MEDICAL ISOLATION FACILITIES IN OUTBREAK RESPONSES

AN OXFAM GUIDANCE PAPER

1 **Arial view of Kumala Ebola Holding Centre, Koinadugu District, Sierra Leone.** ***Credit: J. Brown***

Contents

1. Introduction

This technical briefing paper details the construction and setup of medical isolation facilities in support of infectious disease outbreak responses. It is based on Oxfam's experience of the Ebola Outbreak in West Africa in 2014-15, working with medical partners in Sierra Leone and Liberia. This experience is further supported by the guidance of other key organisations: Médecins Sans Frontières (MSF), The World Health Organisation (WHO), US Centres for Disease Control & Surveillance (CDC), The King's Sierra Leone Partnership (KSLP) and others [See 'further reading']. Although based on Ebola specifically, many of the principles may be a helpful reference for other outbreak responses.

As with all responses, it is important that interventions are well adapted to context. Detailed designs and protocols should be developed closely alongside medical partners to ensure that the plans meet the specific requirements of the context and support organisational ways of working.

1.1. Types of medical facilities

There are many different modalities and names for medical facilities used in response to disease outbreaks (isolation units, holding centres, treatment centres, community care centres etc.) however they share common purposes:

- Screening of people showing symptoms, or who are at high risk of having contracted the disease in order to admit those who are suspected cases (i.e. that meet a **case definition**)
- Safe isolation of suspected cases from the wider community, other patients and staff
- Testing to positively confirm a diagnosis
- Provision of medical care for patients, and/or referral to other healthcare facilities if required
- Management of epidemic information important to the wider response
- Acting as a focal point for community engagement, surveillance and outreach teams and for providing health information to the surrounding communities
- Safe management of medical wastes, including dead bodies prior to burial

These roles will be common across the range of scale and location of facilities – from supporting a family with home-based care in a rural village to a large treatment centre in an urban setting. Oxfam teams may be most likely to work with small, community level facilities, although providing WatSan support to larger facilities is possible. In any case, facility design will need to find a balance between the above roles. For example, in an outbreak setting particularly, the need for safe isolation may practically limit the degree of medical care that can be safely administered.

Medical facilities do not exist in isolation, but should be thought of as part of the wider epidemic response, which may include:

- Epidemic response coordination teams with overall oversight of the response
- Ambulances and other medical transport for transferring suspected cases, patients and samples
- Testing laboratories, where samples are tested in order to confirm a diagnosis
- Surveillance / community outreach teams carrying out active case finding, monitoring of health care facilities and record information to track the epidemic
- Burial / funeral teams who manage dead corpses
- The general health care system
- Academic researchers and medical specialists responsible for developing guidance and standards
- National and local authorities responsible for regulation

In general, a useful distinction may be made between ***holding facilities*** that focus on the rapid isolation and initial care of suspect cases and ***treatment centres*** that provide comprehensive medical treatment. Holding facilities are designed to be set up close to communities to increase the capacity for screening and isolation, but must refer cases, once they are confirmed, to treatment centres to provide the required level of care. The capacity of holding facilities depends on the time required to screen, admit, confirm and refer a case whilst the capacity of a treatment centre needs to include the time required for treatment and recovery, which may be significantly greater. While a patient may spend 24-48hrs in a holding centre, they may require a bed in a treatment centre for several weeks. The decision as to what size and type of facility to construct and where to construct it should be made at the national coordination level, but an understanding of the purpose, capacity and patient flow will be central to designing a facility that is suited to purpose.

1.2. Oxfam's role in disease outbreak

Oxfam does not carry out medical interventions, however we have responded to major disease outbreaks in low and middle income settings over the past nine years through public and environmental health programmes based around core WASH expertise. During the 2014-15 West Africa Ebola outbreak Oxfam partnered with medical organisations to establish and operate medical isolation facilities. This experience has demonstrated the need for public health engineering teams to work closely with public health promotion teams, medical specialists and epidemiologists in acute outbreak settings in order to ensure a full spectrum of interventions can be implemented in an integrated way.

Oxfam believes that understanding communities, building trust and working collaboratively to overcome barriers to seeking out and accessing appropriate health care services is at the core of effective outbreak response. Our aim is a holistic, community-based response where an appropriate package of measures, including health promotion, active case finding, surveillance, isolation, environmental health, Infection Prevention and Control (IPC), prevention, case management and psychosocial support can be delivered in an integrated and responsive way.

Partnering with medical organisations works best when the partnership is built around complementary core competencies, with each partner holding a stake in the outcome of the project. Oxfam should play an active role in community engagement, facility design and construction and project management rather than simply acting as a construction contractor.

1.3. Roles and Responsibilities

Several modalities are possible for the construction of health facilities, in increasing order of Oxfam's level of ongoing responsibility:

- **WatSan upgrade / rehabilitation:** Oxfam improves the water supply, sanitation, waste management and triage/isolation hardware of an existing medical facility run by a state / NGO medical provider
- **WatSan installation:** Oxfam designs and installs water, sanitation and waste management infrastructure as part of the setup of a new medical facility, providing technical support and construction supervision.
- **Build and handover:** Oxfam designs and builds a new emergency health facility and hands over the structures and facilities to a state / NGO medical provider. This could include procurement and provision of non-medical equipment and initial training of watsan operation and maintenance staff.
- **Build and maintain:** As above, but Oxfam would additionally carry out preventative / unplanned maintenance of the facility, with a roving maintenance team or through supervision of contractors.
- **Build and operate (WatSan):** Oxfam designs and builds a new facility, hands over management of the facility to a medical provider but continues to operate and maintain WatSan infrastructure. This would include hiring, training, supervision and management of WatSan staff as well as ensuring ongoing supply of consumables and maintenance.
- **Build and manage:** Oxfam designs, builds and maintains overall management of the facility, including (non-medical) staff management, supply and stock management of equipment and consumables

(except drugs and medical equipment), security, coordination with MoH etc. The medical partner would be responsible for hiring, training and management of medical teams (including clinical hygienist staff working in high risk zones), clinical case management and supply of medicines and other restricted items.

The programmatic requirements on the ground, the relative capacity of Oxfam and the medical partner to fulfill the various technical and support roles, donor requirements, timescale of implementation etc., should all be considered before selecting a modality that includes ongoing support or management a realistic assessment should be made to ensure that resources (competent staff, funding, materials, management capacity) are available for the expected duration of the facility's operation. In particular, the hiring, training and supervising of staff can be a lengthy process and so committing human resources (especially key staff) beyond the initial setup phase may limit the scope of other possible activities. Management of health facilities does not fall within the core competencies or experience of most Oxfam staff and so should only be undertaken with a thorough knowledge of the responsibilities of the management role. Realistically any working modality that includes responsibility for ongoing maintenance will require Oxfam staff to operate in high risk zones. This requires an **organisational commitment to recruit, train and support staff working with an elevated risk of infection**, the specific limitations placed on Oxfam staff through organisation policy should be made explicit at the outset of an intervention and SOPs agreed in advance with staff and medical partners.

2. Community engagement

Engaging with communities is key to building acceptance and to promote positive treatment seeking behaviour. Widespread transmission of fatal disease can be terrifying, especially when a community has no experience of that disease from previous outbreaks. Limited knowledge about the causes, transmission and treatment can lead to the creation of rumours and negative coping mechanisms that may support transmission and prolong the outbreak. In Sierra Leone in 2014 a range of behaviours such as hiding highly contagious dead bodies and seeking treatment from traditional healers emerged from the fear of both the disease itself and the response to the outbreak.

Understanding and overcoming fears around disease can be critical to gaining acceptance within the community, this might be particularly relevant in small rural communities where access to information is limited and traditional beliefs are strong. Efforts to support appropriate self-care and treatment seeking behaviour should be implemented in support of construction projects.

At the siting stage this should involve agreeing with community leaders the land to be used for the centre and associated buildings, as well as discussing any environmental risks and mitigating measures. During construction local labour can be used so that there are people within the community who understand what is being constructed within the facility and why. Before the facility is opened, community representatives should be invited to tour the inside the facility so they can see areas for patient treatment, waste disposal and staff areas that will be inaccessible once the centre opens. Steps in treatment and referral should be explained to counter fears and rumours that the centre might be used for nefarious reasons. Ensure that there is formal, recorded agreement and support for the construction of an isolation facility from local leaders, landowners and authorities before beginning construction.

During operation it might be appropriate to invite community leaders to participate in daily staff meetings to understand the running of the facility and progress with patients; at the very least regular contact and information sharing should be taking place with community stakeholders. As long as they are able to comply with safe working SOPs it is a good idea to accommodate visits from patient's family and friends. This shows that patients are being looked after well and helps to dispel any negative rumours in the community about hidden uses for the facilities. If the community can see that their loved ones are being actively cared for with respect it will support self-referral to the centre, significantly improving the effectiveness of the wider outbreak response.

At the decommissioning stage communities should be informed about the process, risks and mitigation measures needed to decontaminate and decommission the facility. It is important to understand how people feel about the decommissioning of the facility, they may be happy that the site is no longer needed but they may also be concerned if health services are being removed. As sites are being demolished building materials may appear to be valuable resources and communities may expect to receive these as donations after the site is cleared. It is important to be clear about which materials will be left for the community and which will be destroyed or removed.

3. Siting of isolation facilities

3.1. Epidemic need

It is likely that the initial siting of isolation facilities will be made based on the progression of the epidemic and the coordination of the response at a country-level by the Ministry of Health (MoH) supported by WHO, CDC and other international organisations. Decisions on the location of centres will depend on the characteristics of the disease, transmission pathway, logistics requirements and the existing level of health coverage in country as well as the stage in the epidemic.

Siting of medical facilities should be decided in collaboration with local Ministry of Health (MoH) officials, WHO, the medical partner, local communities as well as other stakeholders such as national and local coordination structures, and other NGOs. Before starting construction of facilities there should be a plan in place for staffing and equipping the medical centre. At a country level the need for local community facilities will need to be balanced with human and material resourcing limitations.

Setting up an isolation facility is not a simple or quick activity, facilities should be planned in line with the expected need. It may be appropriate, for example, to rapidly construct a very simple two room facility, with associated latrines, solid waste disposal, changing areas and disinfection area whilst a more comprehensive facility is constructed. It may be possible to achieve the aims of an isolation centre (screening, isolation, patient care and referral) with very little construction (even at a household level) provided there is a focus on good infection prevention and control protocols.

3.2. Use of existing structures

In a rapidly developing outbreak context it may be that a community already has suspected or confirmed cases before response teams arrive or any isolation facilities are constructed. If the number of existing cases is limited, or if cases are spread over a large area it might be best to build upon the existing community response, implementing isolation measures at a household level, or upgrading informal isolation areas if this can be done safely. However, if the caseload is likely to increase or facilities are not appropriate, in most cases it will be safer to construct dedicated facilities than to upgrade what exists already. This ensures facilities meet the specific requirements of an isolation centre and can be constructed without risking contact with infectious material.

