Pessoa-silva, C. L., Jensen, P. & Li, Y. Natural Ventilation for Infection Control in Health-Care Settings Edited by : *WHO Publ.* (2009).

Ventilation

The decision whether to use mechanical or natural ventilation for infection control should be based on needs, the availability of the resources and the cost of the system to provide the best control to counteract the risks.

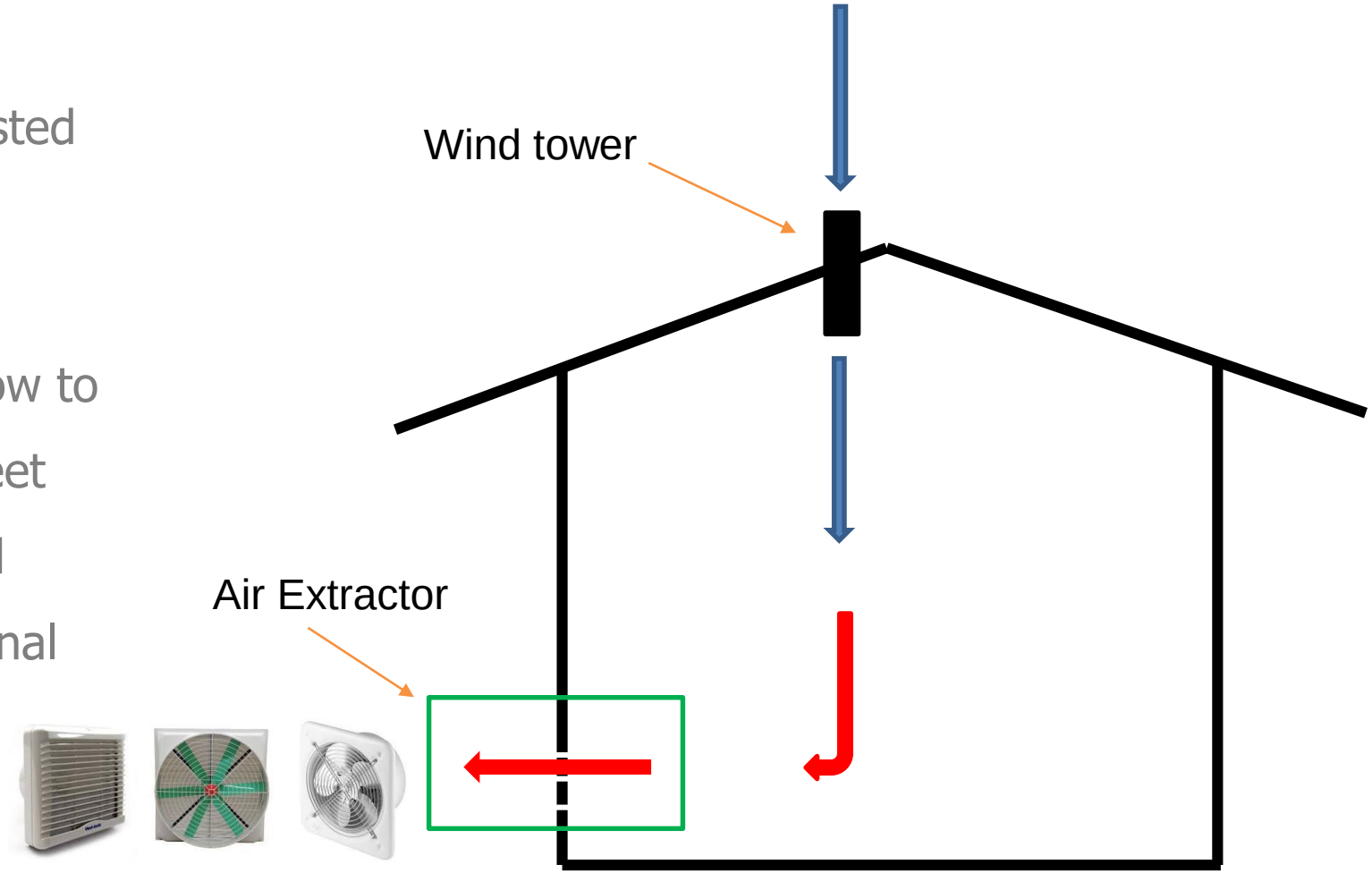
However, considering the need to have a functioning SARI treatment center within a short delay, the difficulty of securing sealed chambers for negative pressure [except for concrete building] the importance of meeting the IPC requirements, this document advice to install a hybrid ventilation system [for patient' ward] as easier to install than a mechanical one and more flexible in term of ventilation rate than a natural one.

Atkinson, J., Chartier, Y., Pessoa-silva, C. L., Jensen, P. & Li, Y. Natural Ventilation for Infection Control in Health-Care Settings Edited by : *WHO Publ.* (2009).

