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Transmission Based Precautions Literature Review: Respiratory Protective Equipment (RPE)

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Author:	**Name:**	Craig Ritchie Allan
	Role:	Healthcare Scientist
	Division:	HPS
Owner:	Infection Control	
Approver:	Lisa Ritchie	
Approved by and Date:	6 October 2017	
Contact	**Name:**	Infection Control Team
	Tel:	0141 300 1175
	Email:	nss.hpsinfectioncontrol@nhs.net
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Version	Date	Summary of changes	Changes marked
3.0	October 2017	Additional research questions added for donning, doffing and decontamination of powered respirators. Fit testing added to recommendations, air changes table added as Appendix 1, power respirator/FFP3 change/removal separated into 2 questions. 'Fit test' distinguished from 'fit check'.	
2.0	July 2015	Addition of AGPs recommendations	
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1. Objectives

The aim is to review the extant scientific literature regarding the use of respiratory protective equipment (RPE) in the healthcare environment to form evidence based recommendations for practice. The specific objectives of the review are to determine:

- What is a respirator?
- What is a 'fit test'?
- What type of respirator is recommended for use in UK healthcare settings?
- Are there any legislative requirements relating to the use of respirators by healthcare workers?
- When should a respirator be worn?
- What is an aerosol generating procedure (AGP)?
- What is the correct procedure for putting on an FFP3 respirator?
- What is a 'fit check' and how is an FFP3 respirator fit check carried out?
- What is the correct procedure for removing an FFP3 respirator?
- When should an FFP3 respirator be changed?
- What is the correct procedure for putting on a powered respirator?
- What is the correct procedure for removing a powered respirator?
- When should a powered respirator filter be changed?
- How should a powered respirator be decontaminated?
- Should an infectious patient wear an FFP3 respirator?
- When should a visitor wear a respirator?

N.B. Transmission Based Precautions (TBPs) are measures that may be required **in addition to Standard Infection Control Precautions (SICPs).** It is assumed, for the purpose of this literature review that all SICPs are adhered to. Guidance on the use of RPE for Infection Diseases of High Consequence (IDHC) is available at:

http://www.nipcm.hps.scot.nhs.uk/documents/literature-review-personal-protective-equipment-ppe-for-infectious-diseases-of-high-consequence-idhc/.

2. Methodology

This targeted literature review was produced using a defined methodology as described in the National Infection Prevention and Control Manual: Development Process.

3. Recommendations

This review makes the following recommendations based on an assessment of the extant scientific literature on the use of respiratory protective equipment (RPE) in the healthcare setting.

What is a respirator?

A respirator is a device designed to protect the wearer against inhalation of hazardous substances and can be used by an individual to provide respiratory protection from infectious agents transmissible by the airborne (aerosol) route.

Within this document respirator refers to either FFP3 facemasks or powered respirators.

FFP3 are disposable facemasks that need to be fit tested.

What is a 'fit test'

Before an FFP3 respirator can be used, a fit test must be performed to ensure that an FFP3 mask can properly fit the wearers face shape, with no gaps between mask and face for air to pass unfiltered.

Tight fitting respiratory protective equipment such as FFP3 respirators can only provide effective protection if the wearer is clean shaven. Fit testing needs to be repeated on a regular basis or when there are any changes to a person's face including weight gain/loss, wearer has undergone significant dental work, or if the wearer has developed facial imperfections such as scars or mole that impair the face seal.[1]

(AGREE rating: Recommend)

It is a legislative requirement that wearers of FFP3 respirators are fit tested by a competent person to ensure that there is an adequate fit to provide protection against infectious agents. The results of the test need to be recorded and available for inspection.

(Mandatory)

Powered respirator hoods do not need fit tested and provide respiratory protection through the complete enclosure of the wearers head, they comprise a powered respirator unit (belt mounted) and a respirator hood.

(Good Practice Point (GPP))

What type of respirator is recommended for use in UK healthcare settings?

Only FFP3 respirators that comply with BS EN149 are recommended for use in UK healthcare settings.

(Mandatory)

If a good fit cannot be achieved with an FFP3 respirator then an alternative respirator that offers the same or greater level of protection (e.g. powered hood) should be considered.

(Mandatory)

Respirator hoods must be fluid-resistant and single-use disposable

(Good Practice Point (GPP))

Powered respirators must have a fully enclosed filter that can be wiped down with detergent and/or disinfectant and have a washable belt.

(Good Practice Point (GPP))

Are there any legislative requirements relating to the use of a respirator by healthcare workers?

There is no direct legislative requirement for healthcare workers to wear a respirator when delivering care, however, UK legislation does require employers to provide PPE that affords adequate protection against the risks associated with the task being undertaken. Healthcare workers have a responsibility to ensure that suitable PPE is worn correctly for the task being undertaken.

(Mandatory requirement)

Healthcare workers must have undergone a fit test prior to using an FFP3 respirator.

(Mandatory requirement)

When should a respirator be worn?

The decision to wear a respirator should be based on clinical risk assessment (e.g. task being undertaken; the infectious status of the patient; presenting symptoms) when caring for patients known or suspected to be infected with microorganisms transmissible by the airborne (aerosol) route. For specific information on infectious agents see: Appendix 11 of the NIPCM

(AGREE rating: Recommend)

Respirators must be worn when carrying out aerosol generating procedures (AGPs) on patients known or suspected to be infected with a microorganism transmissible by the droplet and/or airborne (aerosol) route. Compatible eye protection should always be worn with an FFP3 respirator.