The conversion of an existing communal structure into an isolation centre is possible and may reduce the construction required and may result in higher quality construction than could be possible in an emergency context using temporary structures. However, it is important to make sure that the structure meets the requirements for isolation facilities without significant alterations having to be made. Due consideration also needs to be given to the future community acceptance of buildings used to treat those with infectious disease.

3.3. Site requirements

The space required for the site will depend to some extent on the number of beds required, but in small sites the space requirement may be determined more by the ancillary buildings rather than the wards. For example, **Error! Reference source not found.** shows an example layout for a 12-18 bed isolation facility, with a ward area of roughly 140m^2 and a total area of 2,500m^2 (this example could be reduced in size, however the area required for wards would always be a small percentage of the total).

Land ownership and the terms under which the land is used should be agreed before construction starts so that the ongoing operation of the site can be guaranteed for as long as it is needed. The decommissioning process and agreement over future land use should be agreed with the land owner at the outset.

It is important to plan for potential expansion after the facility is opened, to be able to deal with increases in admissions. This can be achieved either by installing wards that are larger than required at the outset, or by constructing additional wards outside of the red zone after the site is active and then expanding the red zone fencing around the new structures.

The site should have a moderate gradient (between 1-5%), be elevated above flooding level and built on well-draining soils to ensure adequate drainage. Ideally ground water levels should be deeper than 4.5m throughout the year to enable latrine pits to remain 1.5m above the saturated zone.

Access to sufficient water (roughly 5m^3 per day for a 12 bed facility) is essential. Groundwater should be used if possible to reduce the need for pre-treatment. Other sources of water used by the surrounding community should be protected and monitored for contamination (see 3.4). If available, access to grid power should be arranged for lighting, refrigeration, office and communications use, this should be supplemented by backup generators to ensure that the critical systems are reliable.

Consideration should also be made for the accommodation of the staff needed to run the facility, especially if located in a remote area. There may be a significant number of staff working in even a small facility, these people will need housing, food and transport if relocated from another area. Meeting the needs of staff can be a considerable undertaking, staff morale can be severely affected by poor living conditions.

Sites should be located close to main roads that are passable year round to allow access by construction traffic, the regular deliveries of goods and materials as well as for patient transport for arrivals and referrals. A reliable means of communication is also needed to ensure that referrals can be arranged, the outcome of lab testing can be obtained and case numbers can be reported to coordinating authorities. If there is no cell phone signal available satellite phone/internet connection should be set up as a priority.

3.4. Environmental protection

The contamination of environmental resources from healthcare facilities is possible from a range of sources:

- excreta and other bodily fluids from latrine pits, septic tanks, desludging operations
- infected solid waste, including medical wastes (sharps, bandages, bed linen, clothing, cloth used to clean spills)
- organic waste from placenta pits (used to dispose of waste organic matter)
- dead bodies
- chemicals such as chlorine, lime, alum and insecticides

Measures should be in place to prevent the contamination of water that may be used by surrounding communities and local water sources should be regularly monitored to detect any contamination so that actions can be taken to mitigate the potential health impacts. A simple risk assessment format can be found in further reading.

Risks of causing contamination of ground and surface water sources should be minimised by locating the facility on high ground, away from water sources (springs, streams, lakes, wells and boreholes) and away from human habitation (MoWR, 2014) (although this should be balanced with community access and acceptability considerations).

Water resources are at risk of contamination from isolation facilities through a number of mechanisms:

- Groundwater contamination from latrine pits, buried wastes or rainfall infiltration
- Surface water contamination from runoff

In order to minimise groundwater contamination, pits used to dispose of contaminated wastes (latrine pits, sharps pits, organic waste pits, solid waste pits etc.) should be designed so that they are at least 1.5m vertically from the highest seasonal groundwater level. The location, depth and contents of all pits constructed to contain contaminated wastes should be recorded and shared with relevant authorities (e.g. Ministry of Environment / Water Resources / Sanitation, Ministry of Health, local community leaders). These authorities may also be able to provide information on seasonal variation of groundwater levels if these are not available from field teams.

The quality of both ground and surface water should be assessed: 1) before commissioning of the facility; 2) at regular intervals during operation; 3) and, after decommissioning to detect any potential contamination. Specific viral contamination of water is not possible without sophisticated equipment and qualified staff, therefore at a minimum monitoring of water quality should focus on proxy indicators that might suggest contamination from materials disposed of in pits (human wastes, lime, chlorine etc.).

In addition to the above, static water levels in nearby wells and boreholes should be recorded weekly or monthly (depending on variations) to determine if groundwater contamination might be a risk. If there are no suitable water abstraction points nearby, a test borehole can be dug with a simple hand auger, lined with PVC piping.

To prevent contamination of water sources during sample collection and monitoring, staff involved should observe sanitary conditions and ensure that any equipment used is appropriately sterilised. Reusable sample bottles and equipment should be sterilised after use and disposable equipment such as membranes and nutrient pads should be incinerated. Staff should also wear disposable gloves and eye protection to prevent contact with contaminated water.

4. Layout of isolation facilities

4.1. Key principles

Infection Prevention and Control (IPC)

The physical layout of medical facilities should be designed to limit the transmission of from those infected to other patients, staff and the wider community. The most fundamental aspects of infection prevention and control (IPC) involve setting up physical and behavioural barriers between people to limit the transmission infection.

The specific measures taken will depend to some degree on the transmission characteristics of the pathogen involved, but some standard approaches are outlined here. Infection risks can be reduced through a combination of well-planned and constructed spaces and adherence to safe working practice. In an acute emergency context it is likely that facilities and infrastructure will be basic and constructed rapidly, putting more emphasis on behavioural aspects of IPC. However, in any isolation centre the concepts of isolation, risk zoning and flow should define the layout of the facility.

In order to support staff to follow safety SOPs the layout of facilities should be simple, logical and clearly demarcated. It is important that enough space is available to provide separation between areas. It might be useful to draw out the flow diagrams for staff, patients and materials separately to ensure that the site layout allows logical and systematic movement between different work areas.

All isolation related buildings should be located inside the site to ensure that movement between zones is reduced as far as possible. Activities within the red zone should be limited to those that cannot be carried out from a lower risk area. For example, it may be possible to carry out basic patient observations, provision of food and oral medicine from the green zone. To enable this it is important that the red zone, especially patient wards, should be visible from the green zone. A raised ‘ward observation area’ can be constructed to allow medical staff to see and talk with patients and other staff in the red zone to make sure they are safe whilst reducing the time spent in high risk areas.

The layout of an isolation facility will depend on the scope of care that is provided at the centre and how it fits within the wider referral system. For example a facility without an on-site testing lab may need a larger space dedicated to suspected cases, as patients will need to be held here for longer before moving to the confirmed area.

The layout of the facility should be discussed between medical teams, IPC, logistics and WatSan staff to ensure that it is appropriate for all users.

Factors that will influence the layout of the facility include:

- The number of patients expected (catchment area + surplus)
- Level of treatment and testing available on site
- The land available, existing structures and natural features
- Materials and equipment available

The layout of isolation facilities should allow and encourage proper adherence to IPC protocols, in particular they should include aspects of isolation, zoning and flow.

Facilities should be designed to allow future expansion if required. Making changes to the red zone after the facility has been opened is far more challenging and risky than planning for expansion in the construction phase. If required, land adjacent to the red zone could be designated for additional patient wards as part of the design process, construction could then take place in a lower risk environment and the red zone can be expanded to include the new wards on completion.

Construction should be well documented with detailed ‘as built’ drawings to ensure that future teams are able to understand and locate key components – this is especially important for the water supply system and other systems that will be buried.

An example layout of a 12 bed isolation centre is detailed in **Annex O**.

<u>Isolation</u>

Isolation involves the physical and behavioural barriers that prevent contact between suspected or confirmed cases, other patients, staff and the surrounding community.

Three levels of isolation should be considered as part of the facility design[1]:

1. Administrative controls: operating procedures, rules and behaviours that limit risk throughout the whole system
2. Environmental and engineering controls: including cleaning of the environment, providing physical barriers and separation and the ventilation of spaces
3. Personal protection: the provision of the proper personal protective equipment (PPE)

Environmental and engineering controls will include fences, screens and buffer zones. Administrative controls would include Standard Operating Procedures (SOPs), protocols and behaviours such as avoiding patient contact and practicing hand hygiene. The use of PPE, in combination with the administrative and engineering controls is effective as a last line of defence against contact with infectious materials. Patient wards should be

1 Gerberding JL. Occupational infectious diseases or infectious occupational diseases? Bridging the views on tuberculosis controls. Infection Control and Hospital Epidemiology, 1993, 14:686–687.

designed to separate patients from each other and from the community. Staff and materials entering the patient area should be thoroughly disinfected before they leave.

Risk zoning

In order to limit the risks of cross infection the isolation centre should be split into areas with different levels of infection risk, each requiring different levels of personal protective equipment, access restrictions and SOPs. It is important to mark the entrance and exit of each risk zone so that staff are always aware of which area they are in and which protocols should be observed.

The high-risk zone (‘***red zone***’) is the isolation area inside the isolation facility used to accommodate and care for patients. The red zone should be physically separated from the rest of the facility and from the surrounding areas with a double fence spaced to prevent transmission of infectious material from red to green zones. It is should be considered that everything inside the red zone is contaminated with viable disease causing agentsand therefore is highly infectious. Anything entering the red zone must be either disposed of safely by burning, or decontaminated completely (i.e. by soaking in 0.5% chlorine solution) before being removed.

Access to a red zone is limited to patients, suitably trained medical teams, hygienists and maintenance staff under the direct supervision of a trained IPC specialist. The time spent in the red zone should be minimised as far as possible. Full PPE should be worn at all times and strict IPC protocols must be adhered to.

The red zone may be further divided into areas for suspected, probable, confirmed and recovering cases, or those experiencing less acute and more acute symptoms in order to reduce the chance of ***nosocomial infection***.

