TECHNICAL DOCUMENT

Critical aspects of the safe use of personal protective equipment

A training tutorial for healthcare professionals

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This report of the European Centre for Disease Prevention and Control (ECDC) was coordinated by Jeannette de Boer and Carmen Varela Santos.

Authors
Cesar Velasco Muñoz, Jeannette de Boer, Louise van Kranendonk, Carmen Varela Santos, Cornelius Bartels (lead content author).

Contributing experts
Åsa Björndal and Tuija Koivula, Folkhälsomyndigheten, Sweden; Norbert Gresser, Missionsärztliches Institut Würzburg, Germany; Aftab Jasir, Diamantis Plachouras, Vladimir Prikazsky and Carl Suetens (all ECDC)

Photos
Federico Tonozzi, ECDC

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Abbreviations

CDC	US Centers for Disease Control and Prevention
CBRN	Chemical, biological, radiological and nuclear
ECDC	European Centre for Disease Prevention and Control
EVD	Ebola virus disease
FFP	Filtering face piece
HCW	Healthcare worker
IDHC	Infectious diseases of high consequence
PAPR	Powered air-purifying respirator
PPE	Personal protective equipment
WHO	World Health Organization

1 Introduction

The ongoing Ebola epidemic demonstrates that the risk of transmission to healthcare workers (HCWs) is not limited to the worst affected West African countries. It also underscores the relevance of staff safety and protection.

This ECDC tutorial presents the fundamental concepts of personal protective equipment (PPE) and barrier nursing to support preparedness in hospitals across Europe. It provides practical information on the proper use of PPE at the point of care, including technical requirements and procurement aspects.

Furthermore, it aims to strengthen preparedness and capacities for the safe use of PPE in hospitals in Europe and other countries with equivalent standards in health care.

Scope

The scope of the tutorial is improving the protection of staff dealing with infectious diseases of high consequence (IDHC). Therefore it does not exclusively target current risks from viral haemorrhagic fevers but also strengthens hospital preparedness for future health threats posed by novel pathogens.

The focus of this publication is on an extended set of PPE components, which includes goggles, respirators, gloves, coveralls and footwear. Used properly, these PPE components can provide effective protection even from airborne transmission. The issues covered by this document start with procurement and technical requirements as mandated by EU regulation, followed by critical aspects and known pitfalls in the donning and doffing of PPE. As effective staff protection never depends on the protective equipment alone, the tutorial also identifies operational basics of barrier management and nursing, including waste management, disinfection and incident management.

To increase the safety of HCWs, regular in depth training in the use of PPE needs to be understood as an integral part of hospital preparedness. Additional challenges for hospital preparedness lie in the fact that the daily routine procedures in a hospital are heavily affected by only a single case of an IDHC and that a large number of the workforce will be drawn in to this extended environment.

Aim

This tutorial aims to strengthen preparedness and capacities for the safe use of PPE in hospitals in Europe and other countries with equivalent standards in healthcare.

Target audience

- Professionals in infection control and hygiene in hospitals
- Trainers in the topic of infection control and hygiene in hospital settings
- Hospital managers in charge of administration, nursing and occupational health and safety
- Emergency planning managers (hospital emergency preparedness)
- Experts in preparedness planning at the regional and national levels

Learning objectives

- To know the technical requirements when procuring PPE for IDHC
- To become aware of the critical aspects and known pitfalls when using PPE for IDHC
- To understand basic aspects of occupational health and safety with regard to the use of PPE

How to use this tutorial

This tutorial is a 'living' document: This means that ECDC aims to expand, update, and revise the current version based on further scientific evidence and feedback from practitioners in the field.

However, it can only support, but never replace, practical training and regular refresher courses held by experienced PPE instructors.

Methodology

In light of the current Ebola outbreak, recommendations need to carefully balance between a state-of-the-art scientific approach (evidence-based medicine) and the demands of an ongoing emergency.

A dedicated team of ECDC experts developed this document jointly, by combining their expertise on training, clinical medicine, infection control and preparedness.

Additional sources included documents on the use of PPE for the care of Ebola patients, released by international organisations and European public health institutes.

The team also analysed guidelines and training materials from WHO, US CDC, and Médecins sans Frontières.

Furthermore, the team was supported throughout the process by external experts on barrier nursing, hospital infection control, and bio-risk management. A comprehensive video on the use of PPE produced by the Robert Koch Institute (Germany) and a textbook on biohazards[i] provided helpful examples of existing good practice.

[i] Robert Koch Institut und Bundesamt für Bevölkerungsschutz und Katastrophenhilfe. Biologische Gefahren. Handbuch zum Bevölkerungsschutz. Third edition. Bonn 2007. Available from: http://www.bbk.bund.de/SharedDocs/Downloads/BBK/DE/Publikationen/PublikationenForschung/BioGef-I_3Auflage.pdf

2 Staff safety starts with procurement

Procurement decisions in most hospitals are strongly driven by budgetary considerations. Unsurprisingly, this applies in particular to measures which are commonly considered as preparedness for incidents of high impact but of low probability. Staff protection for infectious diseases of high consequence (IDHC) often falls into this category.

On the other hand, prudent procurement is crucial for the safety of HCWs in hazardous biological environments. This requires that hospital planners know the technical requirements and have a clear concept of which PPE components work best in a specific hospital setting. Even more important is an understanding that national and European ('EU Directive 2000/54/EC on Biological Agents[i]) regulations oblige employers to provide appropriate protection for employees working in hazardous biological environments.

From the very beginning, staff – especially HCWs – need to be included in all relevant procurement considerations. Different types, sizes and shapes of PPE components need to be available in order to ensure a secure fit of the PPE. These principles may become compromised if procurement for PPE is guided exclusively by economic considerations.

Procurement of PPE for IDHC also needs to be done in good time. Experiences from the H1N1 influenza in 2009 show that purchasing substantial amounts of PPE can be difficult because PPE demands can exceed supplies during an outbreak of global dimensions.

Once purchased, PPE needs to be stored properly (proper environmental conditions, shelf life specified by the manufacturer). This is critical because equipment damage or failure due to improper storage can lead to exposure.

Key message

- Staff safety starts with proper procurement!

[i] Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work (seventh individual directive within the meaning of Article 16(1) of Directive 89/391/EEC). Official Journal of the European Union. OJ L 262, 17.10.2000, p. 21–45. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0054

3 PPE components for infectious diseases of high consequence

Infectious diseases of high consequence (IDHC) are serious threats to human health. Patients develop severe symptoms, require a high level of care, and the case–fatality rates are high. Often, there is no specific prophylaxis or treatment available. IDHC are transmissible from human to human (contagious). Depending on the transmission mode (e.g. by droplets or airborne) and their infectivity, they can generate large-scale epidemics (e.g. Ebola in West Africa) or even pandemics (e.g. the Spanish influenza pandemic in 1918 or the H1N1 influenza pandemic in 2009).

Staff protection with PPE and the isolation of contagious patients are the two main principles to keep healthcare facilities functional and contain the risk for both HCWs and the community.

The setup of PPE required for IDHC goes beyond normal transmission-based hospital precautions. The rationale is to create an extended margin of safety for staff by anticipating unplanned high-exposure situations. For example, droplet precautions are commonly seen as sufficient for HCWs involved in the treatment of EVD patients. However, enhanced treatment settings involve continuous close contact with EVD patients, resulting in the potential exposure to aerosols, for example during intubation or while the patient is vomiting. Consequently, PPE should always include additional protection against airborne transmission.

The standard components for this treatment setting include respiratory protection, eye protection, hand protection, body protection, and foot protection.

Regulatory framework for body protection: relevant EU occupational health and safety regulations

Council Directive 89/391/EEC of 12 June 1989[i], usually referred to as the Occupational Safety and Health 'Framework Directive', introduces a set of general measures to encourage improvements in the safety and health of workers by imposing basic obligations on employers and workers, emphasising the responsibility of the employer. Particularly relevant is Directive 89/656/EEC[ii], which lays down minimum requirements for personal protective equipment to be used by employees at work. Directive 2000/54/EC[iii] specifically refers to minimum requirements for the health and safety of workers exposed to biological hazards at work.

If EU Member States have carried out the transposition of the relevant Directives into national law, further details with regard to protective equipment may be contained in national legislation.

PPE should comply with the EU legislation, and compliance is indicated either directly by the 'CE' symbol on the PPE, or by means of European Harmonised Standards, which confer a presumption of conformity to the essential health and safety requirements[iv].

The harmonised standard 'EN 14126:20035' adopted under Directive 89/686/EEC[v] describes the performance requirements and testing methods for protective clothing against infective agents. Most of the descriptions in the Directive refer to exposures in traditional occupational settings, for example in the chemical industry.

[i] Council Directive 89/391/EEC of 12 June 1989 on the introduction of measures to encourage improvements in the safety and health of workers at work. Full text of the consolidated version of the Directive (including later amendments) available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:01989L0391-20081211

[ii] Council Directive 89/656/EEC of 30 November 1989 on the minimum health and safety requirements for the use by workers of personal protective equipment at the workplace (third individual directive within the meaning of Article 16 (1) of Directive 89/391/EEC). Full text of the consolidated version of the Directive (including later amendments) available from: http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:01989L0656-20070627

[iii] Directive 2000/54/EC of the European Parliament and of the Council of 18 September 2000 on the protection of workers from risks related to exposure to biological agents at work (seventh individual directive within the meaning of Article 16(1) of Directive 89/391/EEC). Official Journal of the European Union. OJ L 262, 17.10.2000, p. 21–45. Available from: http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0054

[iv] A list of harmonised standards is available from: http://ec.europa.eu/enterprise/policies/european-standards/harmonised-standards/personal-protective-equipment/index_en.htm

[v] Council Directive 89/686/EEC of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment. Official Journal of the European Union. OJ L 399, 30.12.1989, p. 18–38. Available from: http://eur-lex.europa.eu/legal-content/en/ALL/?uri=CELEX:31989L0686

Table 1. European quality norms for protective clothing referenced in EN14126:20035

Type	Description	Relevant standard
1a-B, 1b-B, 1c-B	Gas tight	EN 943-1:2002, EN 943-2:2002
2-B	Non gas tight	EN 943-1:2002, EN 943-2:2002
3-B*	Protection against pressurised liquid chemicals	EN 14605:2005 + A1:2009
4-B	Protection against liquid aerosols (spray tight)	EN 14605:2005 + A1:2009
5-B	Protection against airborne solid particulates	EN ISO 13982-1:2004+ A1:2010
6-B	Limited protection against liquid chemicals (light spray)	EN 13034:2005 + A1:2009

** Consider level 3-B for handling confirmed and probable cases of haemorrhagic fever.*

The appropriateness of protective clothing for hazardous biological environments is described analogous to resistance to chemical exposure. The 'B' following the type class number (classes 1 to 6) indicates that the material is also certified for various types of biological exposure.