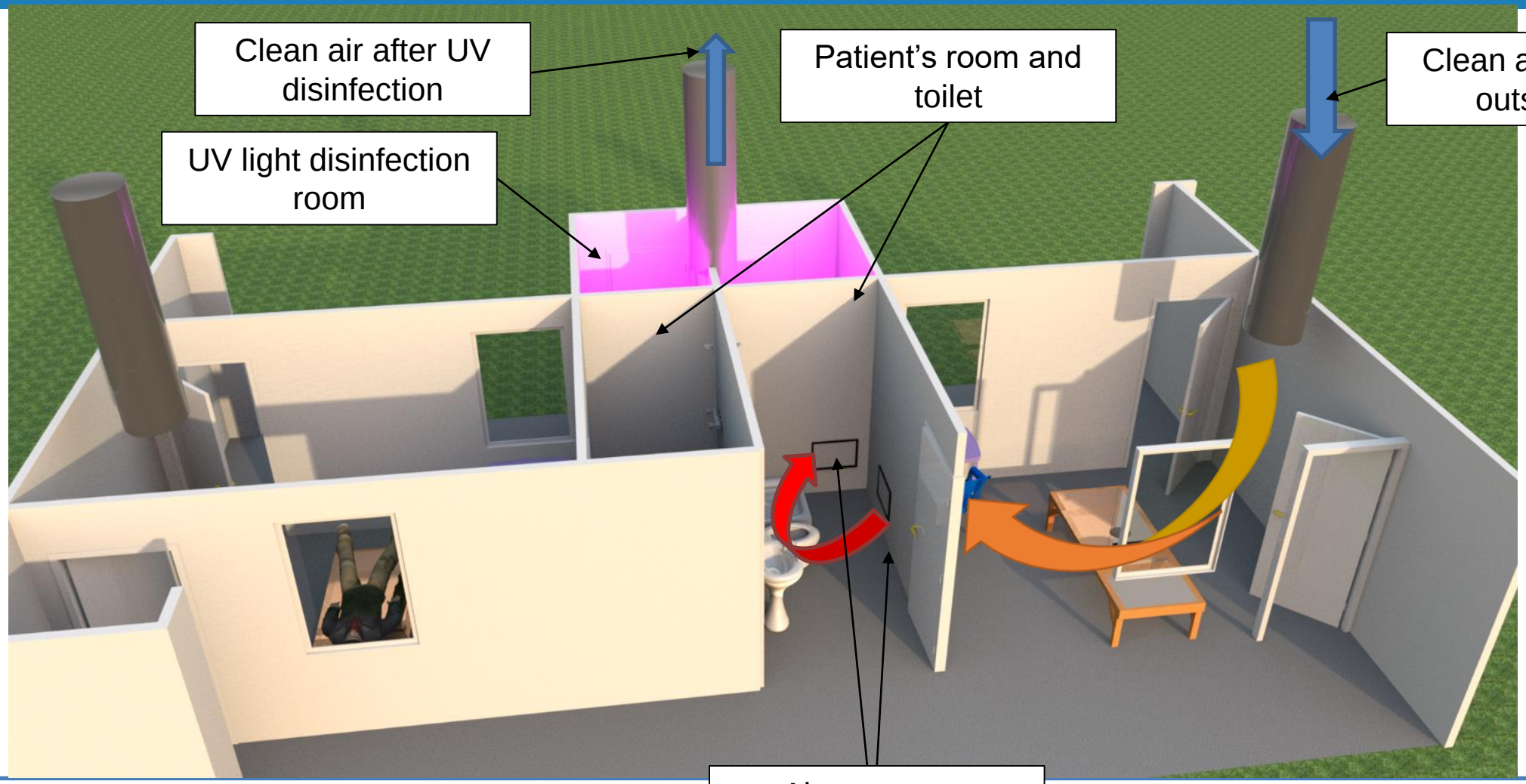
Ventilation proposed – Hybrid ventilation

Top-down ventilation (fan-assisted stack plus a wind tower

The air extractor will easily allow to control the ventilation rate, meet the ACH standard required and assuring a constant unidirectional top-down airflow.



How to install air extractor



World Health Organization

HEALTH EMERGENCIES programme

Exhausted air treatment

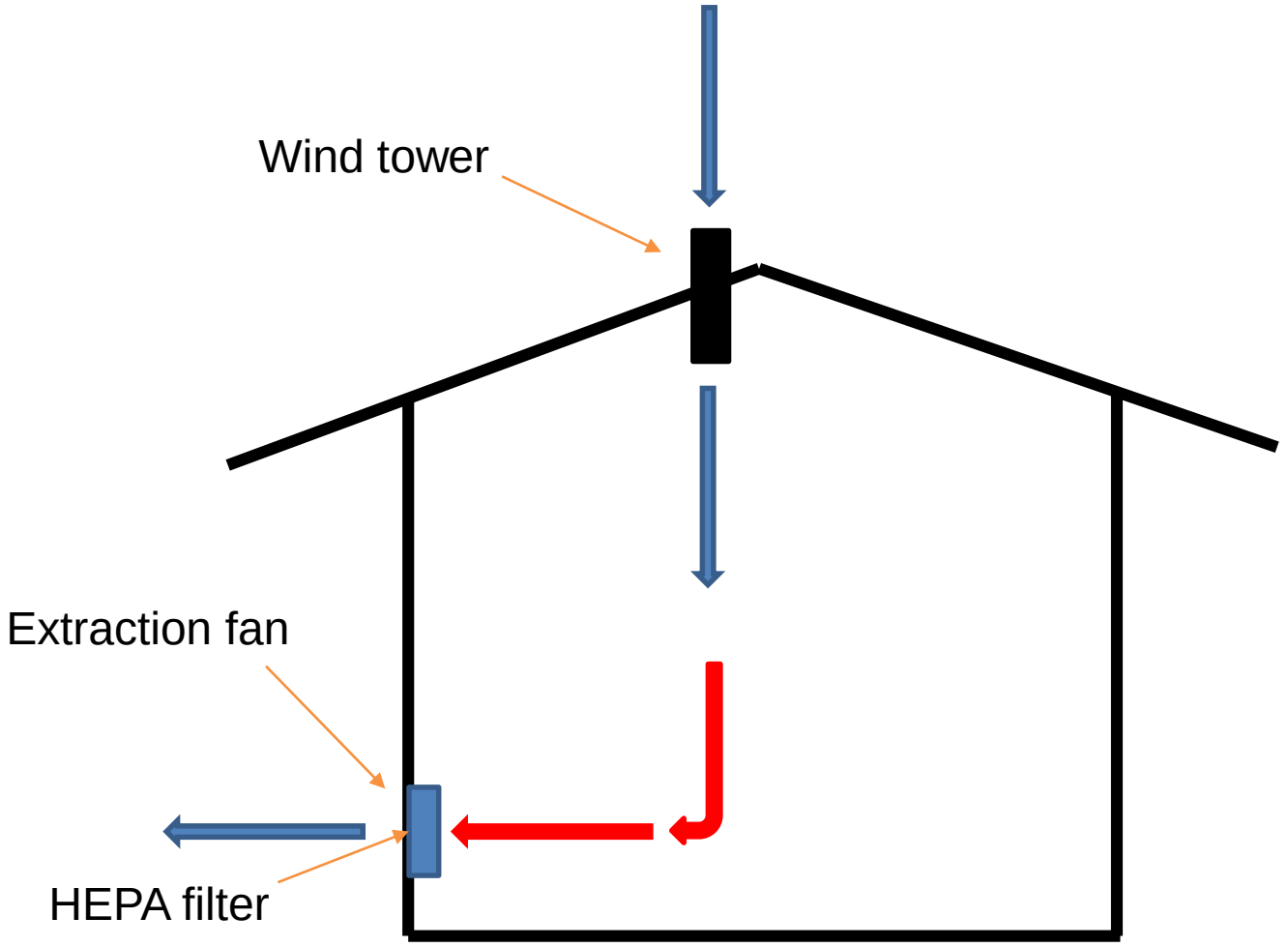
Air from the room can be exhausted directly to the outdoors, where the droplet nuclei will be diluted in the outdoor air, or passed through a special high efficiency particulate air (HEPA) filter that removes most (99.97%) of the droplet nuclei before it is returned to the general circulation. If a HEPA filter is not used, the air should be exhausted directly to the outside away from air-intake vents, persons, and animals.