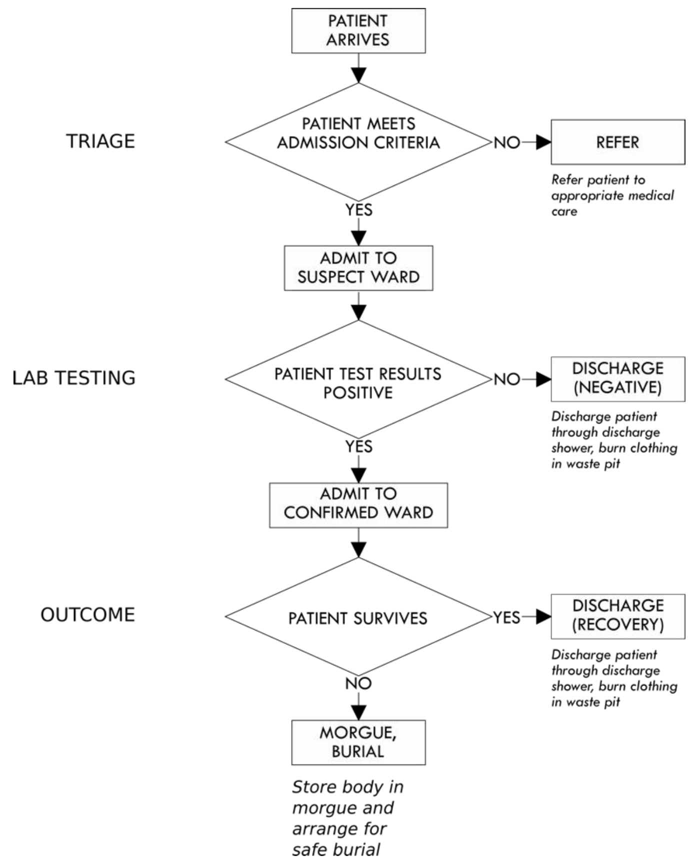
Figure 2 Arial photograph of the temporary isolation centre in Kumala, Sierra Leone, showing risk zones and key structures. ***Credit: J Brown***

The low-risk zone ('**green zone**') is an area inside the isolation facility used by red zone medical teams to take a break from direct patient care and to carry out supporting activities. **In principle no infectious material should be present in the green zone, however due to the proximity to the red zone it is considered to have an elevated risk compared to the outside environment.** Because of this, access to the green zone is restricted to medical staff, hygienists and those involved in operation and maintenance of the centre as needed. Those authorised to enter the green zone should be trained on the risks and protocols to be followed before entering.

The security zone ('**white zone**') is an area inside the Ebola centre that is deemed to have no higher risk of coming into contact with infectious material than the surrounding environment. Access is restricted for security reasons only to authorised staff and visitors on a needs basis. In an infectious disease outbreak there is not a 'no risk' zone, and standard precautions should continue to be taken both inside and outside the centre.

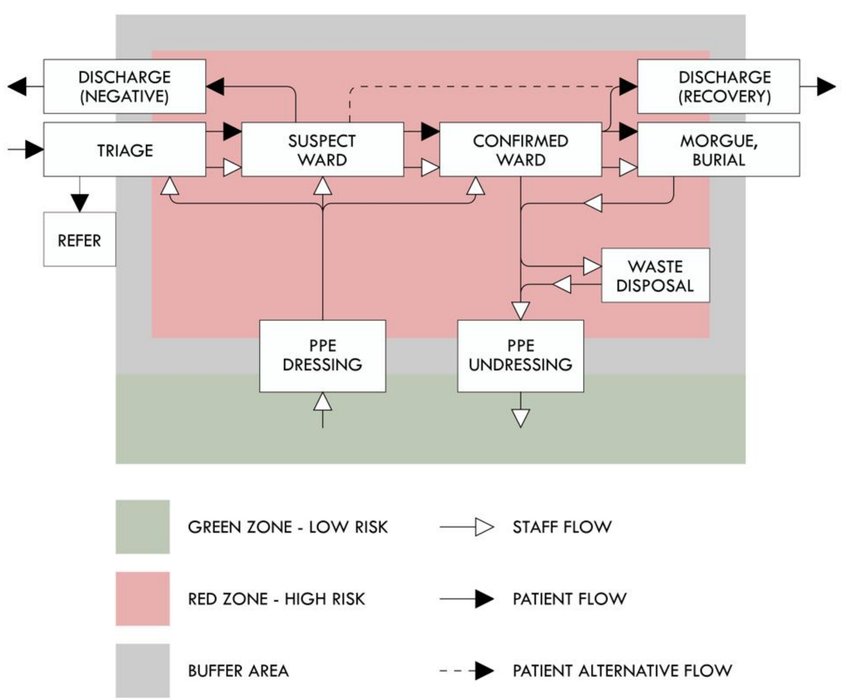
<u>**Flow**</u>

Flow describes the controlled movement of people and materials inside an isolation facility. Proper design of the facility should help to ensure that movement is always from areas of lower risk of contamination to higher risk. This reduces the risk of suspect patients being infected inside the facility by the spread of infectious agents from other patients (nosocomial infection).



Staff (clinical, hygienists and maintenance staff) move through the red zone from the PPE dressing area, starting with patients who are least likely to be infectious or who have less severe symptoms, and moving towards those with higher risk or more severe symptoms. Staff are not able to move against this flow for any reason so the layout of the red zone should be based on a one-way route with specifically and clearly defined access points and walkways. Before moving from a higher risk to a lower risk area staff should go through thorough disinfection at the designated decontamination and PPE undressing area. If possible it is best to allow staff to directly access the patient area they need to, without entering other areas. This means ensuring each patient area has a bypass to allow staff to go directly to the decontamination area without being exposed to higher risk areas – this is also important to ensure that staff are able to exit the red zone quickly and safely in case of accidental exposure, or illness.

Flow also applies to patients such that a patient with increasing symptoms or who is confirmed as infected can be moved from a lower risk to a high risk ward, but movement in the other direction is not allowed. Depending on the context it might be appropriate to construct a further ward for patient recovery, beyond the confirmed patient ward.



In general materials should not be moved between different risk areas, for example each risk area should have its own dedicated cleaning equipment and furniture that is marked with its location. Materials may be moved from the red to green zones only if they can be completely disinfected following an established SOP (i.e. by immersion in 0.5% chlorine solution). Solid and liquid waste must be decontaminated and disposed of within the red zone.

5. Detailed design considerations

5.1. Key principles

Staff working in an isolation facility are working in a dangerous and uncomfortable environment, where small mistakes can have significant consequences for all involved. A well designed isolation facility can contribute greatly to the safety and comfort of staff and patients. The primary principle for the design of isolation facilities is to reduce the exposure to risk and the occurrence of mistakes by reducing the complexity of tasks as far as possible and supporting compliance with SOPs by designing with human factors considered.

Working in PPE is not only physically and mentally exhausting, but also severely inhibits the senses. It would be useful for WatSan staff to undertake red zone training to better understand SOPs, protocols and the constraints of working in full PPE. The following principles should be considered throughout the facility:

- Avoid trip hazards, flooring should be flat and level without level changes
- Routes through the site should be simple and clear with obvious signage indicating correct flow and reminders of SOPs at key points
- Internal doors should be secured to prevent movement of patients between risk zones, bungee cords are simple and easy to use without tearing PPE
- Sharp edges should be eliminated inside the red zone to prevent tearing of PPE, timber can be covered in plastic sheeting to prevent splinters – this will also help disinfection
- Ventilation of inside spaces to reduce heat and to disperse chlorine gas
- Entrances and exits should be clearly marked, secured and supervised at all times to prevent unauthorised entry
- Entry and exit for staff should be separated from those for patients

- Pathways should be clear and easy to navigate when carrying stretchers or body bags
- Privacy and dignity for patients and their families, including culturally appropriate separation of men, women and children, privacy screens between beds (translucent to allow light through)
- Shaded spaces for family and friends to visit patients whilst maintaining a safe separation
- FM Radios or other means of contact with the outside world and to reduce boredom – especially in recovery areas

5.2. Water Supply

Quantity and Quality

A constant and reliable supply of water for disinfection, cleaning and drinking is critical for the running of any health centre. Three parallel water supply lines are required, to supply chlorine solutions of 0.5% and 0.05% and potable water (with an FRC of 0.3-0.6mg/l). Pre-treatment may be required to ensure that water quality is sufficient for effective chlorination (i.e. turbidity <5NTU and pH<8) prior to being pumped into storage tanks and so appropriate pre-treatment may be required.

Chlorine strength	Colour	Uses	Indicative quantity
High strength chlorine solution: 0.5% (5,000ppm)	Red	Disinfection of surfaces, cleaning spills and body fluids, disinfection of PPE, footbaths, disinfection of corpses, washing gloved hands, disinfection of reusable PPE, cleaning excreta and vomit buckets, disinfection of solid waste bags, cleaning plates and eating utensils	200 l / bed / day
Low strength chlorine solution: 0.05% (500ppm)	Yellow	Hand washing, GZ laundry, discharge showers, disinfection of sensitive medical equipment, disinfection of laundry before washing	150 l / bed / day
Drinking water: 0.3-0.6mg/l FRC (0.3-0.6ppm)	Green / White	Drinking, staff and patient bathing, laundry, rinsing reusable PPE (goggles)	50 l / bed

Table 1 Chlorine concentrations, uses and quantities

The quantity of water supplied depends on the size of the facility, the number of staff and the number of patients admitted. Even with very few patients admitted there will be a significant water demand for disinfection, cleaning and hand washing as hygienists may be cleaning the red zone several times per day even if only one patient is admitted. The figures in Table 1 above can be used for initial planning purposes and quantities adjusted during training before the site is opened, however a minimum quantity of 2-3m^3 should be available from the beginning of operation. Additional water may be required if for outreach activities, burials or for the disinfection of ambulances if these are being managed from the centre.

A significant quantity of chlorine will also be required to create the chlorine solutions required. Based on the quantities in Table 1, 18.2Kg of HTH powder (70% available chlorine) will be required per day to run a 12 bed facility.

Total solution demand (l)				
Number of beds:	ppm	1	12	18
High strength /bed	*5,000*	*200*	*2,400*	*3,600*
Low strength /bed	*500*	*125*	*1,500*	*2,250*
Drinking /bed	*1*	*75*	*900*	*1,350*
Total		**400**	**4,800**	**7,200**

Daily HTH requirement (g)		70%	Available chlorine	
Number of beds:	g/l	1	12	18
High strength /bed	*5*	*1,429*	*17,143*	*25,714*
Low strength /bed	*1*	*89*	*1,071*	*1,607*
Drinking /bed	*0.001*	*0.11*	*1.29*	*1.93*
Total		**1,518**	**18,216**	**27,323**

Table 2 Daily chlorine consumption

Depending on the water source and availability, a minimum of two day's storage should be provided to prevent gaps in supply.

Water infrastructure

An example water tower layout is shown in **Error! Reference source not found.**. Water is pumped from source into the upper tanks, which are connected to form a single storage which can be used to feed any of the lower tanks to allow for differences in usage between the three supply lines. A schematic is shown in **Error! Reference source not found.**. Translucent water storage tanks should be used where possible as they allow the level of water to be observed without climbing up to the tank lid. The elevation of the lower tanks should be designed to provide a sufficient residual head at the farthest tap. Installing overhead showers or other elevated water points will increase the required height of the water tower. The upper tanks should be located so that their outlets are level with the inlets of the lower tanks, this maximises the total useable storage volume. Low level washouts should be installed on the lower tanks to enable residual chlorine granules to be rinsed from the tanks.

Most of the pipework and fittings should be located in the green and white zones to reduce the amount of repair work in the red zone. If possible, pipes and fittings inside the red zone should be laid above ground, to ensure leaks can be identified visually and repaired easily. Taps, tanks, piping and other fittings should be colour coded to show the chlorine solution strength as detailed in Table 1.