Clothing material certified for Type 3-B ('Protection against pressurised liquid chemicals') is seen as an effective barrier for various types of biological exposure including aerosols and small particles such as viruses or spores. Furthermore, Type 3-B protection is resistant to chemicals used in enhanced decontamination procedures, as carried out, for example, in specialised treatment centres.

Functional details

However, the type class assigned to protective clothing in EN14126:20035 does not define functional details, such as taped seams, attached hoods, or covered zippers. Therefore, these specifications need to be checked and specified in the procurement process.

Essential features for single-use coveralls for infectious diseases of high consequence include a splash-proof cover of the entry/exit zipper of the coveralls and an incorporated hood.

An integrated foot cover may be advantageous, especially in hospital settings because they can be easily combined with clogs, which are already widely used in surgical or intensive care departments.

Integrated gloves are an additional option but potentially limit the choices for adapting the hand protection to certain activities such as patient procedures or waste management.

Dedicated, removable hoods covering head and shoulders are increasingly used as an alternative to the integrated hood of the coveralls. The potential benefits of this approach need to be investigated further.

In this section we describe the prerequisites for standard PPE components in the treatment of IDHC. A sample checklist for materials is provided in Annex 1.

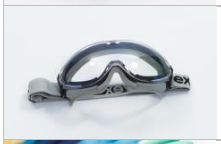
Did you know?

All the materials listed in Table 2 – except for the boots, clogs and scrubs – are single-use, disposable materials, so they need to be disposed of following the established procedures for highly infectious waste.

Cleaning, disinfecting, and re-conditioning of reusable PPE components is labour-intensive and often requires specific equipment not found in standard hospital settings.

Most PPE components come in different sizes. There is no one-size-fits-all principle, which does not come as a surprise because a good fit and a tight seal are essential for the protective functions of many PPE components.

Table 2. PPE and waste management material list

	Material	Specifiable aspects
	Respirators	Different sizes and models; FFP3 and FFP2 (US occupational safety and health standards: N99 and N95)
	Goggles	Different sizes and models; anti-fog coating; no or covered ventilation openings preferred
	Heavy duty gloves	Different sizes and materials
	Gloves	Different sizes, materials and models; latex and nitrile; sterile (medical interventions) and non-sterile (nursing)
	Coveralls	Different sizes; single-use (disposable); integrated hood; fluid- and particle-proof; zipper covered by adhesive flaps
	Hospital scrubs	Different sizes
	Cotton socks	Different sizes
 	Clogs or boots	Different sizes, preferable with non-slip soles; mark or colour-code clogs or boots if only for use in specific areas (e.g. in the patient treatment zone = 'red zone')
	Boot covers	Fluid-proof; have to be mechanically resistant if used as outer cover; non-slip soles are preferable

	Material	Specifiable aspects
	Shoe covers	Non-slip soles are preferable
	Hand disinfectant	Placed at the point of care, in donning and in the doffing areas
	Hair covers	Different models
	Waste management material	Big, leak-proof waste bag for solid infectious waste and clearly-labelled leak-proof bags or containers for linen
		Leak-proof container for solid infectious waste
		Container for sharp, pointed objects (e.g. needles, syringes, glass articles, tubing, etc.)
	Adhesive tape to use with PPE	Tape without textile layer is preferred; quality parcel tape or chemical resistant tape works fine
	Apron	Single-use, disposable aprons

Did you know?

An often underestimated risk factor for PPE users is the poor fit of PPE components. Coveralls, respirators, goggles, gloves and boots should always come in a variety of sizes.

Knowing your staff is critical for a meaningful procurement process.

3.1 Body protection

Coveralls

The coveralls of the PPE ensemble have to be particle-tight and fluid-proof. The zipper of the coveralls needs to be covered by a particle-tight and splash-proof strip or flap.

Most coveralls come with an integrated hood. If not, a separate hood for covering head and shoulders is essential.

The PPE needs to fit the height and posture of the user. The PPE user must be able to move around freely without the coveralls being displaced and giving room for fluids to enter the coveralls.

Helpful hint

- A PPE user needs to test if the coveralls fit by kneeling down and lifting the arms when fully covered by the PPE ensemble. This should be done before entering a contaminated work zone.

Did you know?

Some PPE coveralls come with loops to hold the sleeves in position, thus preventing the sleeves from moving up and showing gaps between glove and coveralls while working.

Never use the finger loop over the inner pair of gloves, because they will be contaminated while doffing. There is no good rationale for accepting this additional risk for secondary contamination.

Some coveralls have integrated foot parts, which simplifies the donning and doffing process because the PPE user can easily remove boots or clogs when leaving the contaminated area. The clogs or boots can then stay behind, which facilitates waste management and the disinfection process for clogs/boots.

Hair covers

Hair covers should be worn under the hood of the coveralls to prevent hair from hanging out, where it can get easily contaminated with bodily fluids from the patient. This also prevents the hair from sticking to the flaps and the tape.

If different types of hair covers are available, the PPE user can check which hair cover provides a better fit.

Helpful hint

- Ponytails or tying back hair with elastic straps under the hair cover can be uncomfortable while working in the PPE.

3.2 Foot protection

There are two options for foot protection: Boots or clogs. Both have advantages and disadvantages.

Boots

Boots are usually made of robust, waterproof material. This also increases the protection from sharp objects like needles and syringes. Boots are the foot protection of choice for heavy-duty tasks and any outside activity.

If boots will be reused they need to be cleaned, disinfected and reconditioned after use. For this option, the boots must be made from a chemical resistant material.

Boots can be used in combination with different boot covers.

Rubber clogs

Clogs should be used in combination with complete boot covers or coveralls with integrated foot sections. Boot covers can be used inside the clogs, provided that they get taped to the coverall legs. This prevents fluids reaching and contaminating the feet of HCWs. Choose clogs that are resistant to water and disinfectants.

Helpful hint

- Consider using different coloured clogs for the different zones (green, yellow and red) (see Section 8.2, Table 5). This way it is easy to recognise which clogs to wear when donning and doffing.

Benefits and limitations of boots covers

If the coveralls have no integrated foot section, clogs need to be used in combination with boot covers to prevent the contamination of feet.

Using boot covers is optional when wearing boots. If boots are covered, disinfection is easier. On the other hand, not using covers provides a better grip to the floor and can prevent falls.

Using boot covers can simplify the cleaning process because it protects the surface of the boot from contamination through splashing, at the cost of an increased risk of slipping. Boot covers also potentially complicate the donning and doffing procedures.

Helpful hints

- Boot covers can be used as a sock when worn under the PPE coveralls. Tape the PPE coveralls to the boot cover. This makes removal easier.
- Using an extra outer shoe cover with an anti-slip treatment can help to avoid accidents. (See blue shoe cover in the photo.)
- Bear in mind that any additional component used in PPE, potentially also adds to the complexity in the donning and doffing process!


The choice of coveralls (i.e. with or without integrated foot section) determines how boots, clogs and shoe covers can be best combined. See Table 3 below.

Table 3. Choosing the right footwear for the type of coveralls selected

Coveralls with integrated foot section		Coveralls *without* integrated foot section	
			
Combined with:		Combined with:	
Boots	Clogs	Boots	Clogs*
			

** In a clinical setting, only coveralls with an integrated foot section can be combined with clogs. If your coverall does not come with integrated foot sections, use separate boot covers instead and tape them to the coverall legs.*

Helpful hints

- Consider providing the PPE user with single-use cotton socks to improve working conditions.
- Boots or clogs should be chosen at least two sizes bigger than normal due to thick layers of cotton socks and integrated foot sections. PPE users should be able to easily slip in and out of their boots or clogs.

3.3 Hand protection

The choice of gloves always needs to balance tactility (e.g. for medical interventions) and the level of protection (defined by mechanical resistance).

PPE users should always use a minimum of two pairs of gloves.

- Inner pair of gloves: covering the skin ('like a second skin')
- Outer pair of gloves: gloves on top of gloves ('working gloves')

Gloves are available in different thicknesses, textures, materials, colours and qualities. PPE users should consider the use of different gloves depending on the exposure risk associated with the planned intervention. Glove combinations adapted to specific tasks improve safety and provide the desired tactility or the needed robustness.

Helpful hints

- Check that the gloves are not outdated as this will compromise their integrity. If possible, provide different colours to differentiate inner and outer gloves.

- Latex gloves may not be the only option provided, as allergies are a common issue in healthcare settings. Nitrile gloves, although less flexible, are a good alternative.

Different types of gloves

Light latex or nitrile gloves	Intermediate thickness	Heavy duty gloves

Helpful hints

Inner gloves

- A glove of intermediate thickness works well as an inner layer.
- Consider gloves with extended cuffs as they cover a larger section of the coverall sleeves.
- Ideally, the inner pair of gloves should have a longer sleeve than the outer pair of gloves. This makes it easier to change gloves.

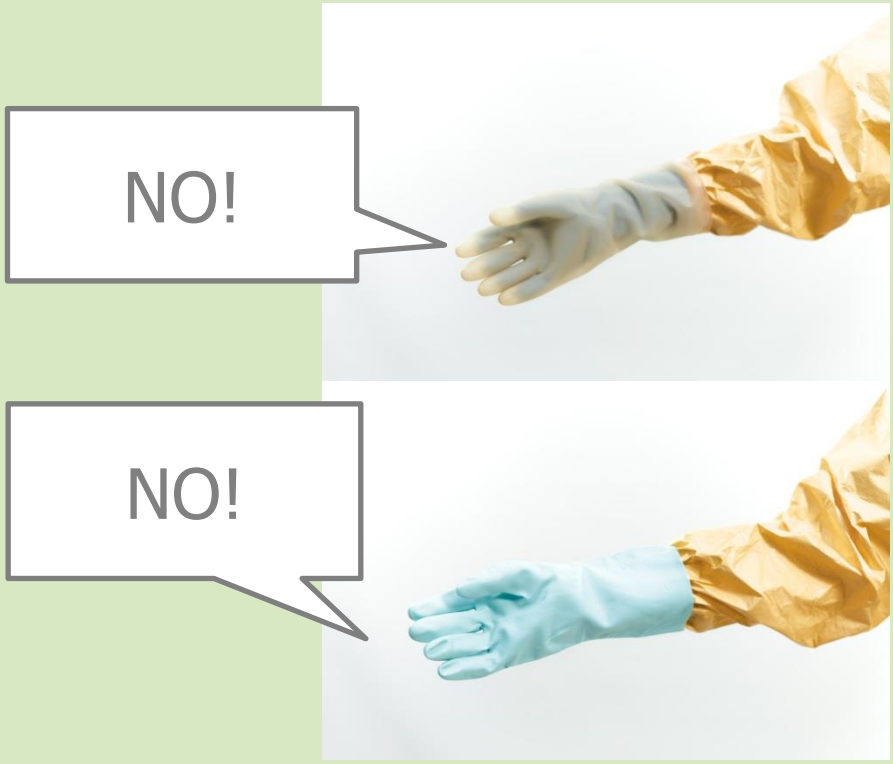
The outer pair of gloves should be adapted to the tasks that the PPE user has to perform. Consider the combinations shown below:

Different combinations of inner and outer gloves		
		
Inner gloves + outer nursing gloves: For patient care	Inner gloves + outer surgical gloves (sterile if required): For medical interventions	Inner gloves + rough outer working gloves: For waste management or cleaning

Did you know?