The layout here proposed doesn't allow simple air dilution as therefore two exhausted air treatments are proposed

CDC. Center for Disease Control and Prevention. Chapter 7-Tuberculosis Infection Control. (2017).

Exhausted air treatment - HEPA

HEPA is a type of pleated mechanical air filter. It is an acronym for "high efficiency particulate air [filter]". This type of air filter can theoretically remove at least 99.97% of dust, pollen, mold, bacteria, and any airborne particles with a size of 0.3 microns (µm).

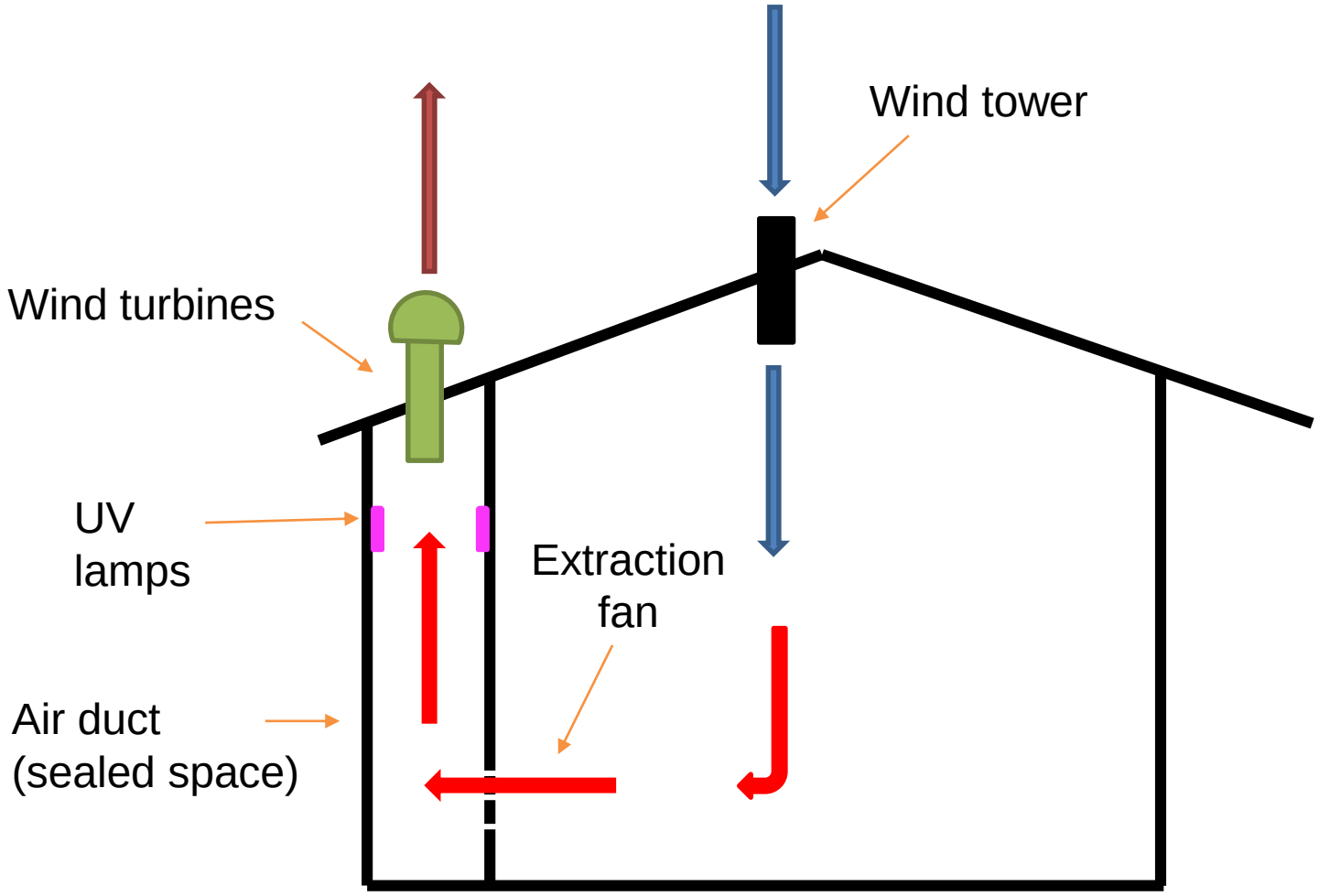


CDC. Center for Disease Control and Prevention. Chapter 7-Tuberculosis Infection Control. (2017).

Exhausted air treatment - Ultraviolet Germicidal Irradiation (UVGI)

UVGI is electromagnetic radiation that can destroy the ability of microorganisms to reproduce by causing photochemical changes in nucleic acids.

Effective room air disinfection depends on circulating maximal room air through the duct and the velocity at which it is circulated. For this reason, is essential to well define the size [volume] of the air duct [sealed space] according to the air extractor capacity.