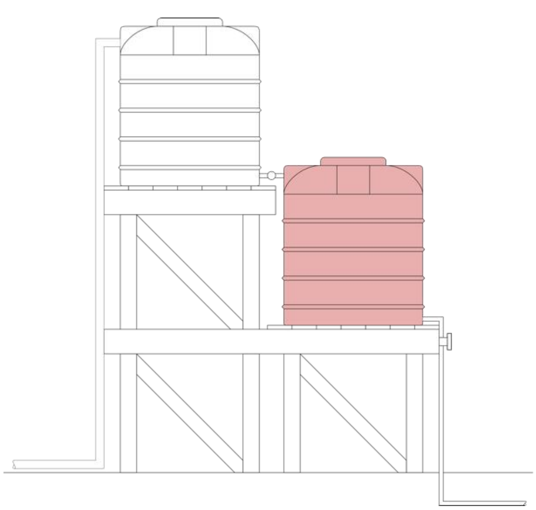
High strength chlorine solutions will quickly corrode metal fittings so these should be avoided where possible: plastic materials should be used instead. In Sierra Leone brass or stainless steel taps used on 0.5% and 0.05% water lines had to be replaced at least every month due to corrosion. If non-metallic fittings are not available in country these will have to be sourced internationally. Where metal fittings are used they should be designed to be easily replaced whilst wearing PPE.

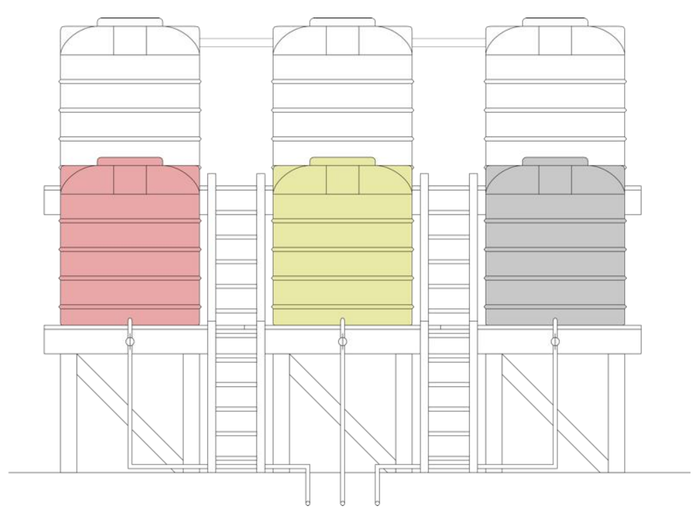
Polyethylene (PE) piping is durable, flexible and easy to lay quickly with compression fittings. Polypropylene Random Copolymer (PPRC) pipe may also be used if fittings are available, although it must be joined by welding and so is not safe to repair whilst wearing PPE.

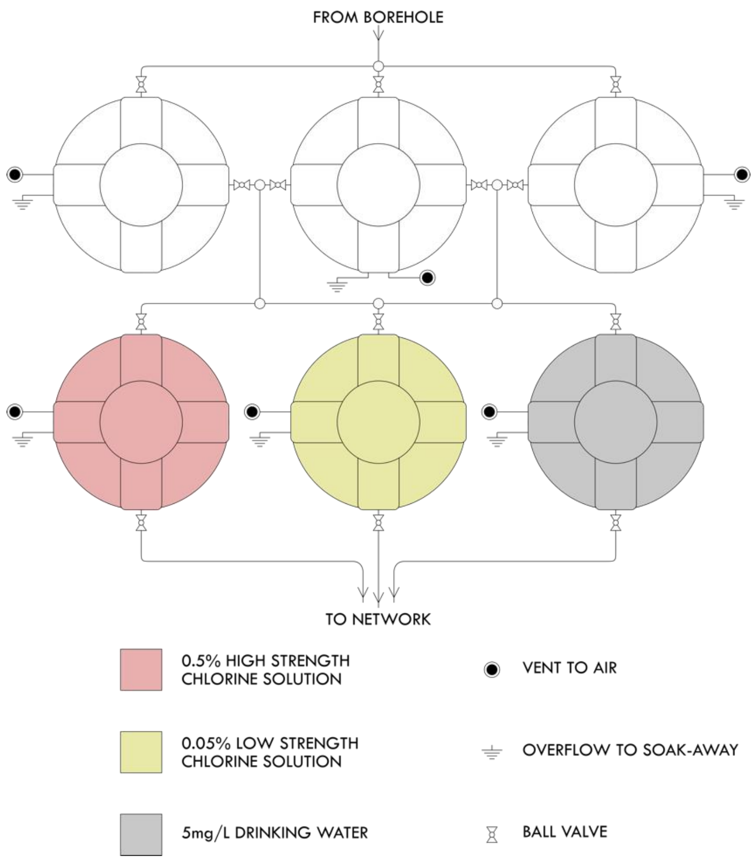
Risk zone	**Location**	**0.5% tap**	**0.05% tap**	**Drinking water tap**	**Handwashing (0.05%)**	**Footbath (0.5%)**	**Notes**
White zone	Entrance				X	X	
	Changing area			X	X		

	Latrines (staff)				X		
	Kitchen			X	X		
	WatSan area	X	X	X			For testing water samples, filling handwashing points
Green zone	Entrance			X	X	X	
	Laundry		X	X			Drinking water required for rinsing goggles
	Rest area (staff)			X	X		
	Latrines (staff)				X		
	Showers (staff)			X			
	Preparation area	X					For filling sprayers, handwashing points
	PPE dressing			X			
Red zone	Wards	X	X		X	X	Glove handwashing points with 0.5% also needed inside for handwashing between patients
	Latrines (patients)	X			X		
	Showers (patients)			X			
	Showers (discharge)		X	X			0.05% needed for disinfection before discharge
	Waste disposal	X		X			Fresh water container in case of fire incident
	PPE Undressing	X	X		X	X	Large drums of 0.5% for reusable PPE,

Table 3 Water needs by location







Error! Reference source not found. shows a three tap standpipe design, and an example of its use in an isolation centre in Sierra Leone. For ease of use the tap stands should be standardised, colour coded and labelled, to reduce confusion over which tap to use. Fitting hosepipes to the taps can reduce spills when filling buckets, jerry cans and sprayers. The plastic globe valves are used to isolate each tap so it can be easily replaced without shutting off the wider supply. The standpipe was pre-fabricated off-site and then installed in place by joining the PPRC (green) pipe to the PE (blue, bottom) network with compression fittings.

5.3. Solid Waste Management

Waste generated inside the isolation centre should be segregated at the point of collection and disposed of inside the SWM area within the red zone.

Waste category	Examples	Disposal
Dry	PPE, bed linen, patients clothes, bandages, cleaning materials	Collect in 2x layers of heavy duty waste bags and incinerate
Wet	Body fluid spills	Collect in spills bucket containing 0.5% chlorine solution and pour into patient latrines
Sharps (if required)	Needles, razors, scalpels, broken glass	Collect in dedicated sharps box and dispose in sharps pits

Table 4 Solid waste management protocol

The SWM area should be located beyond the high-risk patients, before the staff decontamination area so that staff are able to dispose of waste collected in the wards before moving directly to the decontamination area.

The simplest way to safely dispose of solid waste at small, temporary sites is to use a burning pit, where waste is burnt and the resulting ash remains until decommissioning. Pits should be dug to a depth of 2m (although ensure 1.5m from the highest groundwater level) and with a diameter of roughly 2-3m. The volume of waste will be reduced significantly during burning and so pits will fill slowly as long as the waste is well combusted, however it is a good idea to plan for a second burning pit in case the first becomes full. This can be dug in the green or white zones, and when finished the red zone can be expanded around the new pit.

The environmental pollution caused by burning medical waste should be taken into account; at small sites it is unlikely that levels of toxic pollutants will meet international limits[2]. Burning sites should be designed with chimneys that extend beyond the height of surrounding rooftops and should be located at least 20m from wards or staff areas.

In areas with heavy rainfall burning pits will need to be roofed and protected from surface water run-off to prevent flooding.

Figure 3 Covered burning pit (at right, pyramid roof), ***Credit: MDM***

Diesel or other fuel will be required to start combustion of the waste and staff involved in disposal should be trained and supervised to ensure fire safety. PPE is highly flammable and so waste disposal areas should be located where they can be lit from the green zone, with staff wearing scrubs.

It may be appropriate to install De Montfort-style incinerators at small health centres, although the amount of waste generated at an isolation centre may be too high for these units. The UNDP gives estimates of 390 litres of waste per patient per day, of which 240 litres (27kg) per patient per day is infectious waste from the

[2] See: Emmanuel J, Ndoye B (2015) *Assessment and Recommendations Regarding Management of Ebola-Contaminated Waste* UNDP letter to WHO and NGO Stakeholders

red zone[3]. The De Montfort Mk9 incinerator can process up to 50kg/h of waste and so may be suitable for up to 20 bed centres. However PPE is more bulky than general medical waste, and so loading may be difficult. Construction of incinerators should be carefully supervised to ensure the use of fire bricks and high alumina cement, and the correct sizing of steelwork.

Sharps pose a significant risk of injury and infection to staff and should be disposed of immediately after use in a single-use sharps container. This container should then be disposed of in a designated sharps pit (See MSF (2010) *Public Health Engineering in Precarious Situations*: TB6.02).

5.4. Liquid Waste Management

Surface water drainage should be planned at the very beginning of the site selection and design stages to ensure that both rainwater and cleaning water are disposed of safely. As with solid wastes, any surface water originating from the red zone should be disposed in soak away pits within the red zone. Cut off drains should be constructed above the site level to divert surface water. Drainage channels should be constructed around structures and walkways to drain water from cleaning operations and rainwater runoff.

The effectiveness of chlorine solution as a disinfectant is severely reduced when used on soiled surfaces so keeping surfaces clean is important. Adding a layer of coarse gravel over the site will reduce mud and help keep internal spaces clean, reducing the burden on hygienist teams. However, gravel will not be effectively decontaminated by regular cleaning and so walkways and interior spaces should be floored with a smooth, impermeable surface.

Drainage channels should be open and cement-lined to enable easy cleaning and removal of blockages. Walkways should bridge these channels to prevent staff stepping in drain water and spreading contamination.

Ward floors should drain directly into drainage channels to deal with cleaning water, which may contain infectious material. Although the high chlorine content of washing water the risks of infection from wastewater are minimal, soakaway pits should be at least 1.5m above the highest groundwater level and a suitable distance from groundwater sources.

Soak away pits should be sized based on soil permeability tests to deal with the peak daily water flow from both rainwater and cleaning water. For example, a 50m x 50m site with 12 beds in the peak of the rainy season in West Africa might experience 25mm of rainfall in one day. Over 2,500m^2 surface area this would equate to 62.5m^3 of water either soaking directly into the ground or running off as surface water. Dealing with this quantity of run-off is a significant challenge and underlines the need to plan for cut off drains to reduce surface flow from outside the site. **Without rainfall considerations the daily use of cleaning water at 200l/bed/day implies a daily soakaway requirement of 2.4m^3 per day for a 12 bed facility.**

5.5. Fencing

Fences should be low and see through and construction fencing is ideal for internal areas. This allows the staff, visitors and the wider community to see inside the facility without entering an elevated risk area.