Gloves need to fit!

The photos below show gloves (surgical and heavy duty) which are too big. This complicates patient care and increases the risk of breakage and contamination.



3.4 Respiratory protection

Different kinds of masks and respirators offer different levels of protection.

Whether to use surgical masks or respirators depends on the level of exposure. A risk- and hazard-assessment for the different settings and activities is essential before any decisions are made on which level of protection is needed.

Surgical face masks mainly protect from exhaled droplets. If marked 'IIR' (surgical masks Type IIR), surgical face masks are also splash-resistant and protect the wearer from fluid splashes. This level of protection, even when combined with distancing measures, is only safe for first contact precautions and not sufficient for EVD patient care. A respirator also protects from splashes but adds protection from the inhalation of droplets and particles.

The European standard EN 149 defines 'filtering half masks' (also called 'filtering face pieces' - FFP) in three classes, according to their capacity to filter particles.

Table 4. Classification of the different filter penetration limits

Respirator class EU	Filter penetration limit (at 95 L/min air flow)	Inward leakage	Respirator class US (NIOSH)
FFP1	Filters at least **80%** of airborne particles	< 22%	
FFP2	Filters at least **94%** of airborne particles	< 8%	N95 (Filters at least **95%** of airborne particles)
FFP3	Filters at least **99%** of airborne particles	< 2%	N99

NIOSH: US National Institute for Occupational Safety and Health
FFP: Filtering face piece.
N: Not resistant to oil.

FFP 1–3

- FFP3 provides best protection from aerosols and airborne transmission.
- In an enhanced-care setting for EVD patients where secondary aerosolisation cannot be excluded, FFP3 is the respirator class of choice.
- FFP2 is considered sufficient for first-contact precautions, transport, visits, and supervision tasks. Do not consider FFP2 for invasive patient care.
- The seal fit is crucial to ensure the specified level of protection.
- Breathing resistance increases with the class of particle filtration.
- An exhalation valve makes breathing more comfortable and helps prevent goggles from becoming foggy.
- Different models and sizes are needed to ensure a good fit in different face physiognomies.

Examples of FFP3 respirators:

Did you know?

The valve placed in the centre of the respirator is for expiration purposes.

The textile surface lets in filtered air from the outside. The textile part of the respirator is also splash proof.

✓ Qualitative fit test

A qualitative respirator fit test needs to be performed before choosing a respirator for regular use as part of the PPE ensemble. A fit test verifies the seal between the respirator and the PPE user's face. The test is based on an indicator aerosol, sprayed on the user while wearing the respirator under a designated test hood. If the test person can detect the saccharin contained in the aerosol, the fit test is positive, which means that the respirator is leaking. Another model, style, or size which fits the user properly must be found. Employers have to provide users with a reasonable selection of sizes and models to choose from.

Once the respirator fit test is passed, users will continue to use this exact model, style and size. A retest should take place every 12 months to make sure the respirator still provides a perfect fit.

Full-face respirator ('gas mask'): benefits and limitations

Full-face respirators provide a high level of protection. They come with interchangeable filter cartridges which provide protection from biological particles, radiological particles, and vapours from chemical agents.

The respirator covers and seals the entire face. Thanks to the integrated nose and mouth mask, full-face respirators have good antifogging properties. The elastic straps which hold the respirator in place are made of rubber. They can be placed under the coveralls (or an external) hood.

The cost of disposable filter cartridges for full-face respirators is significantly higher than for FFP respirators and goggles. On the other hand, full-face respirators can be reused (after decontamination) for years.

Full-face respirators, as part of the PPE ensemble, can only be used by staff members with proper medical certification and proof of adequate regular training.

Did you know?

FFP3 respirators in combination with goggles are as safe as full-face respirators when working in an infectious-patient care setting – if properly used and adhering to barrier nursing and infection control principles.

Powered air-purifying respirators (PAPRs)

Powered air-purifying respirators (PAPRs) are mostly used in specialised IDHC treatment centres. If used as part of the PPE, working hours can be extended, which is a clear advantage over other systems. PAPRs are multi-use items and have to be decontaminated and reconditioned (new filters cartridges) after use. Additionally, they require regular battery maintenance.

Benefits:

- Low training requirements
- PPE users can have facial hair, like a beard or moustache, and use glasses comfortably.
- PPE can also be used by HCWs with chronic respiratory disorders (e.g. asthma).
- Coveralls with integrated PAPR hoods enable a positive pressure gradient all around the PPE user. This additional body ventilation makes it possible to extend working hours (up to four hours).

Limitations:

- Expensive (procurement of reusable hoods, air tubes and power units; disposable sets of filter cartridges)
- Complex and time-consuming battery management
- Decontamination and reconditioning require structures which are usually only in place in specialised settings.

The use of PAPRs is not synonymous with increased safety levels. If handled properly, the PPE for IDHC described in this tutorial provides the same safety level as PAPRs. All in all, PAPRs offer a higher level of comfort, combined with lower training needs.

3.5 Eye protection

It is important that goggles have a close fit to the face so no liquids can enter the goggles. To achieve a tight fit, goggles with soft sealing edges are the preferred choice.

The goggles have to fit the face of the PPE user and be compatible with the other PPE components (the respirator and the hood of the coveralls). Having a wider range of different goggles to choose from increases the chances of finding a pair that fits perfectly.

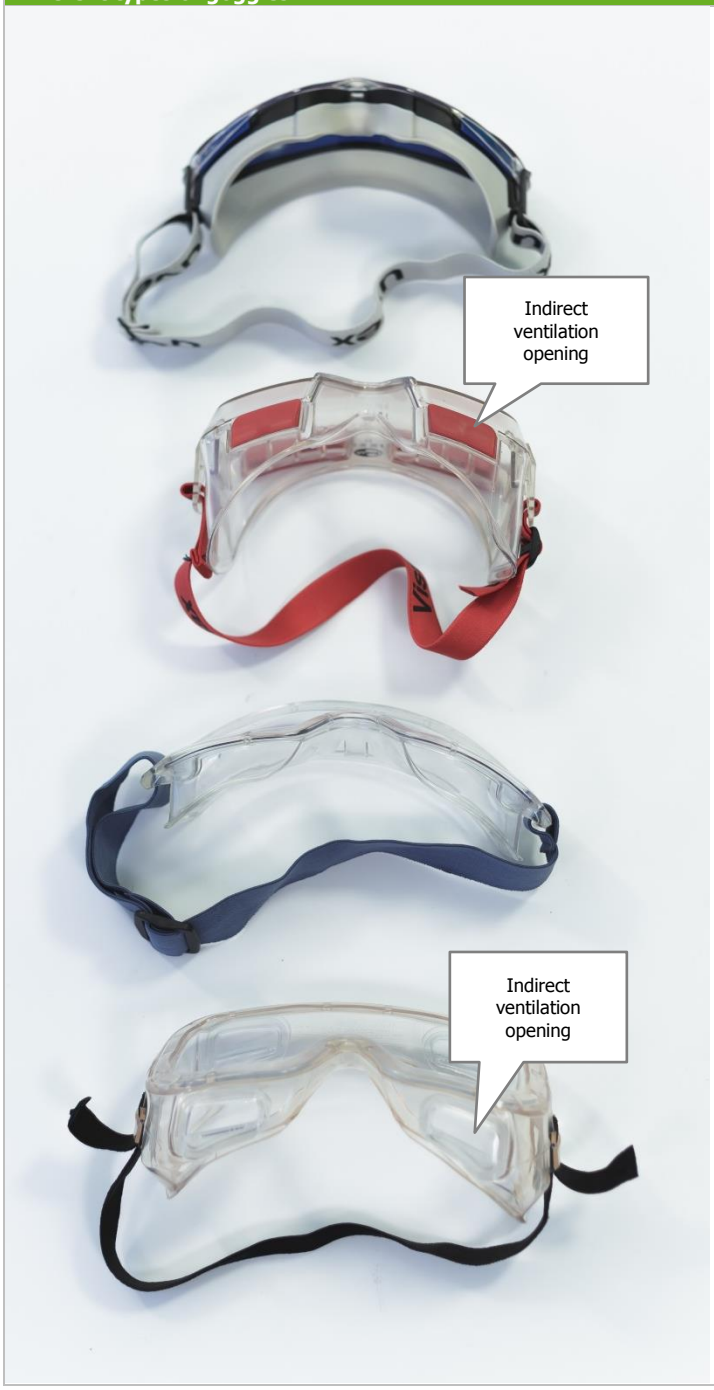
It is important that the goggles do not fog up while being worn, which seriously compromises patient care activities and staff safety.

Generally, goggles use either ventilation or anti-fog coating to prevent fogging. Both methods might be combined.

Ventilated goggles can have direct or indirect ventilation. Direct ventilation means that ventilation openings are not covered; indirect ventilation provides covered openings. Indirect ventilation provides better protection from fluid splashes. Protection, however, is not 100% as the goggles are not airtight. In general, all types of ventilation in goggles potentially increase the risk for contamination during aerosol exposure.

Modern goggles with anti-fog coating are highly effective and are seen as the best option to guarantee perfect vision in all situations.

The recommended option is goggles with soft sealing edges, good anti-fog coating, but without ventilation.

Different types of goggles	Characteristics
	✓ No ventilation, good anti-fog coating, soft silicon seal edge Indirect ventilation, flexible seal edge No ventilation, flexible seal edge Indirect ventilation and standard seal edge

Helpful hint

Glasses worn under goggles can compromise the required tight seal and increase the risk of fogging. Glasses can be worn under the goggles if the seal fit is fully preserved. Using additional anti-fogging spray can help.

Unless using a full face respirator, goggles should always be worn over the hood of the PPE. Most goggles are secured with elastic straps. Wearing goggles over the hood prevents liquids from soaking through to the skin via the elastic strap and also ensures a close fit of the hood, avoiding gaps between hood and goggles.

Key messages

- There is no such thing as 'one size fits all' when it comes to PPE components.
- Testing the fit of all PPE components before entering the red zone is mandatory.

4 Considerations for the use of PPE

The presented PPE components can be used in a variety of settings: they don't depend on electricity and they don't necessarily need dedicated staff decontamination facilities. Most components are designed as single-use items and need to be deposed of immediately after usage.

Different combinations of PPE components are possible. This tutorial challenges the user to understand the rationale behind the different combinations.