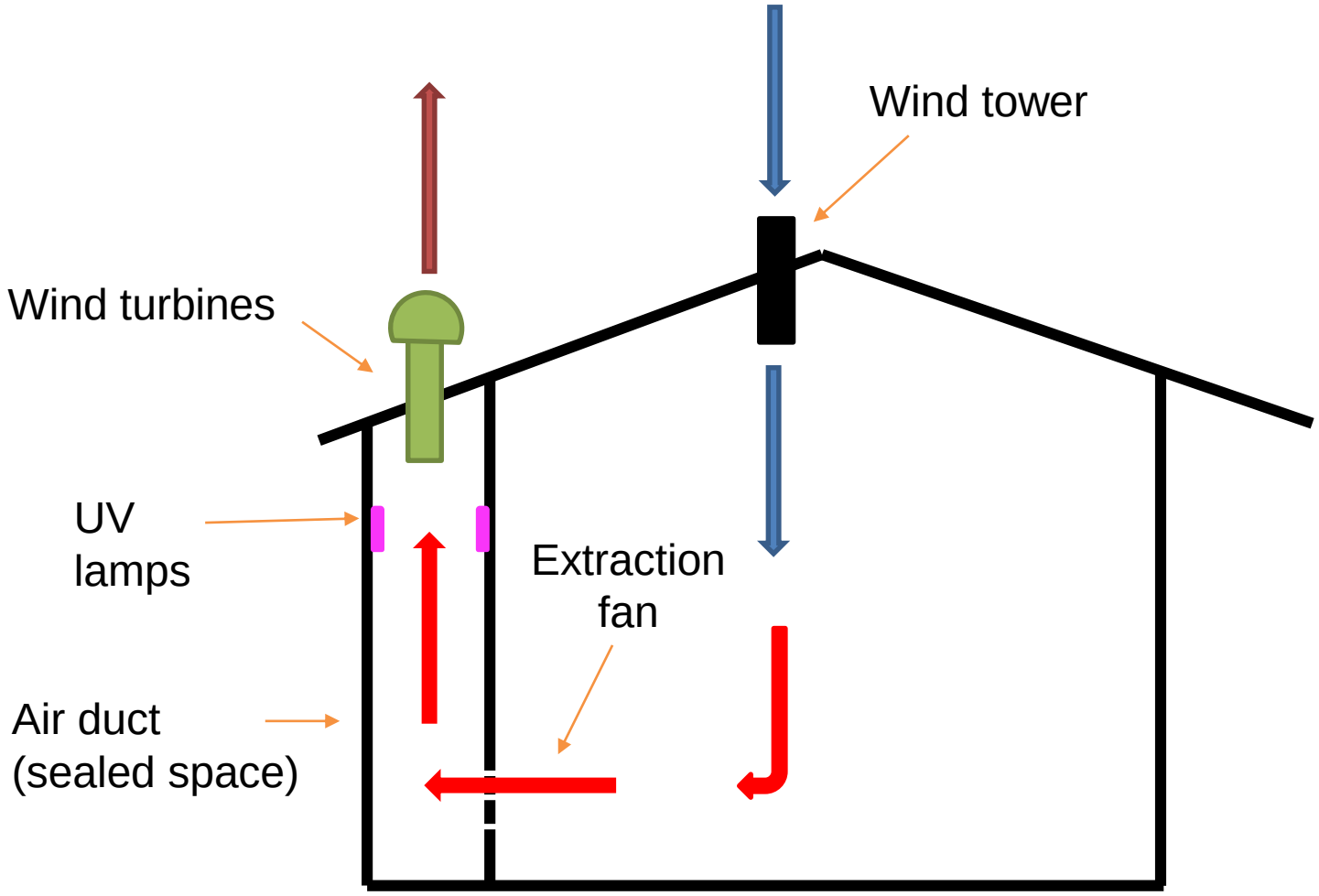


Reed, N. G. The history of ultraviolet germicidal irradiation for air disinfection. Public Health Reports vol. 125 15–27 (2010).

Exhausted air treatment - Ultraviolet Germicidal Irradiation (UVGI)

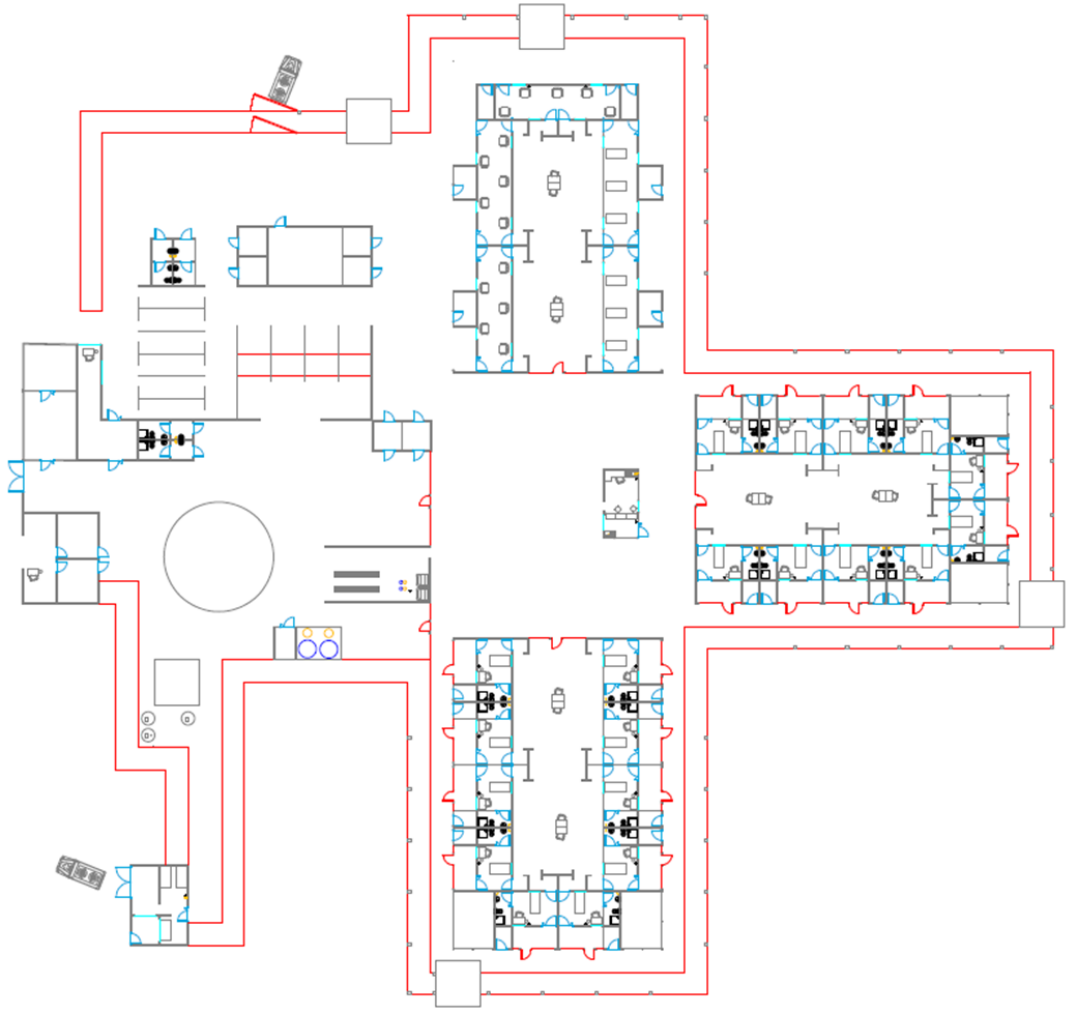
The most important requirement is the **UV wavelength** as it directly affect the disinfection efficiency of the lamp. Only use lamp providing a wavelength of 254 nm or 0,254 µm.