Outer fencing needs to prevent animals entering the facility, a low barbed wire fence can be used around the perimeter of the site to ward off livestock. Fences should be dug into the ground to prevent small animals from burrowing underneath.

[3] ibid.

5.6. Ventilation

Overheating is a major challenge for staff operating in PPE, so all red zone structures should be designed with adequate ventilation to provide suitable climates for staff and patients. Fans and air conditioners are not recommended as they may promote transmission by spreading infectious agents in air droplets so natural ventilation through open doors and windows should be encouraged. In hot environments shade netting fitted to tents and other temporary structures will reduce inside temperatures.

5.7. Wards

Figure 4 Inside an Ebola ward housed in a converted classroom, *Credit: J. Brown*

Wards should be open, with a good source of lighting both during the day and at night. Roughly 6-9m^2 of floor space is required per patient, this allows for a 1m x 2m bed to be placed against a wall with 1m buffer area, creating the minimum of 2m separation between beds. Each bed should be equipped with a bucket for vomit and excreta; cholera beds may be required in wards used for bed-bound patients with severe diarrhoea. Additional space within the ward should be available for hand washing buckets, spills kits and other equipment as well as waste collection buckets.

If suitable existing structures are not available tents can be used as wards and other structures. Tents should be constructed from non-porous materials that will withstand disinfection with high strength chlorine solution: **tents should be constructed on concrete plinths to enable cleaning and proper drainage.** Patients who are mobile should have access to a shaded outside area where they can see and talk with visitors in the white zone.

Figure 5 View of wards (tents) from the nurse's station, *Credit: J. Brown*

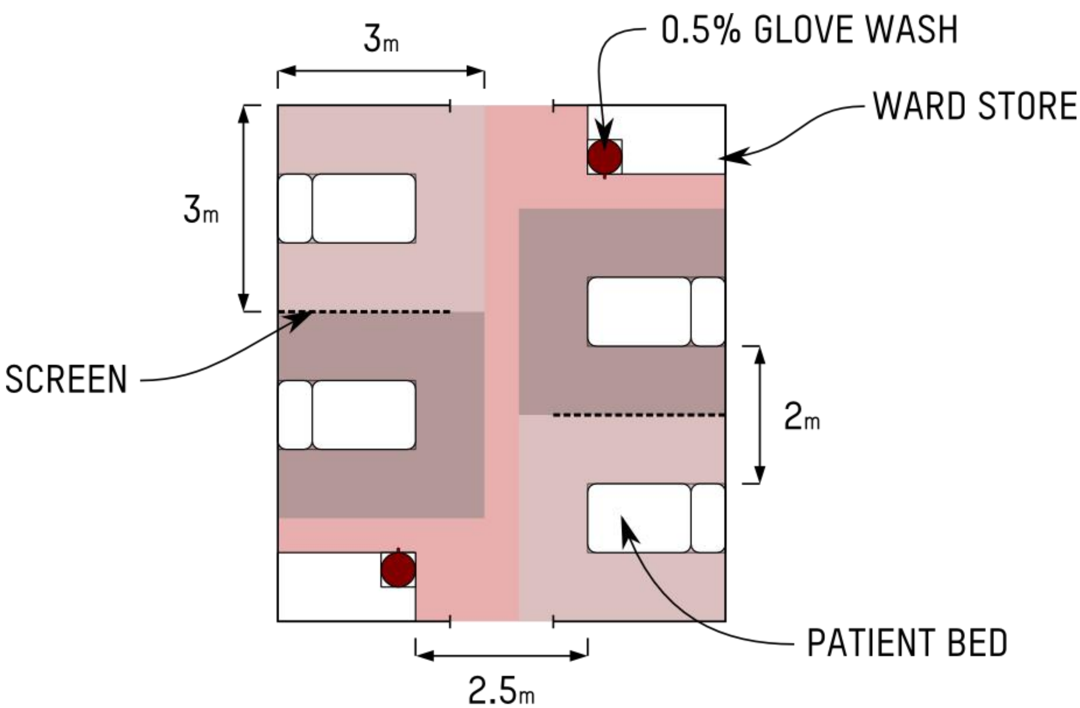


Figure 6 Example layout of 4 person isolation ward (6.5 x 7.5m)

It would be ideal for each patient to have their own room with access to an individual shower and toilet; however this is not likely to be possible except for in the smallest facilities. In communal wards movable screens constructed from timber and translucent plastic sheeting should be used to separate patients to improve physical isolation as well as providing some privacy whilst allowing light into the bedside.

The wards should be designated as either suspected / confirmed or minor / severe symptoms, in discussion with the medical partner and taking into account the context. For example, in situations where the clinical confirmation of the disease is quick and easily available (ie access to rapid tests on site) the former distinction might be more appropriate. The main priority is to separate those patients who are shedding the infectious agent (severely symptomatic) from those who may still be susceptible (unconfirmed).

Ward floors should be impermeable, smooth and flat. Concrete floors should be finished with a smooth sand and cement screed or covered with high quality plastic sheeting secured around the edge of the floor with timber battens. Tents should be placed onto flat and firm flooring. If a plastic ‘bucket floor’ is installed it should be fitted with draining pointsto allow washing liquid to flow into drains.

5.8. PPE Dressing Area

Figure 7 PPE dressing room showing storage shelves, mirrors not shown, *Credit: MDM*

The area designated for dressing into PPE should be sized based on the maximum number of red zone staff on each rotation. It is important that the dressing area is well lit and adequately sized for each dressing staff to be assisted by one other person (consider at least $4m^2$ per staff member, based on the largest red zone team). Full-length mirrors should be provided to allow users to check that PPE is donned correctly.

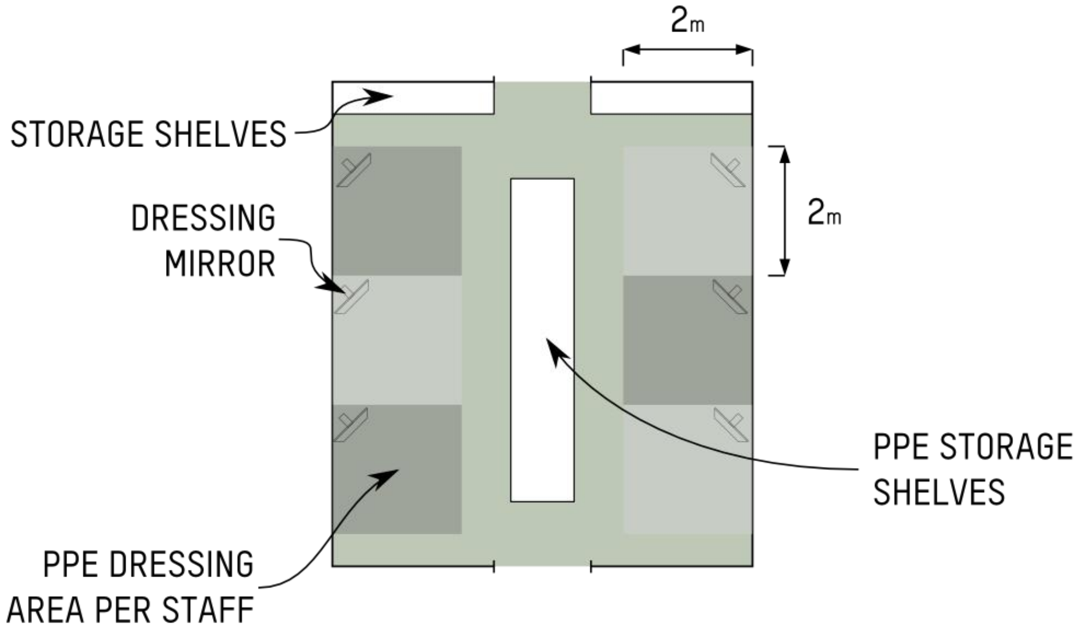


Figure 8 Example layout of PPE dressing area for 6 staff (6.5 x 7.5m)

5.9. PPE Undressing area

Undressing PPE at the end of a red zone rotation is one of the highest risk activities to be carried out at an isolation centre. Staff will likely be fatigued, dehydrated and overheating, especially in hot climates, and are required to carry out roughly 16-18 separate steps to decontaminate and remove their PPE[4]. Mistakes or missed steps can lead to infectious material moving from PPE to staff, putting both red zone and green zone staff at risk.

It is advisable to allow multiple staff to be decontaminated and undressed at the same time to reduce the amount of time spent waiting in the Red Zone. The entrance to the undressing area should be shaded to reduce the risk of waiting staff overheating.

The red zone and green zone areas should be clearly marked to ensure that undressing staff do not move into the green zone until they are completely decontaminated. **Mark the boundary line on the floor and use different flooring materials for the red zone and green zone to clearly identify the boundary.**

PPE is split into single use and reusable items – single use items should be placed in red zone waste bins (e.g. 220 litre plastic barrels) at the entrance to the undressing area to be collected by the hygienists and taken to the red zone waste management area. Reusable PPE such as heavy-duty gloves and goggles should be placed in bins of 0.5% chlorine solution on the green zone side so they can be taken to the laundry / drying area for re-use. 0.5% chlorine solution should be available in the red zone area for washing gloved hands after each undressing step, a 0.05% chlorine solution handwashing stand should be available at the boundary to the green zone to allow staff to wash their hands as the final step in the undressing process.

[4] See: WHO (2014) *Personal protective equipment in the context of filovirus disease outbreak response: Rapid advice guideline* Available: http://www.who.int/csr/resources/publications/Ebola/ppe-guideline/en/

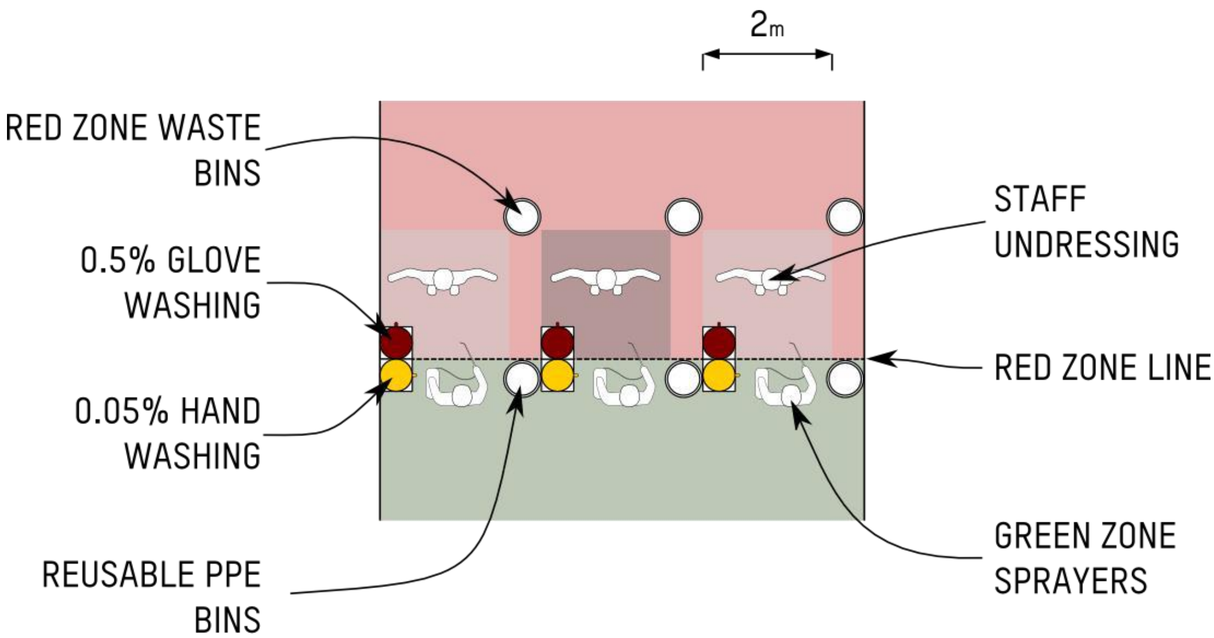


Figure 9 Example layout of PPE undressing area (6.5 x 7.5m)

5.10. Latrines, Showers

Each ward should have its own latrine, which should be gender segregated depending on context and there **should be not more than 5 patients to each latrine**. The cubicle should be large enough for a patient and assistant to move easily without touching the walls (2.5 x 2.5m). Squatting slabs are more hygienic and easily cleaned than seats. Acutely ill patients who are immobile may need to use a bucket toilet, a variant on a disabled person's toilet, or a cholera style bed with bucket emptied by the hygienist team.