4.1 Precautions during first assessments

First contacts between HCWs and possible or probable cases can happen at several locations, for example in hospital waiting areas, emergency rooms, rescue service vehicles, outpatient clinics, primary healthcare settings, public institutions, and ports of entry.

At the time of first contact, the staff should immediately assess the transmission risk and take appropriate precautions to avoid secondary infections.

A combination of awareness, distancing measures, and the use of appropriate PPE effectively reduces the infection risk.

- By using distancing measures (more than 1.5 metres) and common materials, the infection risk can be significantly reduced.
- PPE components: double gloves, hair cover, impermeable gown, surgical Type IIR face mask (or FFP2 respirator if available), face shield or goggles, and shoe covers.
- Limit the number of staff that come into contact with the patient.

Helpful hints

- Contact the relevant authorities or reference hospital. If necessary, transfer the patient.
- PPE used for the first contact is not sufficient to perform nursing, diagnostic or treatment activities.
- Minimise additional moving of the patient to keep the potentially contaminated zone as small as possible.

Assessment of required PPE level

Assessing the necessary level of PPE protection is the key to allocating staff in the most effective and appropriate way for the identified risk level.

Criteria for high-risk exposure are any of the following:

- Close face-to-face contact (e.g. within one metre) without appropriate personal protective equipment (including eye protection) with a probable or confirmed case who was coughing, vomiting, bleeding, or who had diarrhoea; or had had unprotected sexual contact with a case up to three months after recovery.
- Direct contact with any material soiled by bodily fluids from a probable or confirmed case.
- Percutaneous injury (e.g. with needle) or mucosal exposure to bodily fluids, tissues or laboratory specimens of a probable or confirmed case.
- Participation in funeral rites with direct exposure to human remains in or from an affected area without appropriate personal protective equipment.
- Direct contact with bats, rodents, primates, living or dead, in or from affected areas, or bushmeat.

This tutorial specifically deals with confirmed, probable and possible EVD cases in healthcare settings.

4.2 Preparing to work with PPE for infectious diseases of high consequence

Personal clothing should not be worn while working in the patient care areas. PPE users should wear scrubs under their coveralls.

Helpful hints

- Consider sports underwear and single-use cotton socks for comfort.
- Wearing makeup impairs user comfort due to facial sweat and is not recommended when using respirators.
- Consider using the toilet before putting on the PPE.
- Drink 1–2 litres of water before putting on the PPE to prevent dehydration. Profuse sweating is unavoidable while working with PPE so this won't cause the HCW to need to use the toilet.
- Fasting is not recommended before working with PPE.
- Check the PPE items before starting the donning process, looking for irregularities like holes and cracks.

4.3 The use of tape: benefits and risks

There is an ongoing controversial debate among PPE experts on the added value of additional taping of PPE components like gloves, respirators, boots and goggles. There seems to be a majority view that the prudent use of taping contributes to an increased level of safety. However, it is crucial to understand that additional taping has both benefits and risks.

The primary question is what we want to achieve by taping PPE components:

- Facilitation of the doffing process:
  - If gloves or boots are connected to the coveralls by adhesive tape, they can be taken off in one stroke.
- Improved tightness of fit between adjoining items:
  - Targeted taping of small gaps between goggles, respirator and coveralls can prevent fluid from splashing inside. Done properly, this can even provide an aerosol-tight barrier.
- Adapting the fit of the hood:
  - Tape can help to make the hood stay in position, keeping the hood from sliding over the eyes.

Users also need to be aware of the disadvantages:

- Taping is felt as an additional 'safety layer' but if done improperly, it provides a false sense of security, doing more harm than good.
- Inexperienced users are prone to tape over essential functional parts of PPE components. If, for example, a PPE user covers the filter surface with too much tape, he or she may experience difficulties breathing.

- Taping takes time and prolongs the donning process.
- Done incorrectly, taping jeopardises the doffing process. For example, if the tape to seal the glove to the sleeve is too tight around the forearm, it will be very difficult to take off the glove.

Additional taping cannot compensate for PPE components which do not fit, e.g. taping coveralls 'smaller' seriously compromises safety levels.

Proper taping of PPE components requires regular training and lots of experience.

The tape

Different kinds of tape can be used. Tape with a textile-based layer is not recommended, as it can soak up liquids (capillarity effect). Quality parcel tape or tape resistant to chemicals are good alternatives.

5 Donning and doffing

Did you know?

D**on**ning: putting **on** the PPE

D**off**ing: taking **off** the PPE

Symbols used in this section

To quickly signal what is good practice – and what is not – we use the following symbols:

- ✓ Experts' choice. Recommended by expert with substantial experience of the process.
- **[+/–]** Consider the limitations before using this option. Further evidence needed.
- **NO!** According to experts, this practice should be avoided.

5.1 Basic principles in donning and doffing

There are many different ways of putting on and removing the PPE. There is, however, no gold standard on how to do this. It is more important to understand the rationale behind the chosen approach for donning and doffing. The most critical aspects in the process are how to avoid disease transmission to HCWs involved in patient care and avoid self-contamination while doffing.

Consequently, both processes, donning and doffing, need **active assistance** by a member of the team, who has been trained in this. In addition, allocating sufficient time for donning and doffing – while simultaneously avoiding distractions – is essential.

PPE components have to be put on properly and in a precise order to produce an integrated protection system. Double-checking the materials both at the beginning and the end of the donning process adds another safety layer.

During the doffing process it is important to proceed calmly and systematically to avoid mistakes. The doffing process needs continuous quality control and must be adapted to the PPE components in use, in order to minimise contamination risks during removal.

Assistants always need to follow a checklist demonstrating the established procedures for donning and doffing.

Assistance

Donning and doffing PPE without assistance is complex and facilitates PPE dysfunction or even secondary contamination.

During the donning process, the assistant should wear scrubs and perform hand hygiene before starting. When the PPE user is donning to perform patient care activities, the donning assistant should wear nursing gloves and perform glove disinfection between each step.

By contrast, during doffing, the active assistant must wear a full-body PPE ensemble and perform glove disinfection and glove changes in accordance with the established procedure. If the doffing assistant is not taking over the next shift inside the red zone, the additional taping of goggles and respirator is to be omitted.

The exiting PPE user only has minimum activities to perform. In that case, he or she will receive targeted instruction from the active assistant. It is important that the exiting PPE user stands still while remaining in a relaxed, yet stable, position.

In this setting the exiting PPE user is completely guided and handled by the assistant. This has the advantage that the PPE user doesn't need to manipulate the PPE on potentially contaminated body areas without having direct sight.

If the assistant will also withdraw to the green zone after this activity, the following procedure should be employed.

The last one doffing

The last PPE user to remove the PPE ensemble will have to perform all tasks without external assistance. Receiving guidance from the supervisor or from a highly experienced PPE user without being touched ('qualified observer') is the essential principle during this process.

The 'last one doffing' can be the last active assistant withdrawing from the red zone but also a person who had performed the last tasks in patient management. However, doffing alone after obvious exposure to bodily fluids or waste should be avoided at all costs, even when a qualified observer is available.

The spoken instructions from the qualified observer to the 'last one doffing' should be clear and unequivocal. A mirror, placed close to the doffing zone enables self-monitoring during the process, providing additional control.

Helpful hints

- HCWs removing their PPE alone should use a mirror, especially when opening flaps and zippers and removing goggles and respirators.
- The most experienced staff should be the last one doffing.

5.2 Donning (putting on the PPE)

It is critical to never don a PPE without proper assistance.

Suggested steps for donning

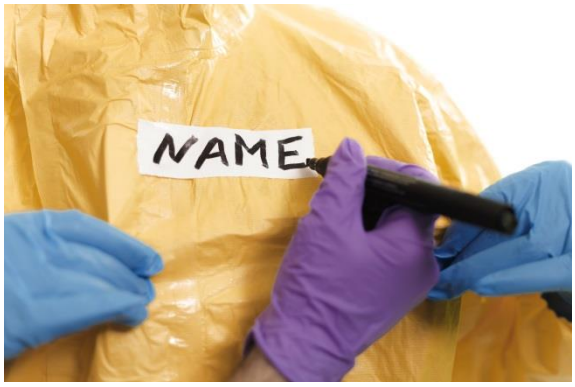
Steps	Action
1	Putting on scrubs and hair cover
2	Hand hygiene
3	Putting on the coveralls
4	Foot protection
5	Hand protection
6	Respiratory protection and orientation fit test
7	Hood
8	Zipper
9	Flaps
10	Eye protection
11	Inner glove disinfection and outer gloves
12	Apron (optional)
13	Testing the PPE components
14	Ready to pass through the yellow zone and to enter the red zone.*

*Stop in yellow zone if you have to perform assisted doffing for a buddy first. (See Section 8.2.)

Steps 1 and 2: Putting on scrubs and hair cover; hand hygiene

To ensure comfortable and safe working conditions for the PPE user, the PPE user should wear hospital scrubs and a hair cover under the coveralls. The scrubs will absorb sweat, and the hair cover prevents fluids from seeping in through individual strands of hair sticking out from the hood. Before putting on the PPE components, perform hand hygiene.

Step 3: Putting on the coveralls



Good communication and identification between PPE users is important. Attaching a name tag (a simple piece of tape labelled with permanent marker) to the front of the hood, the chest, and/or the back is a good idea.

Did you know?	Writing directly on the coveralls may affect the integrity of the coverall fabric.

Step 4: Foot protection

Two options are possible: coveralls with or without integrated foot sections. The choice of coveralls influences the type of foot protection selected (clogs or boots) and the associated attachment method (tape or no tape).

✓ *Coveralls with integrated foot sections*

Coveralls with integrated foot sections can be used inside boots or clogs. This will facilitate the donning and doffing process.

Did you know?

With integrated foot sections, the PPE user can easily switch clogs when crossing from the yellow zone to the red zone (donning).

When removing (doffing) the PPE, users should leave the dedicated red-zone clogs in the red zone.

If clogs are clearly assigned to each of the yellow and red zones, they will not have to be disinfected for the next donning. This procedure is time-efficient and avoids unnecessary exposure. However, visible contamination on foot protection needs to be removed.

✓ *How to produce coveralls with integrated foot sections*

If the coveralls do not have an integrated foot section, it is possible to create such a foot section by taping the separate boot cover directly to the legs of the coveralls.

Always tape the boot cover to the coverall legs at (and not above) the juncture. Never tape the boot cover tightly around the ankles.

Helpful hint

- Tape the boot covers to the coverall legs at the widest part of the calves so the feet can easily slip out of the coveralls when removing the PPE.

Coveralls without integrated foot section

Never place the leg of the coveralls inside the boots if there are no integrated foot sections. This potentially exposes the feet to contaminated fluids. Also, never use clogs without boot covers if the coveralls do not have an integrated foot section.

Placing the coverall leg over the boot and taping them together, or using boot covers over clogs/boots, are two possible options.

Helpful hints

Keeping fluids away from the inside of the boot is very important.