The mechanisms of UVGI on microbes are uniquely vulnerable to light at wavelengths at or near 253.7 nm, because the maximum absorption wavelength of a DNA molecule is 260 nm



Tseng, C. C. & Li, C. S. Inactivation of virus-containing aerosols by ultraviolet germicidal irradiation. Aerosol Sci. Technol. 39, 1136–1142 (2005).

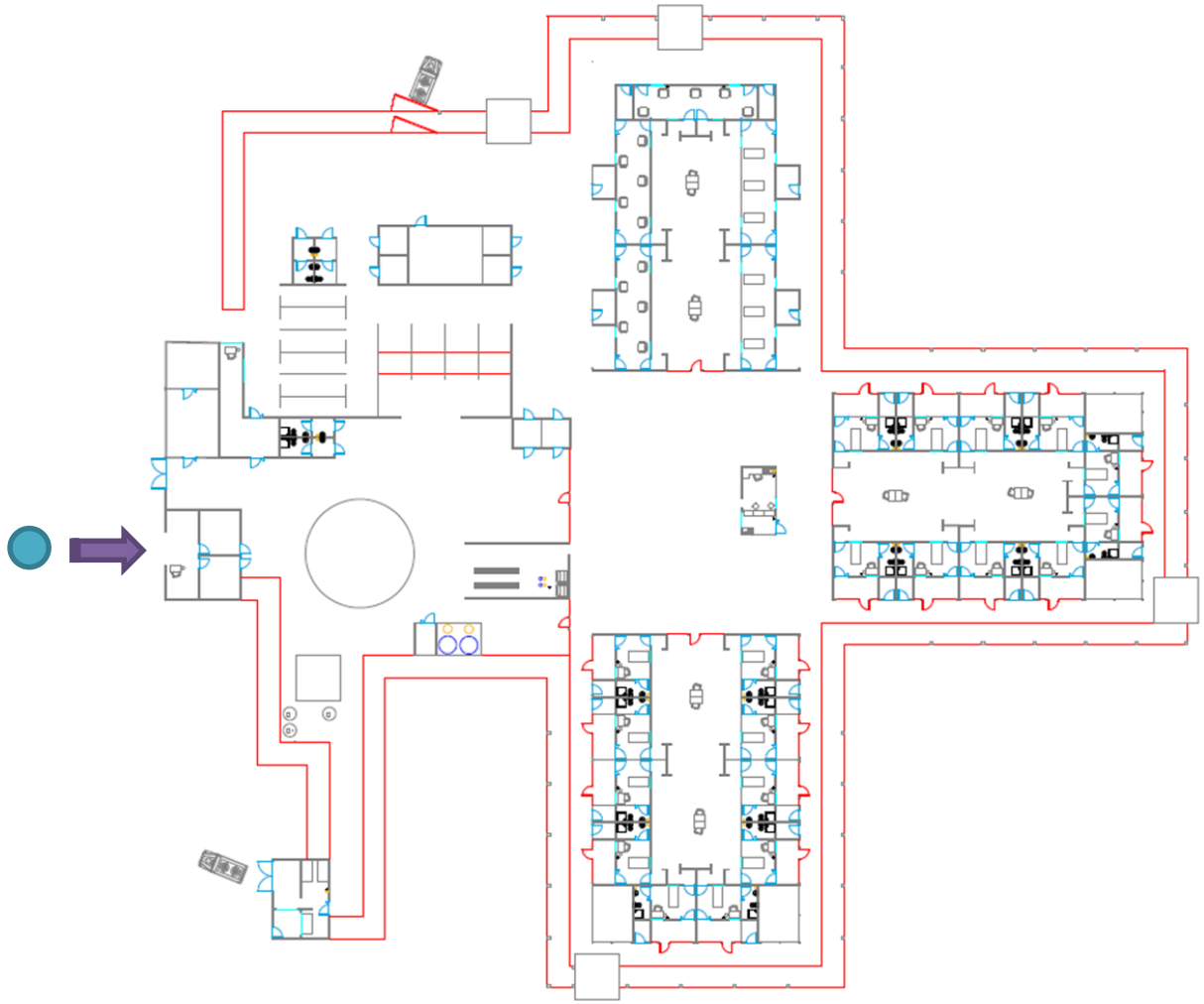
Staff's flow



World Health Organization

HEALTH EMERGENCIES programme

Staff's flow



1: Staffs entry

At this point all staffs:

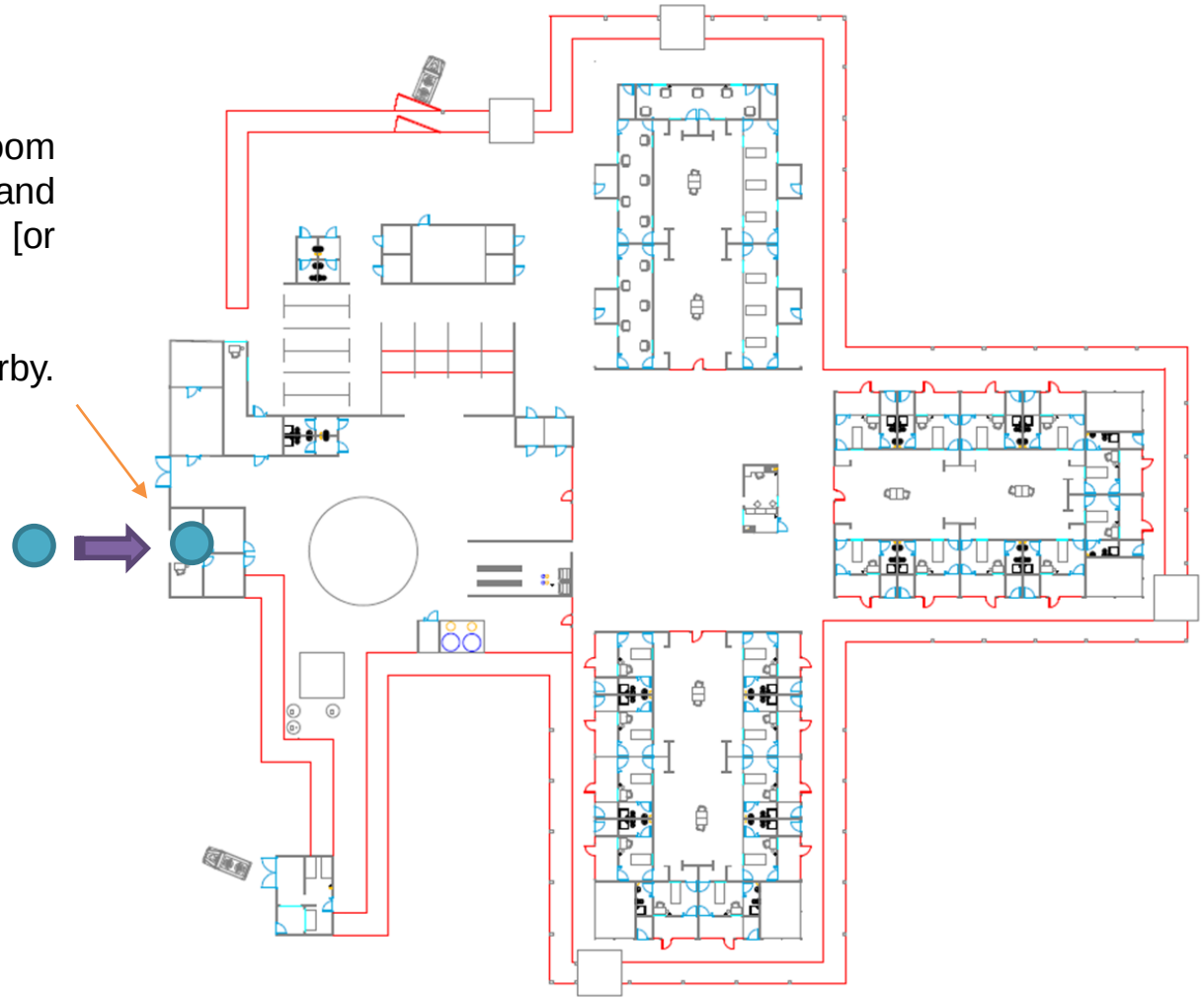
- Hand washing,
- Temperature check
- Presence record