Direct drop pit latrines are more appropriate than offset pit or septic tank designs as they are simple to build and do not block. In consolidated soils latrines should be sited at least 30m from any groundwater source, and 1.5m vertically from the highest groundwater level. Comprehensive guidance was developed for the West Africa Ebola outbreak which may be a useful starting point for other responses[5].Latrines should also meet specifications for accessible WASH facilities[6].

Patients in the late stages acute disease may be at risk of collapsing inside toilets and showers, so avoid doors that can be locked from the inside.

5.11. Triage / Screening

The triage area is the admissions area for new patients, screening is important to ensure that suspected cases are isolated, but patients who do not meet the case definition are **not** put at risk by being admitted to the facility. All new patients need to be assessed by trained clinical staff against standardised admission

[5] Sierra Leone Ministry of Water Resources (2014) *Protection of water resources from wastes at and around Ebola care facilities*
[6] See: Handicap International (2008) *Manual #2 - Access to water and sanitation facilities Part 1 – Toilets and closed showers*

criteria (usually the same as the disease case definition). At the triage point the prospective patient will either be admitted to the centre or referred to a more appropriate health service.

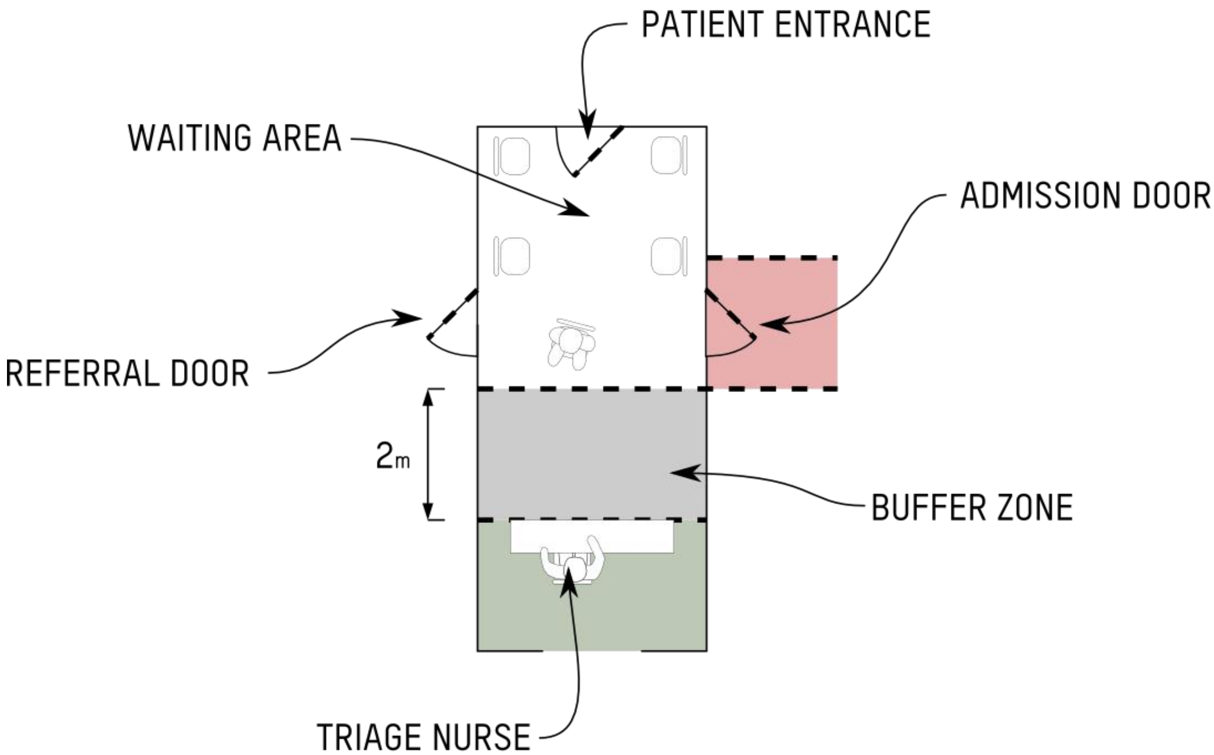


Figure 10 Example layout of triage area (3.5 x 8m)

Screening is carried out without physical contact – the patient and staff should be separated by a physical barrier and buffer zone. The screening staff will be wearing basic PPE and will require a 0.5% chlorine solution for decontamination of reusable PPE and areas for undressing, hand hygiene and waste management. The triage area should have a 2m buffer zone formed by two parallel fences to separate the triage nurse from the patient. Seats should be provided in both sides of the buffer fencing as the triage process can take some time and the patient might be quite unwell. If there are a lot of patients to be screened it might be appropriate to extend the patient side of the triage area to form a small waiting area. In this case chairs should be separated by at least 1m. Access by stretcher for patients who are too unwell to walk should be considered. In this case screening may be carried out with the patient inside an ambulance, or the patient admitted directly to the facility if screening has taken place prior to arrival.

Patients who meet the admission criteria will be admitted directly to the red zone, escorted by staff in full PPE. Patients who do not meet the admission criteria should leave through a separate gate to be referred to other healthcare services. Handwashing facilities should be available for referred patients.

6. Operation and maintenance

Once the site is operational it will require support from WatSan and IPC specialists to ensure that a safe and efficient working environment is maintained. Meetings between medical, IPC and WatSan teams should be held on a daily basis to ensure that issues are raised and resolved as soon as possible. An incident log (see **Annex F**) and issues tracking sheet (**Annex G**) should be used to monitor accidents and requests for changes or repairs. Tracking accidents and issues is important to understand trends and where preventative actions may need to be taken. The sheets can be used as part of briefing each incoming shift of staff so that everyone is kept up to date with any breakdown of equipment and changes to SOPs that have occurred since their last shift.

6.1. Daily operation

Water supply

Batch chlorination should be performed at least daily to ensure the strength of chlorine solutions is maintained. Chlorine concentrations should be tested at the beginning and end of every shift with test strips designed for appropriate concentration levels (see Oxfam logistics catalogue items FCTH[7], FCTEH[8]) and results recorded in a log book shared with the medical team. Results from test strips should be periodically (weekly) confirmed by the WatSan / IPC team lead with digital titration or photometer[9] measurements to ensure that readings are well calibrated. A recent study[10] comparing different methods for measuring chlorine strength recommends digital titration by trained personnel using the HACH digital titrator (8209 method[11]) and chlorine test strips manufactured by Serim (100-750ppm range[12]). Where the 0.5% (5,000ppm) and 0.05% (500ppm) solution strengths are outside of the range that can be tested, accurate dilution will be required to bring the sample into the testable range.

Water use should be quite stable from day to day and so wastage can be reduced by making up only the amount of solution required. Unused chlorine solution should be disposed of before mixing fresh solution and any build-up of sediment washed out.

The water source should be monitored for changes in quality and water level, which should be investigated. Raw water tanks should be kept full as a backup measure in case of water source failure. Backup submersible pumps and spares should be held in stock to enable rapid maintenance.

It is important that the WatSan teams work in coordination with the hygienists and medical teams to ensure that the required quantity of water for disinfection is available before each set of red zone rounds. Sprayers and buckets of 0.5% solution should be filled before starting batch chlorination to ensure there is a supply in case of emergency – batch chlorination should not be carried out while staff are in the red zone as this will stop the supply.

6.2. Maintenance

Maintenance in the red zone should, where possible, be planned in advance in order to reduce the risk to staff. Maintenance staff should be trained on all routine tasks before the centre is opened to ensure they understand the layout of the centre and have the chance to practice working in PPE in a safe environment.

As little work should be carried out in the red zone as possible as the risks are high and tasks are made significantly more difficult by wearing PPE. Replacement parts can be assembled before being taken into the red zone to simplify work.

Daily operation of the site on the IPC/WatSan side will require waste disposal, cleaning and disinfection of red and green zones, monitoring and maintenance of equipment including both WatSan and electrical systems

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[7] https://www.oxfam.org.uk/equipment/catalogue/g/water-testing/test-strips-chl-high
[8] https://www.oxfam.org.uk/equipment/catalogue/g/water-testing/test-strips-chl-Extra-High
[9] For example see Hanna Instruments 'Ultra High Range Chlorine Portable Photometer - HI96771'
[10] Wells E, Wolfe MK, Murray A, Lantagne D (2016) *Accuracy, Precision, Ease-Of-Use, and Cost of Methods to Test Ebola-Relevant Chlorine Solutions*. PLoS ONE 11(5): e0152442. doi:10.1371/ journal.pone.0152442
[11] http://www.hach.com/asset-get.download-en.jsa?id=7639983937
[12] http://www.serim.com/product_detail.aspx?pid=16

and responding to issues as they arise. It is important for the safety of staff working on site that a competent engineer is available at all times to ensure correct use and maintenance of systems and equipment.

7. Decommissioning

Decommissioning of medical isolation facilities may be carried out at the end of the outbreak, or in case the facility is no longer required. Decommissioning should be carried out in coordination with the MoH, local communities and other agencies and should follow national guidelines – the process will require supervision from a suitably qualified IPC specialist. The national guidance issued in Sierra Leone is detailed in **Annex J**.

7.1. General considerations

The safety of staff and the surrounding community, along with the protection of the surrounding environment should be considered when planning the decontamination process. Decommissioning requires coordination, financial resources and adequately trained labour and should be planned in detail before work starts. In general, IPC protocols should remain in place for the duration of the decommissioning process until the site has been signed off as safe by the IPC supervisor. This means that a large part of the work will need to be carried out in full PPE by people who have been trained to work in a red zone.