- Pull the coverall legs over the boots.
- Fold the slack of the coverall leg to cover the upper part of the boot.

Benefits and limitations of taping in foot protection

There are two benefits of taping the boots to the PPE:

- Easier doffing
- Preventing leakage of fluids to the inside of the boot.

Pull up the coverall legs before taping them to the boots, otherwise they will be uncomfortably short when moving around.

[+/–] Boots taped directly to the coveralls

Boots can also be taped directly to the coverall legs. This may make it easier to step out of the boots when doffing but the tape has to be removed later from the boot surface to separate the boots from the coveralls.

[+/–] Coveralls taped to the boot cover: additional shoe covers over the clogs or boots

In some settings it might be considered an advantage if boots or clogs are covered by boot covers. In this case, additional taping of the connection of boot cover and coverall leg is critical for two reasons:

- To prevent liquids getting inside the covers
- To enable a safe 'one stroke' doffing process.

Take into consideration that any kind of shoe worn inside a boot cover can potentially break it. Also, retrieving clogs or boots from the waste bag after doffing can be difficult if they remain trapped inside the covers.

Any additional component used in PPE, potentially also adds to the complexity of the donning and doffing process!

Using a shoe or boot cover helps to prevent contact with fluids but makes waste management more difficult and the soles more slippery. Consider using a second pair of rough-surface covers to prevent slipping.

Tape the shoe cover directly to the trousers and fold the slack to cover the taped area. The coveralls always stay over the boot.

Pull up the trousers before attaching them to the widest part of the calves.

Do not put the coveralls inside the boot!

Tape the boot covers directly to the trousers and not to the boot because the boots will eventually have to be recovered from the waste pile. This way, the boots do not come into contact with the tape and can easily be retrieved.

Boot covers are secured with at least two layers of tape wrapped all around. Fold down the remaining slack of the trousers. A shoe cover with non-slip soles worn over the boot/clog cover can help to avoid accidents.

Step 5: Hand protection

More layers of PPE do not mean more protection. A third layer of gloves complicates patient care and even increases the risk of percutaneous injury with sharps.

Instead, double gloving is seen as a standard approach, balancing between the needs for flexibility, tactility and safety.

It always provides an external working layer which can easily be adapted according to different tasks or renewed, whenever the situation would require it.

Gloves should always be pulled over the sleeves of the coveralls to prevent fluids from entering either the glove or the sleeve. Different types of glove are suitable as first-layer gloves.

Benefits and limitations of taping the inner gloves

Taping the inner gloves to the coveralls offers several advantages:

- The glove will stay in place during work activities.
- It is easier to remove the PPE because the gloves can be pulled off together with the coverall sleeves in one stroke.

The following potential pitfall should be kept in mind:

- When removing the PPE, gloves should come off easily. If the tape is wrapped tightly around the wrist, it will be impossible to pull the hand out of the glove.

To ensure personal comfort and easy glove removal, one of the following methods can be used.

✓ Suggested option: taping the gloves to the coveralls with a distance ring (spacer)

To ensure a loose connection between the glove and the sleeve, use a roll of tape or a cardboard roll as a spacer.



Slide the roll of tape/ cardboard roll (spacer) over the hand. Pull the sleeve over the spacer. Pull the glove over the spacer.

Tape the glove to the sleeve, using the spacer as support.

When doffing, pull your hand out of the glove while removing the spacer at the same time.

Helpful hints

- Never tape directly from the roll because this applies too much pressure on the taping, which severely restricts the blood flow to the hands.

- Cut a sufficient number of small strips of tape before starting the donning process.

✓ Alternative option #1: vertical taping with two or more strips of tape

Pull the glove as high as possible over the sleeve of the PPE coveralls. Tape the glove to the sleeve using a minimum of two strips of tape alongside the forearm.

This option also ensures the easy removal of the PPE.

✓ Alternative option #2: basic taping (without spacer)

Pull the glove up over the sleeve of the PPE coveralls until reaching the widest part of the forearm. Tape the glove to the sleeve so it fully covers the opening of the glove. However, this method relies on having gloves with long sleeves available.

Helpful hint

- The diameter of the section of tape around the forearm/wrist should be wider than the thickest part of the hand. If not, it will be impossible to pull the hand from the glove during the doffing process.

[+/–] Alternative option #3: no taping

Even if no tape is used, assistance is still needed when putting on (and removing) the inner gloves. Slip into the finger loops before putting on the first pair of gloves. They prevent displacement of the gloves and avoid skin exposition.

The PPE assistant needs to hold the glove while the PPE user pushes his or her hand into the glove until a substantial section of the sleeve is inside the glove.

Step 6: Respiratory protection and orientation fit test

Helpful hints

- To keep the respirator from sliding, the position of the elastic straps of the respirator is essential. The upper strap essentially remains in a horizontal position, while the bottom strap is pulled toward the crown of the head.

- It is crucial that the PPE user chooses a respirator that provides a reliable sealed fit, otherwise aerosols could be inhaled. There are different methods to fit-test a respirator.

Respirator fitting: orientation fit tests

Before putting on the PPE ensemble, a qualitative fit test – which is not part of the donning process – should be carried out to select a properly fitting respirator (see Section 3.4, above).

An orientation fit test has to be done every time a respirator is put on, in order to ensure that the respirator has a proper fit and seal. Even a respirator model that passed the qualitative fit test needs to be tested in an orientation test during the donning process.

To test whether the respirator is placed properly, the assistant should cover the expiration valve with his/her hand. When the PPE user blows in the respirator, the respirator should expand and no air loss should be detected on the sides. When blowing in the respirator, the PPE user should not feel air blow into their eyes.

If air is escaping the respirator during the test, the respirator should be adjusted. The metal bar on the top of the respirator (when present) can be adjusted and is important to ensure a proper fit and seal. Double-check if there is any air leakage by repeating the procedure.

The respirator straps should always be under the hood of the coveralls

Helpful hints

- Respirators often have textile elastic straps to secure the respirator to the head. Ensure that the ends of the elastic bands are put inside the hood of the coveralls to prevent liquids getting in the face due to capillarity.
- Tuck dangling strap ends under the main section of the straps or cut them before putting on the hood of the coveralls.

- Respirators must have a proper seal fit. Wearing a beard will seriously compromise this goal.

Did you know?

Sneezing inside the respirator is possible. Just make sure you do not touch the respirator with your hands.

Having a runny nose while wearing a respirator is not a problem as long as you do not touch the respirator.

Step 7: Hood

Although taping is usually not considered a good option to adjust coverall size, tape can be used if the hood is too big.

Steps 8 and 9: Zipper and flaps

Make sure that the flaps are properly closed and form a flat surface without wrinkles.

The PPE user can help the assistant with the closing of the flaps by pulling the suit away from the body.

The PPE user can hold up the coveralls to avoid pressure on sensitive body areas and facilitate sealing the flaps.

Step 10: Eye protection

Place the goggles over the hood and ensure that the textile elastic strap is tight. Now, your entire face should be covered by both respirator and goggles. This will protect you from contact with potentially contaminated fluids.

Once the goggles are in place, check that there are no gaps between the different PPE components. It is helpful if the PPE user moves his or her head and body to check that the goggles stay in place. There should not be any air flow to the eyes or cheeks.

Suggested option: disposable goggles

Use disposable goggles with anti-fog coating. Wear them over the hood to secure the coverall hood and to avoid gaps between the goggles and the hood. The elastic straps of the goggles are often made from fabric so keeping the elastic strap on the outside of the hood prevents liquids from soaking in.

Helpful hints

- If the PPE user needs to wear glasses, ensure that they don't affect the seal fit.
- For experienced users of contact lenses, they are the preferred choice.

[+/–] *Alternative option #1: face shields*

Face shields for eye protection can be used for first-assessment precautions. But consider the potential limitations of non-sealing eye-protection in patient care settings.

Benefits:

- Face shields protect from fluid splashes.
- They do not fog.

Limitations:

- Face shields do not protect from aerosols.
- It might be challenging to move without displacing the face shield.

Careful supervision is needed to check that the PPE user does not touch his or her face when using face shields.

✓ *Alternative option #2: full-face respirator (gas mask)*

Gas masks normally have non-textile straps so they can be used under the coverall hood. Check that the disposable filter cartridges are correctly placed before using them.

Taping of respirator and goggles

Taping respirator and goggles to the hood is a complicated and time-consuming process. Taping over even a small section of the respirator considerably limits the air intake, which is detrimental to working conditions.

However, additional taping in the face area can be performed, but only to close minor gaps remaining between hood, goggles and respirator, preventing splashes from reaching the skin.

For diseases transmitted by air, additional taping in the face area can even provide a tight barrier to aerosols.

When performing additional taping in the face area, prepare smaller pieces/strips of tape before starting. Then use the tape to cover gaps and/or to seal the respirator and the goggles to the hood.

Tape the sides of the goggles to the hood. Do not cover the elastic straps as they are made of fabric, which could get wet due to capillarity.

Use smaller pieces of tape to seal the goggles to the respirator in order to avoid covering more surface of the respirator than necessary.

Cover all possible gaps between goggles, respirator and the hood with tape and make sure that the tape is properly stuck to the hood. Ensure that the area around the nose is covered with tape.

Do not tape too much of the surface of the respirator since this seriously limits the air intake.

Step 11: Inner glove disinfection and outer gloves

The outer pair of gloves can be easily changed. The choice of outer gloves depends on the work activities.

Step 12: Apron (optional)

Using a plastic apron can be useful when carrying large plastic bags, cleaning up, or handling a dead body. Rubber boots are also the preferred choice when performing these activities.

Step 13: Testing the PPE components

Once the PPE user wears the full PPE ensemble, a member of the team should verify that there are no irregularities in the material and no open gaps.

Helpful hints

- A PPE user can test if the coveralls fit by kneeling down and lifting the arms when fully covered by the PPE ensemble.
- If PPE components get displaced during this test, they need to be re-arranged and fixed before entering the patient-care area.

Step 14: Ready to pass through the yellow zone and to enter the red zone

Once the donning is finalised in the green zone, the HCW passes to the yellow zone. From there, step into the red zone. If foot pieces and clogs are the foot protection of choice, use the dedicated clogs provided for each zone.

Final result

This is an example of a PPE user prepared to go into the red zone.

5.3 Doffing (removing the PPE)

Did you know?

Contaminated PPE area or surface =
The surface of a PPE component which was exposed to the environment while working in the red zone.

Clean PPE area or surface =
The surface of a PPE component which was covered by another part (e.g. tape) of the PPE ensemble while working in the red zone.

Assisting the PPE user actively in the doffing process is essential for preventing him from manipulating the PPE on potentially contaminated body areas without having direct sight. This is even more crucial when it comes to the delicate parts of the doffing process, such as removing additional tape in the face area or opening the flaps and the zipper.

Providing the PPE user with active assistance in the removal process is preferred over guided assistance by a qualified observer and over self-assisted doffing using a mirror.