Staff's flow

2: Changing room

Male and female changing room to remove personal clothes and wear scrubs and boots [or closed shoes].

Staff toilets are available nearby.



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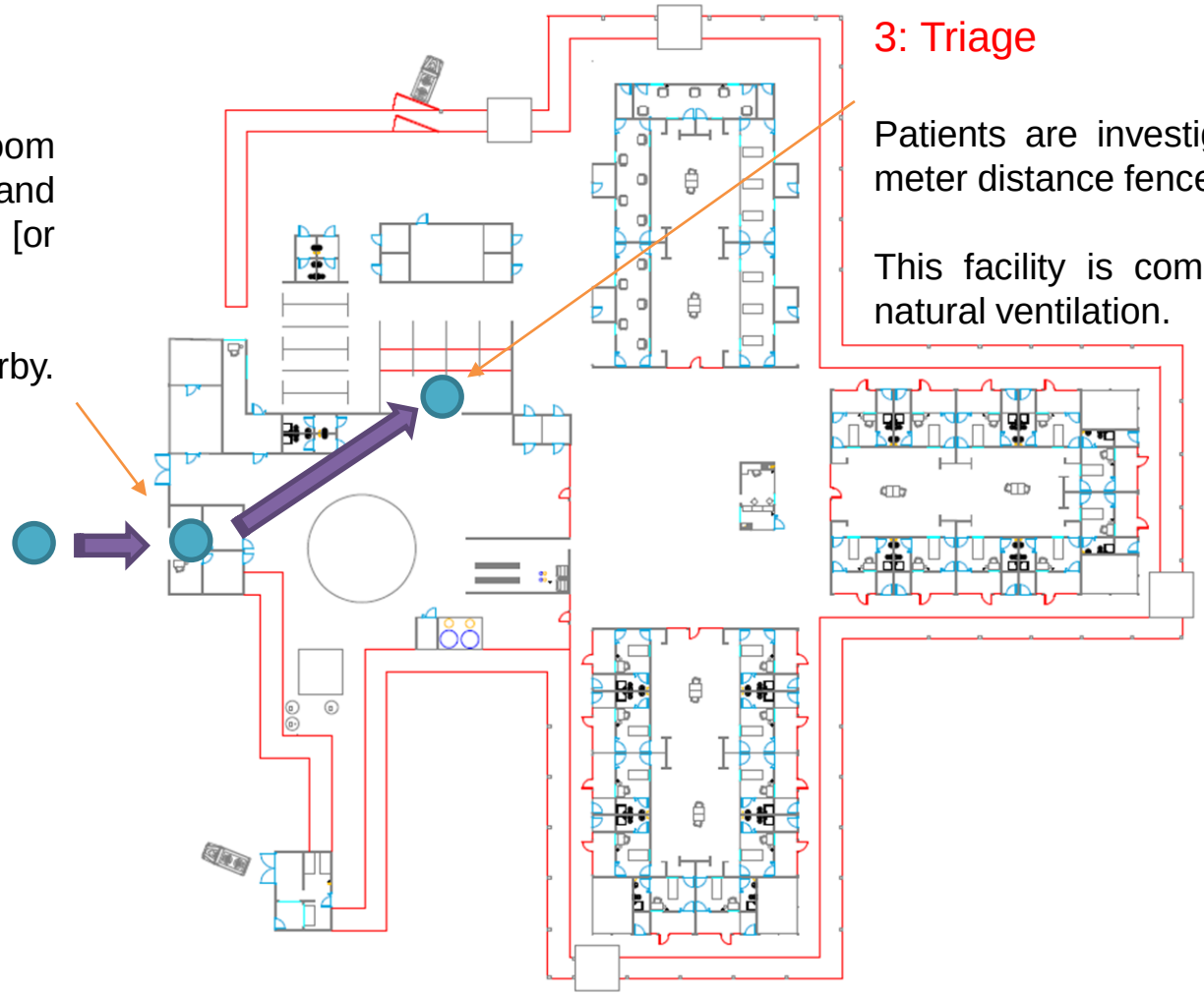

3: Triage

Patients are investigated in the individual triage booth. A two meter distance fence [1,2 m height] separate patients from staffs.

This facility is completely open [no doors] to allow a proper natural ventilation.

1: Staffs entry

At this point all staffs:

- Hand washing,
- Temperature check
- Presence record

Staff's flow

2: Changing room

Male and female changing room to remove personal clothes and wear scrubs and boots [or closed shoes].