Virus persistence

Before planning decommissioning it is important to understand how the virus (or other disease causing agent) is able to survive in the environment. **Annex A** shows a summary of evidence on persistence of Ebola Virus on different surfaces. Similar evidence from the other studies should be used in the planning for other diseases, or expert advice sought if this is not available. This will help to decide the length of time that the facility should be closed before decommissioning starts, and how the various materials in the site should be decontaminated.

Environmental protection

During the decommissioning process it is important to be aware of and mitigate against potential environmental contamination, caused by:

- Smoke from burning pits
- Final disposal of chemicals and other wastes
- Ongoing contamination of groundwater resources from latrine pits and other wastes

Responsibilities

It is important to work with all relevant stakeholders to plan, carry out and sign-off the closure, decontamination and decommissioning process. This will include:

- The MoH, WHO and other actors coordinating the epidemic response who will be responsible for ensuring that the number of isolation facilities is sufficient for the outbreak stage.
- The MoH, supported by WHO, CDC and other IPC specialists will be responsible for inspecting and regulating the decommissioning process and validating that this has been carried out as per regulations.
- National environmental health agencies, the ministry of water will be responsible for assigning final disposal sites for landfill and other wastes and approving procedures for closing latrine pits, septic tanks etc.

Staff safety
Where possible use trained labour who are familiar with the construction of the site. Initial terminal cleaning and decontamination should be carried out by the hygienists familiar with regular red and green zone cleaning. Additional training and safety equipment may be needed to ensure that disassembly and demolition are carried out safely. The type of PPE worn by those carrying out decommissioning should be decided by balancing the risks of infection and injury. Whilst terminal cleaning and decontamination should be carried out with standard full PPE, disassembly and demolition requires heavy duty protective clothing including construction helmets, work gloves, safety glasses and hard toed boots. Advice should be sought from IPC specialists on the level of protection required during the final deconstruction phase. Equipment used in the red zone should be carefully monitored, signed in and out at the beginning and end of each shift, both to prevent loss and to ensure appropriate decontamination.

Working in red zone PPE is physically tiring, while range of movement, touch, vision and hearing are all impaired – this significantly increases the risk of injury. The psychological stress of working in a medical isolation facility should also be considered and staff should be closely supervised. Physical exertion should be reduced by limiting shift lengths and closely monitoring working practices.

First aid kits should be readily available on site at all times, along with a designated safety officer (at least one per shift) trained to use it. Additionally, an infection exposure kit should be available containing saline, freshly prepared 0.5% and 0.05% chlorine solutions and 20cc syringes. Any incident which carries a risk of exposure (i.e. a needle-stick injury, contact with bodily fluids, damaged PPE, broken skin etc.) should be treated immediately following accidental exposure SOPs, recorded and referred to a medical care for post-exposure prophylaxis. This does not only relate to potential exposure to Ebola, but for HIV, Hepatitis B, Tetanus and other blood-borne diseases.

Standard safety practices for working at height, or in excavations, working with power tools and other machinery should be followed. Refer to “Oxfam Good Practice guidelines for Health and Safety for work on water, sanitation and shelter projects, 2001” and national health and safety regulations.

Community engagement
As in all phases of construction, community engagement is key to successfully decommissioning a medical isolation facility. It is important to understand and respond to the way the local community feels about the decommissioning process. They may be happy that the facility is no longer needed, or that a potentially dangerous site will be removed, there may also be concern about medical staff leaving and ‘what happens next?’. If existing buildings have been used as part of the facility, there may be fears or beliefs around these buildings being returned to their previous roles.

It is important to communicate the risks that may remain after a site has closed down but before it is decommissioned – materials used for the construction of high risk areas may appear to be valuable and there may be a risk of these being stolen before they can be safely removed. Plans for distribution of durable goods and high value resources during decommissioning should be made clear before the process begins to avoid creating false expectations. It may be useful to hold a meeting with local community representatives before the site is decommissioned to discuss the process, ongoing risks and to address concerns. These meetings should address as a minimum:

- The process and timeline of decommissioning, the risks and precautions that will be taken
- The future use of the site, what long term risks there may be and how these should be reduced
- Where the nearest health facility is and what they should do if they feel unwell

After the site is decommissioned and made safe, a further site visit may be made with local community representatives to address any ongoing concerns. If existing buildings have been used, carrying out repairs, renovations and replacing furniture after final cleaning may help the community to feel confident using the buildings again. Improvements to water sources, power supplies and other services should where appropriate be handed over to the community as part of the programme exit.

7.2. Specific process

The following section provides an overview on decommissioning, for detailed guidance specific to Ebola facilities, see **WHO (2015)** ***Rapid Guidance on the Decommissioning of Ebola Care***.

Preparation

The preparation for decommissioning should begin well in advance of the closure of the site as it involves liaising with various stakeholders and thorough planning. The authorisation for site closure and decommissioning will be provided by the MoH or other coordinating authorities, involving both national authorities and local community leaders in the planning process is critical.

During this phase a provisional plan for the decontamination and disassembly or demolition of the site can be made, by listing all of the structures, equipment and materials at the site and planning for their decontamination and disposal.

Logistics teams should be involved in this planning, both to ensure that the materials and equipment required for decommissioning are available on site and that disposal of inventory is carried out and recorded correctly.

An initial risk assessment should be made based on as-built drawings, an understanding of the site construction and materials inventory, identifying the hazards on site and planning mitigation measures to implement during decommissioning.

Special attention should be paid to hazardous materials, for example water treatment chemicals, medical wastes (sharps, infectious wastes, drugs), hazardous construction materials and latrine sludge. Disposal plans for hazardous materials should follow national guidance (see also **Oxfam TBN18: Hazardous Waste**)

The human and financial resources required should be planned and scheduled during the preliminary planning phase.

Terminal cleaning and decontamination

Terminal cleaning of all areas should take place as soon as the final patient is discharged and before the centre is closed. All loose materials in the red zone should be disposed of following red zone SOPs (i.e. by burning or decontamination in 0.5% chlorine solution).

There is likely to be a significant amount of material to be incinerated or burned during the decontamination and decommissioning process – it may be required to increase the size of the red zone waste disposal area by digging a new burning pit and extending the red zone fences to include this area.

Once all loose materials and equipment in the red zone has been disposed, the site should be thoroughly cleaned, initially with soap and water to remove visible soiling, followed by disinfection with 0.5% chlorine solution. Cleaning should proceed following standard red zone SOPs, observing flow from clean to dirty areas to avoid contamination. Materials that cannot be effectively disinfected with high strength chlorine should be removed and burned.

Inspection and risk assessment

After the terminal cleaning has been completed, a detailed inspection and risk assessment should be conducted by the WatSan and IPC specialists in order to finalise the provisional decommissioning plan and to update the risk assessment. This inspection should identify any specific hazards that were not already anticipated, with special attention paid to damaged structures and hazardous wastes.

The final decommissioning plan should be updated based on the results of this inspection and will include a detailed scope of works for each area and a disposal protocol for the disposal of all materials on site. This plan may need to be approved by national authorities, in any case any major changes to the plan should be communicated to relevant authorities, the local community and all staff involved in the decommissioning.

Disassembly / Demolition

After thorough decontamination and planning, temporary structures on site can be removed according to the national guidelines. Particular attention should be paid to latrines, septic tanks, medical waste pits, grey water soakaways and solid waste pit, which pose particular risks. In general, latrines should be decommissioned as normal – treating with lime and backfilling pits to at least 0.5m. Medical waste pits and burning pits should be sealed with concrete slurry before backfilling in order to reduce the risk from disposed sharps. Water networks, especially those used for chlorine solutions, should be left intact if appropriate and useful in the future. See **Annex M** for an example chronological decommissioning plan.

Final site works

Once the site has been made safe ensure that a site plan is made indicating the location of waste disposal pits, decommissioned latrines, soakaways etc. for the land owner and national authorities. Final inspection and sign-off should be made with national authorities and the IPC lead.

8. Further reading

8.1. Decommissioning:

Government of Sierra Leone Ministry of Health and Sanitation, 2015. *Standard Operating Procedures on the decontamination of Ebola Care Centres (ECCs).*

Ground Truth Sierra Leone, 2015. *Decontamination and the Ebola response*.

World Health Organization, 2015. *Decommissioning considerations: IPC and WASH*.

World Health Organization, 2015. *Rapid Guidance on the decommissioning of Ebola Care Facilities*.

World Health Organization, 2015. *Checklist for terminal cleaning and decontamination of Ebola Facilities*.

8.2. Disinfection:

Eggers, M. et al., 2015. *Povidone-iodine hand wash and hand rub products demonstrated excellent in vitro virucidal efficacy against Ebola virus and modified vaccinia virus Ankara, the new European test virus for enveloped viruses*. BMC infectious diseases, 15, p.375. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4574578&tool=pmcentrez&rendertype=abstract

Hopman, J. et al., 2015. *Efficacy of chlorine solutions used for hand hygiene and gloves disinfection in Ebola settings: a systematic review*. Antimicrobial Resistance and Infection Control.

Iqbal, Q. et al., 2016. *Shelf-Life of Chlorine Solutions Recommended in Ebola Virus Disease Response*. PLoS ONE, 11(5).

Lantagne, D., 2014. *Methods to Make Chlorine Solution in Ebola Emergencies*,

Wells, E. et al., 2016. *Accuracy, precision, ease-of-use, and cost of methods to test Ebola-relevant chlorine solutions*. *PLoS ONE*, 11(5).

Wolfe, M.K. et al., 2016. Seeking Clearer Recommendations for Hand Hygiene in Communities Facing Ebola: A Randomized Trial Investigating the Impact of Six Handwashing Methods on Skin Irritation and Dermatitis. *Plos One*, 11(12), p.e0167378-. Available at: http://dx.doi.org/10.1371%2Fjournal.pone.0167378.

8.3. Ebola clinical:

Bociąga-Jasik, M., Piątek, A. & Garlicki, A., 2014. Ebola Virus Disease — Pathogenesis, Clinical Presentation and Management. *Folia Medica Cracoviensia*, Liv, pp.49–55.

Bray, M., 2014. Epidemiology, pathogenesis, and clinical manifestations of Ebola and Marburg virus disease. *Wolters Kluwer*, pp.2006–2009.

World Health Organization, 2014. Case definition recommendations for Ebola or Marburg virus diseases. , (August), pp.1–3.

8.4. Ebola persistence:

Bausch, D.G. et al., 2007. Assessment of the risk of Ebola virus transmission from bodily fluids and fomites. *The Journal of infectious diseases*, 196 Suppl(Supplement_2), pp.S142-7. Available at: http://jid.oxfordjournals.org/content/196/Supplement_2/S142.full.

Bibby, K. et al., 2015. Ebola Virus Persistence in the Environment: State of the Knowledge and Research Needs. *Environmental Science and Technology Letters*, 2(2), pp.2–6.