The doffing process takes place in the dark yellow zone designated for this purpose. Only HCW wearing full PPE protection can enter the dark yellow zone to go into the red zone or to assist with doffing.

Suggested steps for doffing

Steps	Actions Contaminated staff (PPE user)	Actions Assistant (clean)* (Dark yellow zone)
1	Removing the optional apron. (Red zone)	
2	Step out of the red zone.	PPE inspection of the HCW ready for doffing to identify cuts or contamination; disinfection of the PPE (wipe with disinfectant)
3	Removing the outer gloves.	Use new pair of outer gloves.
4	Stay relaxed and stand still so the assistant can easily access the components.	Removing tape from face area if present.
5		Removing the goggles.
6		Open the flaps.
7		Use new pair of outer gloves.
8		Open the zipper.
9		Removing the hood.
10		Roll down the coveralls.
11		Roll down the sleeves with the integrated gloves (taped).
12	Step out of the coveralls (with integrated foot section) and put on the light yellow-zone clogs.	Hold the coveralls and stay in the dark yellow zone.
13		New pair of outer gloves

Steps	Actions Contaminated staff (PPE user)	Actions Assistant (clean)* (Dark yellow zone)
14	Stand still in the light yellow zone while the assistant removes your mask from the dark yellow zone.	Removing the PPE user's respirator.
15	Hand hygiene and step into the green zone	
16	Take off the hair cover, re-hydrate and take a shower.	

** Consider glove disinfection every time an item is removed.*

During the doffing process: the PPE user should only move on command to avoid contamination. The PPE user should not use their hands while PPE is being removed by the assistant.

Disinfection of the gloves worn by the assistant: Use of alcohol-based hand disinfectant or a disinfectant for non-enveloped viruses is also needed at various steps of the doffing process. The assistant should consider glove disinfection of the outer gloves after each item is removed.

The exiting HCW should perform hand disinfection using a dedicated, 'clean' dispenser immediately on entering the yellow zone.

Changing the gloves of the assistant: During the doffing process, the assistant will need to change gloves a minimum of three times. This process can be made easier if the assistant initially wears four pairs of gloves on top of each other and then takes off pair after pair. The first three pairs of gloves are meant to be taken off during the doffing process.

Gloves need to be changed when the assistant has finished touching the 'contaminated areas' and starts touching the 'clean areas'. Gloves also have to be changed before removing the respirator.

Change gloves:

- before removing the goggles;
- after opening the coverall flaps and before opening the zipper; and
- before removing the respirator;
- any time there is the slightest suspicion that secondary contamination could have occurred in a glove that needs to be 'clean'.

Helpful hint

- The assistant can wear four pairs of gloves on top of each other, which makes it easier to get to a fresh pair of gloves. Instead of having to put on a new pair of gloves every time, the assistant will simply remove the outer pair.

Step 1: Doffing the apron – PPE user, alone

The PPE user removes the optional apron himself, ideally by breaking the apron straps, making sure the apron is not removed over the head. When removing the optional apron, the goggles or the respirator should not be touched by the contaminated apron.

Roll the apron from the inside to the outside to avoid unnecessary contamination of the outer pair of gloves.

Step 2: PPE inspection and disinfection – assistant

Before starting the doffing process, the active assistant should look for visibly contaminated areas or cuts. Additional disinfection with a disinfecting wipe and heavy-duty gloves should be considered.

When using coveralls with integrated or taped foot sections in combination with clogs, stepping out of the foot protection is easy. Dedicated red-zone clogs can stay to be reused by the next HCW in the red zone. The PPE user steps into the dark yellow zone dedicated for doffing.

Helpful hint

- Leave your clogs in the red zone before stepping into the waste plastic bag in the dark yellow zone. Dedicated red-zone clogs will not be discarded, they can be reused.
- Stand with legs spread and hold arms at a distance from the body.

In case boots are taped to the coveralls with or without a boot cover, or clogs are used inside the boot covers: they will be removed inside the waste bag in the dark yellow area. Boots disposed in the waste bag will be disinfected by an assistant for reuse. (See Step 12 in this section).

Helpful hint

- Detergent-based disinfectants make the floor slippery. Stepping into the plastic waste bag before disinfecting the PPE will circumvent this risk.

Consider performing PPE disinfection of the HCW being doffed with single-use wipes and disinfectant. If there is visible contamination in the face area, consider decontaminating the face area as well. Apply the disinfectant used in your clinical setting. The disinfectant quickly reduces the risk of potential contamination with bodily fluids during the doffing process; this does, however, not imply that you should not strictly follow the established doffing protocols.

Step into a waste bag for PPE component disposal in the dark yellow area. The PPE user should stand in a rolled-down, leak-proof infectious waste bag. All removed PPE components and the used wipes should be placed in the bag.

The assistant should always use heavy duty gloves when disinfecting the PPE.

Step 3: Removing the outer gloves – PPE user alone

Inspect and disinfect the outer pair of gloves and take them off.

Inspect the inner pair of gloves and disinfect them.

Inspect the PPE user's outer pair of gloves in order to identify cuts, visible contaminations, or tears. Proceed with disinfecting the PPE user's gloves and take them off. (See also Annex 2 'Removing the gloves'.)

Inspecting and disinfecting the inner gloves – assistant

Inspect the inner pair of gloves before removing them and disinfect them if they are visibly soiled, cut, or torn. If you identify or suspect any breaches, perform glove disinfection using a container with alcohol prepared for this purpose.

Step 4: Removing tape from the face area (if applicable)

Do not touch any area previously covered by the tape (clean area) with the gloves as they are considered contaminated. Hold the goggles while removing the tape in order to avoid them being pulled off the coveralls.

Press the coveralls to the face. Only touch the areas not previously covered by tape in order to avoid dislodging the respirator or the goggles.

The assistant should never touch a 'clean area' with contaminated gloves.

Do not touch: Never touch areas which were covered with tape with the first pair of gloves.

Touch: You can touch all areas not previously covered by tape to facilitate the removal of the tape.

Step 5: Removing the goggles – assistant

Most goggles are designed and certified for single use. The disinfection of non-disposable goggles requires strict adherence to the certified procedure.

Steps 6 and 7: Open the flaps; put on new pair of outer gloves – assistant

After opening the flaps, attach their adhesive sides to the suit to secure them.

Change gloves before opening the zipper.

Step 8: Open the zipper

Where can the assistant touch during the doffing process?

Touch: Change gloves before opening the zipper. When opening the zipper, only touch the clean area, i.e. only the area that previously was covered by the flaps.

Do not touch: Do not touch contaminated areas when opening the zipper.

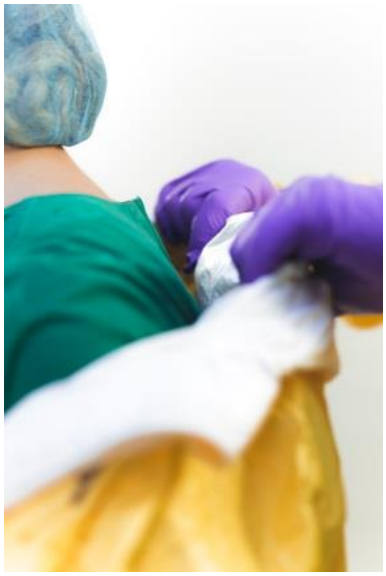
If you accidently touch a contaminated area, change gloves before opening the zipper any further.

Touch: Once you have changed your gloves to open the zipper, you can also touch the clean area previously covered by the flaps.

Steps 9 to 10: Doffing the coveralls – assistant

Make sure you perform glove disinfection before rolling the hood down from the inside.





Optional back cutting of the coveralls – assistant

Making a vertical cut from the top of the hood down to the waist area with blunt scissors can be a time-efficient alternative for doffing. Perform a wipe disinfection before making the cut.

Main advantage: The steps to open the front zipper as described above can be skipped. Also, the back of an HCW returning from the red zone can always considered to be less contaminated.

Obviously, in this approach active assistance is also mandatory.

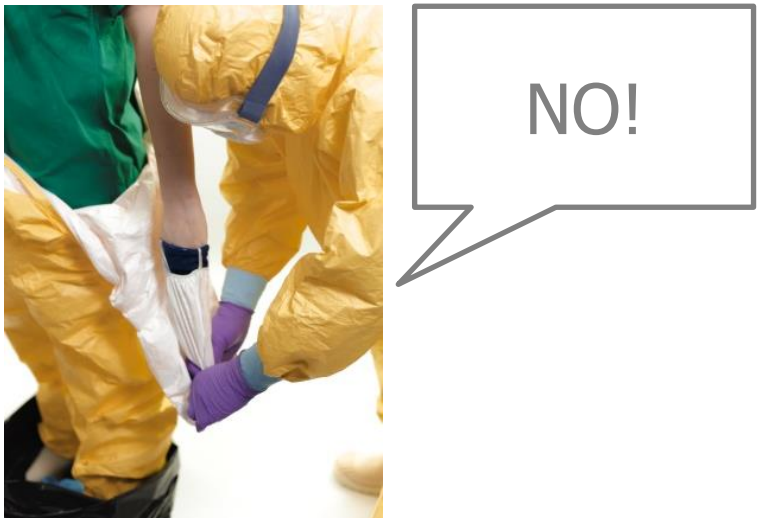
Step 11: Rolling down the coverall sleeves – assistant

If the inner pair of gloves is taped to the coverall sleeves, the removal process is relatively easy because both gloves and coveralls can be removed together in one movement.

The inner pair of gloves should not be removed before the coveralls. If the inner pair of gloves was not taped to the coveralls, the doffing process needs to be done even more carefully.




Using the finger loops is recommended in order to avoid gaps between sleeves and gloves. Gloves can get stuck to the hand during doffing if the inner pair of gloves was not taped to the coveralls.



The assistant can help remove the gloves from the inside, touching only the clean area with a new pair of gloves. But there is an unnecessary risk of contamination of the clean area with the assistant's arms.

Don't touch the PPE user's chest with the respirator during the doffing process. Remain stationary and do not move during the entire doffing process unless it cannot be avoided.

Step 12: Stepping out of the footwear – PPE user, assisted

Assistance for this process is critical. If assistance is not available, remove the boots but avoid touching them (a dedicated 'boot jack' might be an option). Always use double-glove protection to hold the boots in this process.

Remove the protective overshoes by pulling out your feet and slip into a clean pair of clogs (provided by a second assistant or previously placed on the floor). The boots or clogs would remain in the waste bag for removal and disinfection in the dark yellow area by an assistant wearing full PPE protection.

Consider the help of an assistant in the yellow zone in terms of buddy awareness. Always use nursing gloves and perform hand hygiene after this step.

Disposal of boots (waste bag)

The boots are the only component of the PPE that can be reused. Decontamination of the boots should be carried out under strict infection control measures. Boots need be retrieved from the waste bag, cleaned, disinfected and dried. Placing the boots in a container with liquid disinfectant (in the dark yellow zone) is an efficient first step for the re-conditioning. Once dried, boots can be placed in the green zone for the next donning process.