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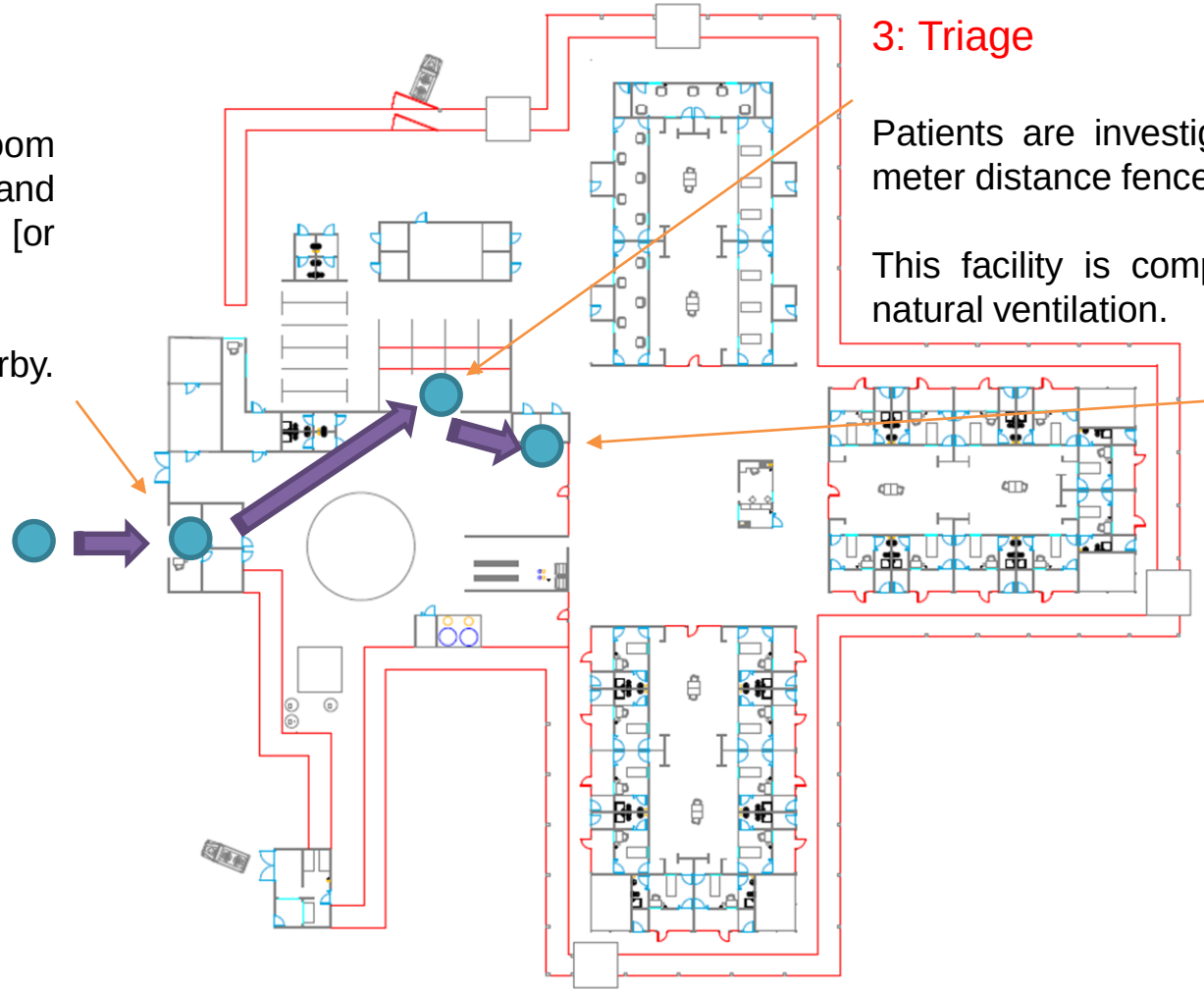


3: Triage

Patients are investigated in the individual triage booth. A two meter distance fence [1,2 m height] separate patients from staffs.

This facility is completely open [no doors] to allow a proper natural ventilation.

4: Triage – donning/doffing

Staff can wear specific PPE before going to the patient at the triage.

1: Staffs entry

At this point all staffs:

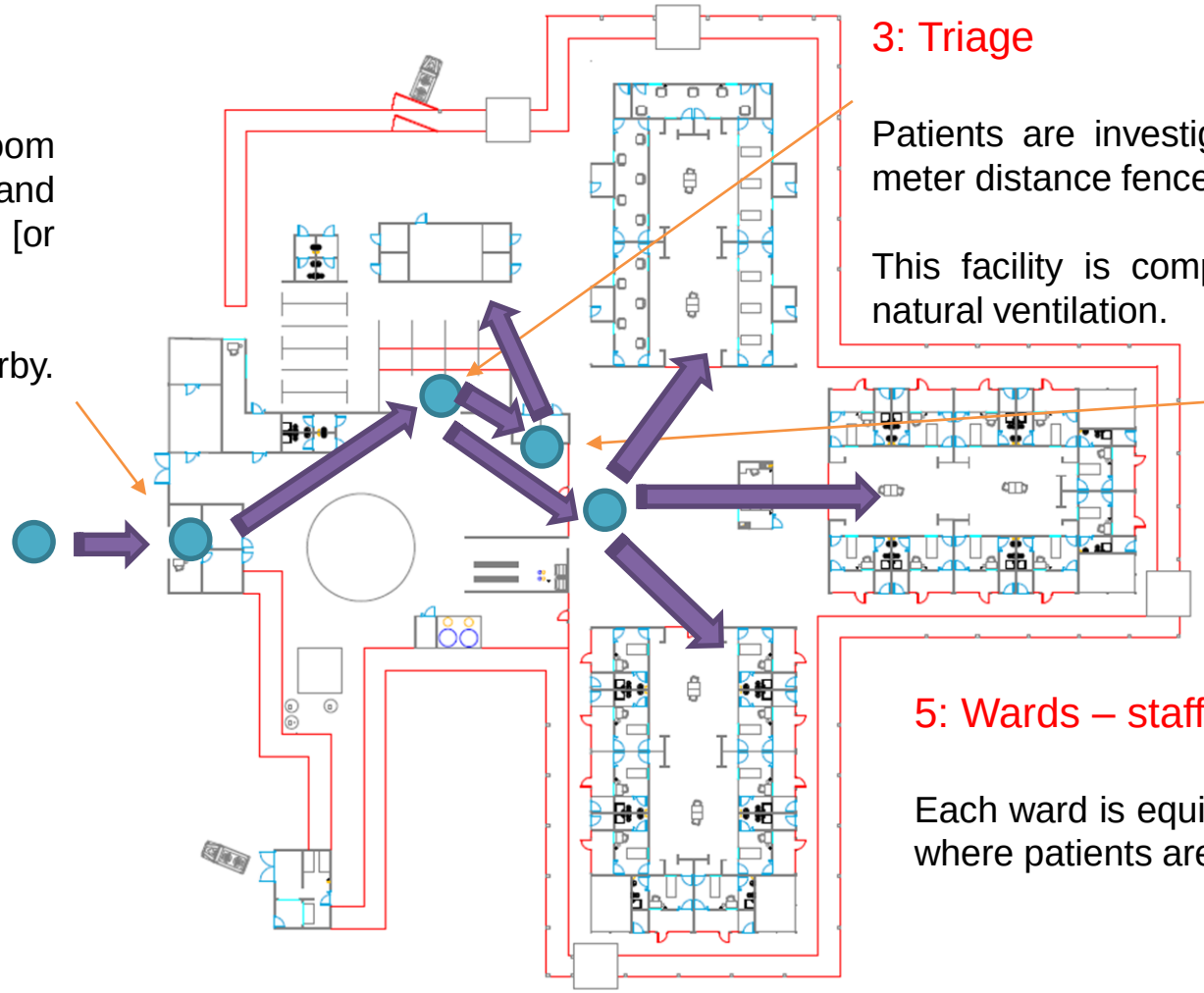
- Hand washing,
- Temperature check
- Presence record