Bibby, K. et al., 2015. Persistence of Ebola Virus in Sterilized Wastewater. *Environmental Science and Technology Letters*, 2(9), pp.245–249.

Cook, B.W.M. et al., 2015. Evaluating environmental persistence and disinfection of the Ebola virus Makona variant. *Viruses*, 7(4), pp.1975–1986.

Cook, B.W.M. et al., 2016. The Disinfection Characteristics of Ebola Virus Outbreak Variants. *Scientific Reports*, 6, p.38293. Available at: http://www.nature.com/articles/srep38293.

Fischer, R. et al., 2015. Ebola Virus Stability on Surfaces and in Fluids in Simulated Outbreak Environments. *Emerging infectious diseases*, 21(7), pp.1243–6. Available at: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4480404&tool=pmcentrez&rendertype=abstract.

Hopman, J. et al., 2015. Efficacy of chlorine solutions used for hand hygiene and gloves disinfection in Ebola settings: a systematic review. *Antimicrobial Resistance and Infection Control*, 4, p.O13.

Janvier, F. et al., 2016. Ebola virus RNA stability in human blood and urine in West Africa's environmental conditions. *Emerging Infectious Diseases*, 22(2), pp.292–294.

Prescott, J. et al., 2015. Postmortem stability of Ebola virus. *Emerging Infectious Diseases*, 21(5), pp.856–859.

Schuit, M. et al., 2016. Differences in the comparative stability of Ebola virus makona-c05 and yambuku-mayinga in blood. *PLoS ONE*, 11(2).

Smither, S. et al., 2016. Effectiveness of four disinfectants against Ebola virus on different materials. *Viruses*, 8(7).

Youkee, D. et al., 2015. Assessment of Environmental Contamination and Environmental Decontamination Practices within an Ebola Holding Unit, Freetown, Sierra Leone. *PLoS ONE*, 10(12).

8.5. Environmental protection:

Government of Sierra Leone Ministry of Water Resources, 2014. *Protection of water resources from wastes at and around Ebola & care facilities.*,

Lapworth D J, Carter R C, Pedley S & Macdonald A M. 2015. Threats to groundwater supplies from contamination in Sierra Leone, with special reference to Ebola care facilities. *British Geological Survey Open Report*, OR/15/009. 87pp.

8.6. Isolation centres general:

ICAP, 2015. *Rapid Mixed Methods Assessment of the Ebola Community Care Center Model in Sierra Leone*,

King's Sierra Leone Partnership, 2014. *A Guide for the Establishment & Supervision of Ebola Holding Units*,

Oosterhoff, P., Mokuwa, E.Y. & Wilkinson, A., 2015. Community-Based Ebola Care Centres A formative evaluation. *Ebola Response Anthropology Platform*. Available at: http://www.Ebola-anthropology.net/case_studies/community-based-Ebola-care-centres-a-formative-evaluation/.

Sterk E. Médecins Sans Frontières—Filovirus Haemorrhagic Fever Guideline. 2008. Available: http://jid.oxfordjournals.org/content/204/suppl_3/S791.full

UNICEF, 2014. *WASH Package for Ebola Care and Treatment Centres / Units: Guidance Note*, UNICEF. Available at: http://reliefweb.int/report/liberia/wash-package-Ebola-care-and-treatment-centresunits-guidance-note.

World Health Organization, 2014. *Key considerations for the implementation of an Ebola Care Unit at community level*,

World Health Organization, 2015. Manual for the care and management of patients in Ebola Care Units/ Community Care Centres. , (January), pp.5–40. Available at: http://www.who.int/csr/resources/publications/Ebola/patient-care-CCUs/en/.

World Health Organization, 2016. *Clinical management of patients with viral haemorrhagic fever. A pocket guide for front-line health workers*, Geneva. Available at: http://apps.who.int/iris/bitstream/10665/205570/1/9789241549608_eng.pdf?ua=1.

World Health Organization & UNICEF, 2014. *Ebola Virus Disease (EVD): Key questions and answers concerning water, sanitation and hygiene*,

8.7. Infection Prevention and Control:

Atkinson, J. et al., 2009. Natural Ventilation for Infection Control in Health-Care Settings. *World Health Organization*, p.133 p. Available at: http://whqlibdoc.who.int/publications/2009/9789241547857_eng.pdf.

Bell, M. et al., 2008. Report of the second meeting, Informal Network on Infection Prevention and Control in Health Care, Geneva, Switzerland, 26-27 June 2008. In *Second Meeting Informal Network on Infection Prevention and Control in Health Care*. p. 33. Available at: http://apps.who.int/iris/handle/10665/69982%5Cnhttp://apps.who.int/iris/bitstream/10665/69982/1/WHO_HSE_EPR_2009.1_eng.pdf?ua=1.

Centers for Disease Control and Prevention, 2015. Infection prevention and control recommendations for hospitalized patients under investigation (PUIs) for Ebola Virus Disease (EVD) in U.S. hospitals. *U.S. Centre for Disease Control and Protection (CDC)*. Available at: http://www.cdc.gov/vhf/Ebola/healthcare-us/hospitals/infection-control.html.

Centers for Disease Control and Prevention & World Health Organization, 1998. *Infection Control for Viral Haemorrhagic Fevers in the African Health Care Setting.*, Atlanta. Available at: http://www.cdc.gov/vhf/abroad/pdf/african-healthcare-setting-vhf.pdf.

Günther, S. et al., 2011. Management of accidental exposure to Ebola virus in the biosafety Level 4 Laboratory, Hamburg, Germany. *Journal of Infectious Diseases*, 204(SUPPL. 3), pp.785–790.

Pittet, D., Allegranzi, B. & Boyce, J.M., 2009. *The World Health Organization Guidelines on Hand Hygiene in Health Care and their consensus recommendations.*, Available at: http://www.ncbi.nlm.nih.gov/pubmed/19508124.

UNICEF, 2015. *Ebola Virus Disease : Personal Protective Equipment , UNICEF Specifications*,

World Health Organization, 2014. *Interim Infection Prevention and Control Guidance for Care of Patients with Suspected or Confirmed Filovirus Haemorrhagic Fever in Health-Care Settings , with Focus on Ebola*, Geneva. Available at: http://apps.who.int/iris/bitstream/10665/130596/1/WHO_HIS_SDS_2014.4_eng.pdf?ua=1&ua=1&ua=1.

World Health Organization, 2014. Ebola guidance package Infection prevention and control (IPC) Guidance Summary. *WHO/EVD/Guidance/IPC/14.1*, (August), pp.1–5.

World Health Organization, 2004. Practical guidelines for infection control in health care facilities. *SEARO Regional Publication*. Available at: http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Practical+Guidelines+for+Infection+Control+in+Health+Care+Facilities#0.

World Health Organization & International Labour Office, 2014. Ebola Virus Disease : Occupational Safety and Health.

8.8. Lessons Learned:

Bayntun, C. & Zimble, S.A., 2016. Evaluation of the OCG Response to the Ebola Outbreak Lessons learned from the Freetown Ebola Treatment Unit , Sierra Leone. , (April).

Gates, B., 2015. The Next Epidemic — Lessons from Ebola. *New England Journal of Medicine*, 327(15), pp.1381–1384.

Médecins sans Frontières, 2015. *Pushed to the Limit and Beyond*, Available at: http://www.msf.org.uk/sites/uk/files/Ebola_-_pushed_to_the_limit_and_beyond.pdf.

Medicos Del Mundo, 2015. *Sierra Leone Ebola Mission Report*,

8.9. Social factors:

Boscarino, J.A. & Adams, R.E., 2015. Assessing community reactions to Ebola virus disease and other disasters: Using social psychological research to enhance public health and disaster communications. *International Journal of Emergency Mental Health*, 17, pp.234–238.

Ebola Response Anthropology Platform, 2014. Emergency Ebola Anthropology Network Advisory Brief: Culture and Clinical Trials. , pp.1–4.

Grant, C. et al., 2014. *Helpdesk Report: Ebola- local beliefs and behaviour change*,

Oosterhoff, P. & Wilkinson, A., 2013. Local Engagement in Ebola Outbreaks and Beyond in Sierra Leone. *Ids Practice Paper in Brief*, (September). Available at: http://opendocs.ids.ac.uk/opendocs/bitstream/handle/123456789/5857/ID565 Online.pdf?sequence=1.

8.10. Transmission:

Boone, S.A. & Gerba, C.P., 2007. Significance of fomites in the spread of respiratory and enteric viral disease. *Applied and Environmental Microbiology*, 73(6), pp.1687–1696.

Judson, S., Prescott, J. & Munster, V., 2015. Understanding Ebola virus transmission. *Viruses*, 7(2), pp.511–521.

Olu, O. et al., 2015. Epidemiology of Ebola virus disease transmission among health care workers in Sierra Leone, May to December 2014: a retrospective descriptive study. *BMC infectious diseases*, 15(1), p.416. Available at: http://www.biomedcentral.com/1471-2334/15/416.

8.11. WASH in Health care:

Adams, J. et al., 2008. Essential environmental health standards in health care. *World Health Organization*, p.57. Available at: http://www.who.int/water_sanitation_health/hygiene/settings/ehs_hc/en/.

Centers for Disease Control and Prevention, 1996. Guidelines for Water, Sanitation and Hygiene in Cholera Treatment Centres.

Handicap International, 2008. Manual 2 - Access to water and sanitation. In *HOW TO BUILD AN ACCESSIBLE ENVIRONMENT IN DEVELOPING COUNTRIES*.

Médecins sans Frontières, 2010. *Public Health Engineering in Precarious Situations* 2nd ed.,

8.12. Health care waste management:

Chartier, Y. et al., 2014. *Safe management of wastes from health-care activities*,

Edmunds, K.L. et al., 2016. Disposal of waste contaminated with Ebola virus Recommendations for dealing with waste contaminated with Ebola virus: a Hazard Analysis of Critical Control Points approach. , (January), pp.1–17.

Emmanuel, J. & Ndoye, B., 2015. *Assessment and Recommendations Regarding Management of Ebola-Contaminated Waste*,

Government of Sierra Leone Ministry of Health and Sanitation, 2015. *Waste management at Ebola care facilities*,

UNICEF, 2014. Ebola Virus Disease: Waste Management Guidance UNICEF Supply Division Ebola Virus Disease (EVD): Waste Management Guidance.

World Health Organization, 2005. Management of solid health-care waste at primary health-care centres: a decision-making guide.

ANNEXES

- **A. Ebola persistence studies**
- **B. Characteristics of infectious disease**
- **C. Example SOPs for working in Ebola Centres**
- **D. Example MoU for temporary closure of Ebola centre for maintenance**
- **E. Guidelines for staff supporting Ebola centres**
- **F. Example incident reporting format**
- **G. Example Ebola centre issues tracking sheet**
- **H. Example isolation facility organigram**
- **I. Example isolation facility decommissioning plan**
- **J. Rapid Isolation kit equipment and supplies**
- **K. Example 12 bed medical isolation centre plans**