Reusing the boots is cumbersome:

- Retrieving them from the waste bag is difficult.
- The use of disinfectants has certain limitations.
- It is difficult to avoid splashes when cleaning the boots.
- Additional workforce is needed.

If integrated or taped-on foot sections are used, boots or clogs do not have to be disposed of or disinfected every time.

Step 14: Change gloves and remove the respirator – assistant

Change gloves before removing the respirator.

Avoid touching the face when removing the respirator. Pull the respirator off the face and carefully move it up. Pull straps over the head and remove the respirator completely.

The respirator is removed by the assistant still standing in the dark yellow zone, while the HCW being doffed already moved towards the light yellow area.

Step 15: Perform hand hygiene and step into the green zone

Step 16: Remove the hair cover, re-hydrate and take a shower

Key messages

- Donning and doffing need to be actively assisted.
- Be consistent in following all of the steps.
- Not rushing and being fully focussed on the task at hand is crucial to prevent mistakes.

6 Operational considerations

6.1 Working under PPE

Wearing PPE heavily affects your work routines.

Starting with the first step, the donning process requires your full attention, long before starting to care for the patient.

The biggest challenge for many HCWs dealing with IDHC is a change of mindset: from patient focus and patient care activities to self-protection, the protection of other staff members, and the prevention of spread to the community.

Beside the physical constraints (heat, dehydration, and intensive duty rosters), there are several psychological aspects to prepare for:

- Full clinical pictures of IDHC like EVD may be traumatic, even for experienced HCWs.
- The normal patient-HCW model of interaction/communication is disrupted. One reason lies in the 'depersonalisation' of the HCW who is now completely masked, which may be perceived as threatening. Communication is hampered by respirators and coverall hoods.
- The fear of undetected contamination or secondary transmission to relatives and friends results in increased stress levels for HCWs.

The main principle for working in the contaminated treatment zone (red zone) is: Never go there alone, always work in a team. A minimum of two HCWs wearing PPE at the same time is needed in order to provide the necessary amount of help and assistance.

Active assistance is mandatory during the donning and the doffing process. The PPE user must be able to fully trust the person providing assistance. Training to get used to these procedures is very important. The 'buddy system', established as an essential safety mechanism in scuba diving, is a perfect model for staff working with PPE and IDHC.

Helpful hints

- Never adjust any of the PPE components during patient care or waste management.
- Consider learning some breathing and relaxation exercises when preparing for working under PPE.
- Take into account that the working time under PPE for IDHC is limited on two hours maximum, even in an air-conditioned environment.

Targeted operations

If the patient needs special care, the PPE user has to use specific equipment. For instance, the patient may need an x-ray or require an invasive intervention carried out under sterile conditions.

When sterile conditions are required, perform glove disinfection for the inner pair of gloves and before putting on the outer pair. The inner gloves can never be removed.

Consider wearing an apron on top of the coveralls when cleaning up. Also consider an extra pair of heavy-duty gloves, an impermeable gown, and boots.

Helpful hint

- Standard hygiene measures (both for HCWs and patients) have to be performed with the PPE. HCWs should think of the PPE as their normal outfit. With regard to disinfection, the inner gloves should be seen and treated as 'skin'.



6.2 Hand and glove hygiene

Hand disinfection dispensers are needed at the point of care and diagnosis, in the doffing area, and in the donning area.

Helpful hint

- Always remember that the sanitizer dispensers in the red zone and in the dark yellow zone are to be considered as contaminated. Never touch the pump with your clean gloves. Instead, use your elbows.

Hand/glove hygiene

Performing hand hygiene according to international recommendations (WHO) is a critical aspect in this setting.

Hand hygiene has to be performed before the donning, after each change of gloves (if necessary), and after the doffing.

The performance of clinical or waste management duties must be done according to the 'WHO five moments for hand hygiene': 1) before touching a patient; 2) before clean/aseptic procedures; 3) after bodily fluid exposure/risk; 4) after touching a patient; and 5) after touching patient surroundings.

When working with PPE, 'hand hygiene' becomes 'glove hygiene'. Hand/glove hygiene should be performed:

- before putting on gloves/wearing PPE (i.e. before entering the isolation room/area) (*hand hygiene*);
- before performing clean/aseptic procedures (*glove hygiene*);
- after any exposure/risk to/from the patient's bodily fluids (*glove hygiene*);
- after touching (actually or potentially) contaminated surfaces/items/equipment in the patient's surroundings (*glove hygiene*); and
- after removing the PPE and entering the yellow zone (*hand hygiene*).

Hand hygiene in isolation rooms/areas should be performed every time the above criteria indicate it, along with a change of gloves. When caring for several patients in the same room, it is essential to complete all tasks before moving to the next patient.

Performing hand hygiene, including after the doffing of PPE, is part of routine infection control.

HCWs should perform hand (and glove) hygiene frequently, especially before and after patient contact, contact with potentially infectious material, and before putting on/removing PPE.

Glove disinfection

Performing glove disinfection is a critical aspect in this setting. After putting on the inner gloves, they always stay on. Use them as if it they were the skin of your hands.

Gloves need to be disinfected regularly and after these critical moments:

- During the doffing process (both assistant and PPE user)
- Whenever there is a possibility of potential contamination.

Allow the gloves to dry after disinfection.

Always disinfect your hands right after you have removed your inner gloves.

Helpful hints

- Think of the inner gloves as if they were your skin.
- Change gloves between patients and tasks, especially after contact with bodily fluids.
- Replace the outer gloves if they become damaged or torn.

6.3 Mitigation of transmission risks by disinfection or decontamination

Risk mitigation by disinfection should be considered after high-risk procedures, especially when bodily fluids are present on PPE components.

For surfaces or objects contaminated by blood or other bodily fluids or secretions, prompt cleaning followed by disinfection using standard hospital detergents and disinfectants is recommended.

Linen and any equipment contaminated with bodily fluids should be placed in impermeable, clearly labelled bags and processed according to procedures for highly infectious waste.

Staff disinfection

Disinfecting staff members exiting the red zone should always be considered, as this adds an additional safety layer, before starting the actual doffing procedure.

Helpful hint

- After splashes with body fluids, the PPE user first takes off the apron (if worn) after which he or she can be wiped clean with any disinfectant used in the hospital. The assistant in charge of the clean-up must use an outer pair of heavy duty gloves.

- Use the disinfectants already available in the hospital.

Disinfection by spraying is not applicable in closed hospital settings. Especially in small environments, spraying disinfectants can rapidly lead to toxic concentrations in the air. There is also a considerable risk of generating an explosive aerosol.

6.4 Targeted operations for patient care

Although working with PPE prevents infection, one should always try to avoid splashing when performing high-risk tasks.

If possible, place yourself at a 45-degree angle to the patient so that acute splashing of bodily fluids does not reach your front and face.

Limit the number of staff in direct contact with the patient. Prevent unnecessary exposure by assigning specific tasks to a limited number of HCWs, making sure that not all the PPE users in the red zone are exposed to bodily fluids.

Key messages

- Think of the inner gloves as if they were your skin.
- Common sense based professional attitudes may give effective support in minimising contamination risks.

7 Tactical considerations

7.1 Staff planning

Working with PPE requires a considerable amount of human and economic resources. Coordination and preparation of the donning and doffing processes help to make the most efficient use of those resources.

The nursing and treatment procedures need to be adapted to the patient's condition and carefully balanced with the availability of trained workforce in the shift work roster. Explore all the options for transferring the patient to a specialised treatment centre at an early stage.

Some consideration for the staff:

- The assistant for doffing should be the HCW that is about to enter the red zone because he is still fresh and alert and the PPE has already been donned.
- Consider two working hours in PPE as the absolute maximum in a fully air-conditioned hospital.
- Prepare to reduce shift length if staff in the red zone show signs of exhaustion.

A conservative approach based on two HCWs working in the red zone says that 24 PPE ensembles are needed per patient and day (24-hour basis, maximum work time two hours).

Work has to be done in shifts. Each shift should have a sufficient number of experienced staff members.

- Plan your shifts in a way that there are always people available who can assist with the doffing of the PPE in the dark yellow zone.
- Proper coordination with the hospital structures outside of the isolation setting is crucial.
- Identify dedicated staff for providing consistent information to the patients' relatives and close contacts.

7.2 Incident management and reporting

Be prepared that incidents such as needlestick and sharps injuries can happen at any time.

Helpful hint

- When an incident occurs, do not act on impulse, reflect on what happened and assess before acting
- Ask your buddy/assistant what they noticed, report what happened, and try to come up with a solution.

Reporting incidents

All incidents have to be reported in order to address occupational health and related liability issues and to prevent future events. Analyse all reported incidents to identify lessons learned. Establish a culture of open reporting of incidents and nearby incidents as this will sustainably contribute to an improvement in staff safety in the long run.

Needlestick and sharps injuries

Staff need to prepare for needlestick and sharps injuries even in high precaution areas such as in the red zone.

Hospitals normally have established safe injection practices as part of their standard procedures. However, for incidents in an IDHC setting emergency plans need to be adapted to the barrier nursing environment.

If an accident occurs, act calmly and inform your buddy and your supervisor. Only HCWs wearing full body PPE can provide direct assistance in the dark yellow zone or in the red zone.

Helpful hints

- Prepare a container with alcohol disinfectant that can be used after a needle incident to clean the hand. The hand should be put into this container with the glove/s still on! In the meantime, the assistant can start the doffing process.

PPE components displaced

Some PPE components such as the respirator or the goggles can be displaced during work, which compromises the safety of the HCW.

Consider going to the doffing area (dark yellow zone) and ask for assistance to have the components of the PPE readjusted (assistant wearing full PPE protection). Change gloves, perform glove disinfection, and then ask for assistance.

Coverall rips, cuts and tears

If coveralls are torn, remain calm and proceed to the doffing process. Do not continue working with the compromised coveralls, not even after provisional fixing.

Steps:

- Disinfect the affected area.
- Fix the torn area with tape to avoid unnecessary contamination of skin or scrubs during doffing.
- Proceed calmly to the doffing process.

Damaged gloves

If a glove is damaged, determine whether only the outer glove is damaged or also the inner one/s. If only the outer glove is damaged, replace the torn glove. Be sure to apply proper glove hygiene. When the inner glove is also damaged, act as described below. Always report this as a high-risk incident.

If a damaged inner glove is discovered during the doffing process, disinfect the inner glove by putting the hand in the container with disinfectant. Put on a new inner glove on top of the broken one, so bare skin doesn't come into contact with the coverall sleeve during doffing. Proceed calmly with the doffing process and do not forget to report this incident.

Fainting

If your buddy faints or is indisposed, provide care without displacing any PPE components. Never assist any member of the team in the dark yellow or red zone without wearing a full PPE.