Staff's flow

2: Changing room

Male and female changing room to remove personal clothes and wear scrubs and boots [or closed shoes].

Staff toilets are available nearby.



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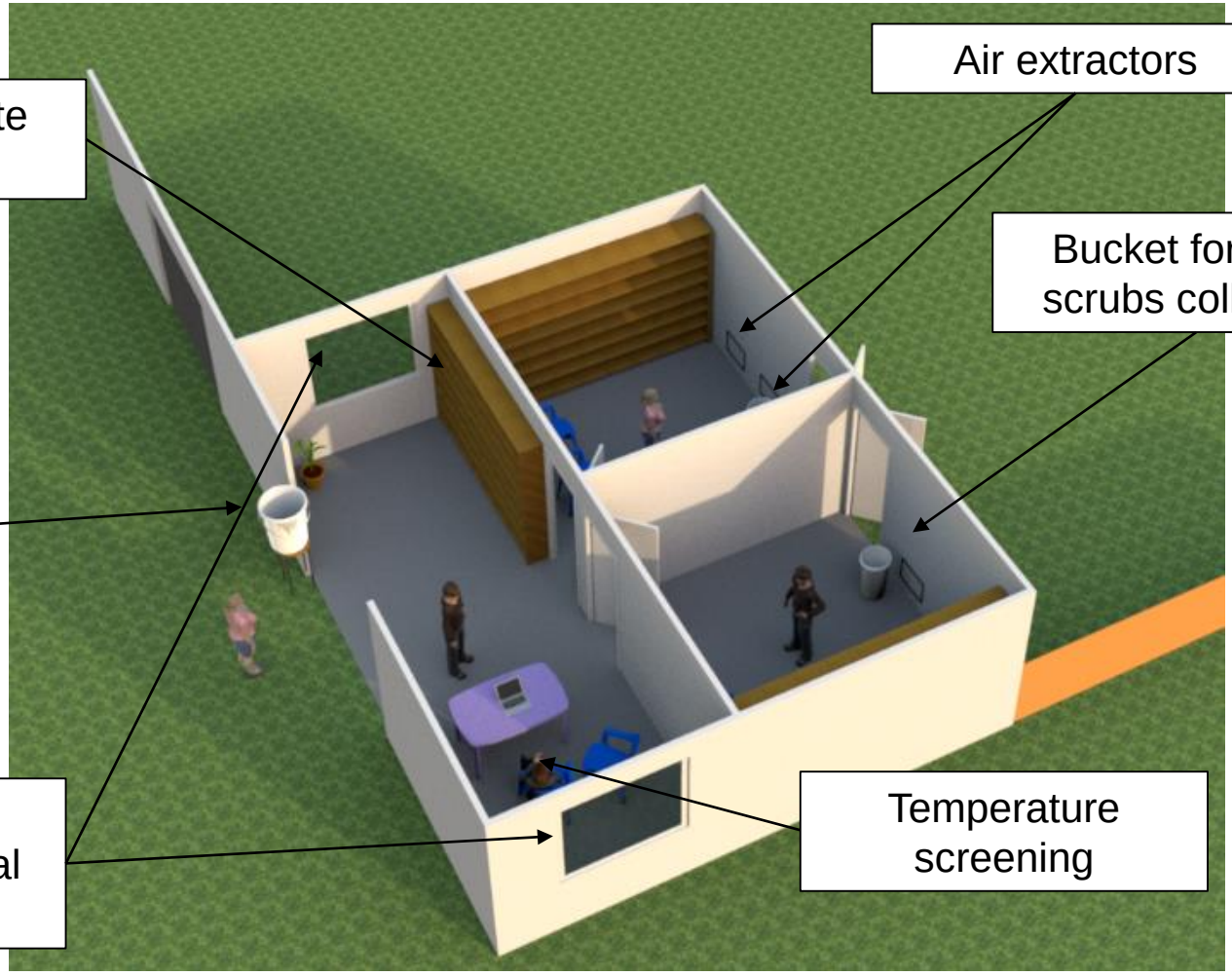
- Temperature check
- Presence record

5: Wards – staff area

Each ward is equipped with a working space for staffs where patients are not allowed.

Staff's flow - entrance



Existing building: minimum requirements

Existing building may be used as SARI treatment center if the minimum requirements are met:

- ✓ The minimum ventilation rate of 60 l/s/patient is met for mild and moderate patients ward,
- ✓ The minimum ventilation rate of 160 l/s/patient is met for severe patients ward,
- ✓ The airflow direction is from clean zones to dirty zones,
- ✓ Patient and staff' flow can be clearly defined and distances respected,
- ✓ Proper cleaning procedures can be implemented [construction materials allow cleaning and disinfection. E.g. Concrete floor, washable painted walls but no wood]

More bed capacity….

If the epidemiological situation requires to increase bed capacity:

Consider to build new wards

or

Build big common wards [no individual rooms] and group together patients with the same etiological diagnosis

Questions

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Thank you

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