Key messages

- Never work alone.
- If an incident occurs, think first, ask the team to help and act calmly.

8 Considerations on barrier management

8.1 Waste management

Infected materials should be put in impermeable bags or hard plastic containers. These bags and containers need to be clearly labelled as highly infectious waste.

Considerations on waste management:

- Solid non-sharp waste should be placed in impermeable, clearly labelled bags to be discarded following applicable environmental regulations for the disposal and inactivation of infectious medical waste. Temporary disposal sites should be located as close as possible to the patient care area.
- Sharp, pointed objects (e.g. open vials, needles) should be placed in hard plastic containers and labelled clearly.
- Liquid waste (e.g. vomit, urine and diarrheal fluids) may be disposed in the sanitary sewer, as long as the HCW has appropriate PPE, followed by disinfection using standard hospital detergents and disinfectants.

Helpful hint

- The area designated for the final treatment and disposal of waste should have controlled access to prevent entry by non-authorised staff.

Extra protection for waste management

Consider using an extra pair of heavy-duty gloves when handling linen and waste as these items are highly infectious. Using additional layers of glove makes it more difficult to perform clinical duties.

Using a plastic apron can be useful when carrying large plastic bags, cleaning up, or handling dead bodies. Rubber boots are also useful.

Key messages

- Waste management is crucial throughout the entire process.
- Waste bags and containers need to be clearly labelled to identify them as highly infectious waste.

8.2 Zones and space requirements

Did you know?

Barrier nursing means nursing within clearly defined zones around the patient to which activities of different exposure risk are assigned.

The aim of barrier nursing is to protect the HCW but also the community from transmission of infectious diseases of high consequence.

Proper barrier management is the cornerstone in containing the spread of EVD in clinical settings.

Table 5. Barrier management: Zones and areas

Different zones	Activities	Specifications
Red zone	• Patient treatment area • Point of care; diagnostics • Cleaning and disinfection of HCW after visible contamination	• Monitored by direct or video assisted observation
Dark yellow zone **Light yellow zone**	• First re-entry step for staff exiting the red zone • Assisted disinfection and doffing for exit HCW • Potentially contaminating processes, such as cleaning and disinfection of boots and waste bags • Preparing waste for further processing, such as packaging waste bags in containers with non-removable clip-on lids • Storage of waste • Hand disinfection for HCW before stepping into the green zone	• Critical zone for prevention and control of secondary contamination. • Abundant space required for unrestricted assisted doffing process of two HCW in PPE • Additional dedicated cleaning and disinfection areas • Additional generously dimensioned waste storage areas.
Green zone	• Second step re-entry of staff from light yellow zone • Complete assisted donning for entry HCW • Briefing and de-briefing of staff • Staff coordination and supervision of activities • Inbound and outbound communications	• Strict access control • Space for clean supplies • Zones for staff recreation
Outside isolation area (access control)	Hospital routines	Hospital structures

Functionally, the yellow zone needs to be understood as the decisive area, in which secondary contamination is prevented and controlled: Here a contaminated HCW exiting from the red zone is brought in to clean conditions, which enable him or her to safely enter the green zone. Also, any material coming from the red zone, such as waste bags, re-usable PPE items, patient samples needed to be processed outside of the isolation unit are first cleaned and disinfected in the yellow zone. A particular function lies in the temporary storage of considerable amounts of waste produced every day in the nursing of a patient with an IDHC.

However, in all these processes there are some with a higher potential for secondary contamination than others, e.g. assisted doffing of an HCW compared to waste storage. Therefore the yellow zone needs to be conceived as with a gradient from dark yellow to light yellow according to the decrease in risk of secondary contamination. The 'dark yellow zone' starts immediately at the border with the 'red zone' while the 'light yellow zone' borders with the green zone. It is crucial that processes in the yellow zone are always allocated to the right gradient. E.g. assisted doffing of an HCW must be carried out in the dark yellow zone.

The transition from dark yellow to light yellow does not follow any spatial or structural elements, such as doors or rooms. It is a virtual gradient following different kinds of functions.

Helpful hints

- Different zones need to be clearly marked.
- Prevention and control of secondary contamination happens in the yellow zone.
- The yellow zone has a virtual gradient from 'high potential for contamination' (dark yellow) to 'low potential of contamination' (light yellow).
- Instructions for staff should be displayed at the entry of the isolation area.
- If there is a cross-contamination incident outside the red zone (e.g. patient leaving the red zone), the contaminated area has also to be considered as a red zone. New yellow and green zones need to be established around the new red zone. The zones can be put back into normal function by room disinfection, once the patient has been dismissed.
- Donning and doffing areas must be separated and visually marked. The donning area is in the green zone.
- The doffing area must be in the dark yellow zone, but has to be clearly separated from the light yellow zone.

Dedicated clogs

Dedicated clogs restricted to the red zone greatly simplify donning and doffing. Consider using integrated foot sections or attach boot covers to the coveralls and keep a pair of dedicated clogs in the red zone.

Distribution of space

Make sure that the green and yellow zones are big enough. The light yellow zone, which is both for logistic support and for temporary waste storage, needs to be fairly large to accommodate all activities.

Supervision

The presence of an experienced and specifically trained supervisor in barrier nursing observer is critical.

The main tasks of the supervisor are coordinating the clinical and the logistical operations at the point of care, organising waste management and supplies and leading on documentation and incident management.

Consider distancing measures to avoid unnecessary exposure of the supervisor (video camera monitoring or supervision from yellow zone). Supervisors should always be prepared to provide ad hoc support in the red zone. In case of staff-related emergencies they need to enter the red zone in PPE at short notice. The supervisor should not participate in routine tasks in patient care.

The supervisor can also support an assistant inexperienced at doffing, or guide the HCW who is the last exiting the red zone when there is no active assistance. The presence of a supervisor alone is not sufficient to guarantee the safety of HCWs in donning and doffing. Every HCW who puts on or removes PPE also needs an active assistant ('buddy system').

Key messages

- The light yellow zone needs to be big enough.
- The doffing area is in the dark yellow zone and is separated from the patient point of care in the red zone and from the waste storage in the light yellow zone.
- The processes among the different zones are coordinated by a designated supervisor, who also guards the integrity of each zone.

9 Staff safety requires proper training

There are few specialised treatment centres for infectious diseases in Europe. They are characterised by a high technical standard, e.g. rooms with negative air pressure, airlock anterooms, or dedicated decontamination showers for staff exiting the red zone, which simplifies the doffing of PPE. Even more important than the technical details is the fact that staff in these centres are continuously trained in the use of protective equipment and barrier nursing.

However, a large majority of hospitals are not specialised for IDHC and will face some serious challenges when attempting to build emergency capacity for highly contagious diseases:

- HCWs often display a traditional attitude towards patients, which is focused on providing support, care, and treatment.
- Prioritising self-, staff- and community protection over traditional caregiving roles requires a major shift in the self-perception of HCWs.
- It only takes a single IDHC patient to disrupt all daily routine processes and upset staff allocation.
- Recruiting staff for being part of a roster of experts ready to deal with IDHC patients only works on a voluntary basis. HCWs need the best possible training to be prepared for such work.
- In order to work with confidence in an IDHC scenario, HCWs need to continuously assess the 'invisible' risk of secondary contamination.
- 'Experienced' instructors on PPE and barrier nursing are difficult to find. Look for additional resources which can support the process of improving personal protection and safety.

As long as the case numbers are low, patients with an IDHC can be transferred to specialised treatment centres, which also means that non-specialised hospitals only need limited IDHC capacity.

Nonetheless, unplanned emergencies can happen, and non-specialised hospitals need to 'build safety through training'. There are several practical steps to achieve this goal:

- Staff protection is an employee's legal responsibility. It can be easily prioritised from a hospital's management perspective in periods of increased risk for importation of an IDHC, such as EVD from West Africa in 2014.
- Hospitals need to identify and mobilise relevant partners, e.g. officers for occupational health and safety, occupational physicians, specialised HCWs for hygiene and infection control, emergency planning managers, etc.
- Intersectoral cooperation is essential in this context. Emergency planning can then be supported by, for example, fire departments and their specialised units for the management of CBRN (chemical, biological, radiological and nuclear) threats. The principles of staff protection in this area are identical to the ones in a clinical setting. There are also CBRN-trained units in the area of civil protection which could easily share their know-how with HCWs. Military medicine is an additional potential resource because it covers the treatment of casualties from CBRN attacks.
- Specialised treatment centres for IDHC are ideal partners for conducting training activities. This type of partnership can be established at the regional, national and international level. Ideally these partnerships start in 'peacetime', so cooperation in a real life emergency has to overcome only a low threshold. Joint training initiatives in pre-outbreak times offer an enormous added value when it comes to the smooth coordination of patient transfers in outbreak emergencies.

Key messages

- Staff need to be thoroughly trained in protective equipment and barrier nursing before cases of an IDHC appear.
- This tutorial is a support document for trainers; it can also be used for self-study, but it is not intended to replace hands-on training courses.
- Training limited to the use of PPE is not enough. Infection control and barrier nursing constitute a specialised area of work which needs an integrative training approach.

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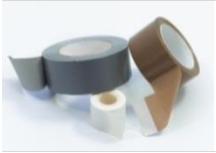
Annex 1. Checklist for PPE and waste management items

Table A-1. Checklist: PPE and waste management items

	Item	Specifiable aspects	Due for review	In progress	Completed
	Respirators	Different sizes and models; FFP3 and FFP2			
	Goggles	Different sizes and models; anti-fog coating; no or covered ventilation openings preferred			
	Heavy duty gloves	Different sizes and materials			
	Gloves	Different sizes, materials and models; latex and nitrile; sterile and non-sterile			
	Coveralls	Different sizes; single-use (disposable); integrated hood; fluid- and particle-proof; zipper covered by adhesive flaps			
	Hospital scrubs	Different sizes			
	Cotton socks	Different sizes			
	Clogs or boots	Different sizes, preferable with non-slip soles; mark or colour-code clogs or boots if only for use in specific areas (e.g. in the patient treatment zone = 'red zone')			

	Item	Specifiable aspects	Due for review	In progress	Completed
	Boot covers	Fluid-proof; have to be mechanically resistant if used as outer cover; non-slip soles are preferable			
	Shoe covers	Non-slip soles are preferable.			
	Hand disinfectant	Placed at the point of care, in donning and in the doffing areas			
	Hair covers	Different models			
	Waste management material	Big, leak-proof waste bag for solid infectious waste and clearly-labelled leak-proof bags or containers for linen			
		Leak-proof container for solid infectious waste			
		Container for sharp, pointed objects (e.g. needles, syringes, glass articles, tubing, etc.)			
	Adhesive tape to use with PPE	Tape without textile layer is preferred; quality parcel tape or chemical resistant tape works fine			

Annex 2. Removing the gloves

Properly removing gloves, while keeping the under-layer clean, should be practised frequently.

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