(AGREE rating: Recommend)

Respirators should be put on by healthcare workers before entry into the patient room/area and/or prior to performing an aerosol generating procedure (AGP).

(AGREE rating: Recommend)

The time after which a patient room/area can be entered without respiratory protection should be determined following a risk assessment that takes into account the number of air changes per hour (ventilation rate). For recommended air change rates see Appendix 1.

(AGREE rating: Recommend)

What is an aerosol generating procedure (AGP)?

Aerosol generating procedures are certain medical and patient care procedures that result in the production of airborne particles (aerosols) and create the potential for airborne transmission of infections that may otherwise only be transmissible by the droplet route.[2] The following procedures are currently considered to be AGPs:

- Intubation, extubation and related procedures e.g. manual ventilation and open suctioning.
- Cardiopulmonary resuscitation.
- Bronchoscopy.
- Surgery and post-mortem procedures involving high-speed devices.
- Some dental procedures (e.g. drilling).
- Non-invasive ventilation (NIV) e.g. Bi-level Positive Airway Pressure (BiPAP) and Continuous Positive Airway Pressure ventilation (CPAP).
- High-Frequency Oscillating Ventilation (HFOV).
- Induction of sputum.[2]

[This is an area of active research and this list is likely to be subject to change to reflect this].

(AGREE rating: Recommend)

What is the correct procedure for putting on an FFP3 respirator?

The generic steps for putting on an FFP3 respirator are outlined below; however, specific manufacturer instructions should be followed.

1. Hold the respirator in one hand and separate the edges to fully open it with the other hand. Bend the nose wire (where present) at the top of the respirator to form a gentle curve.
2. Turn the respirator upside down to expose the two headbands, and then separate them using your index finger and thumb. Hold the headbands with your index finger and thumb and cup the respirator under your chin.
3. Position the upper headband on the crown of your head, above the ears, not over them. Position the lower strap at the back of your head below your ears.
4. Ensure that the respirator is flat against your cheeks.
5. Mould the nosepiece across the bridge of your nose by firmly pressing down with your fingers until you have a good facial fit. If a good fit cannot be achieved, try another size or design of FFP3.
6. A fit check should now be performed to ensure there are no leaks.

(Good Practice Point (GPP))

What is a 'fit check' and how is an FFP3 fit check carried out?

After the FFP3 respirator has been put on, but before entering the work area, a 'fit check' must be performed to ensure a secure seal is formed between the mask and the wearers face; leaving no gaps where unfiltered air may pass.[1]

The generic steps for a respirator fit check are outlined below; however, specific manufacturer instructions should be followed.

1. Cover the front of the respirator with both hands, being careful not to disturb the position of the respirator on the face.
2. For an **unvalved** product – exhale sharply; for a **valved** product – inhale sharply.
3. If air flows around the nose, readjust the nosepiece; if air flows around the edges of the respirator, re-adjust the head bands.
4. A successful fit check is when there is no air leaking from the edges of the respirator. Always perform a fit check **before** entering the work area.

(AGREE rating: Recommend)

What is the correct procedure for removing an FFP3 respirator?

The generic steps for removing an FFP3 respirator are outlined below; however, specific manufacturer instructions should be followed.

Before leaving the relevant work area:

1. Gloves, gown/apron and eye protection should be removed (in that order, where worn) and disposed of as healthcare (including clinical) waste.
2. On removal of eye protection, it should be handled by the headband or earpieces only.
3. Where non-disposable eye protection has been used, appropriate measures for decontamination between uses need to be in place.
4. Hand hygiene must be performed after removal and disposal.

After leaving the area:

5. Respirators can be removed and disposed of as healthcare (including clinical) waste.
6. Untie or break the bottom ties first, followed by top ties or elastic, and remove by handling ties only.
7. Hand hygiene must be performed after disposal.[1]

(Good Practice Point (GPP))

When should an FFP3 respirator be changed?

FFP3 respirators should be changed: after each use; if breathing becomes difficult; if the respirator becomes damaged; or if it becomes obviously contaminated with body fluids such as respiratory secretions.

AGREE rating: Recommend)

What is the procedure for putting on a powered respirator?

A powered respirator will be worn with a fluid-resistant, disposable gown; the suggested procedure for donning the powered respirator ensemble is:

1. Apply a disposable, fluid-resistant gown
2. Apply the belt-mounted respirator unit to the waist and buckle securely and comfortably
3. Apply the respirator hood and attach the breathing tube
4. Switch on the respirator unit
5. Ensure the respirator hood is comfortable and secure.
6. Apply a fluid-resistant, disposable apron over the ensemble

(Good Practice Point (GPP))

What is the procedure for removing a powered respirator?

Single use components should be immediately disposed of into the clinical waste stream, reusable components should be placed into a designated container marked for decontamination immediately as they are removed. The suggested procedure for removing the powered respirator ensemble is:

1. Remove gloves and the fluid-resistant, disposable apron before leaving the clinical area
2. Detach the breathing tube from the respirator hood (a buddy may assist if needed)
3. Carefully remove the respirator hood by grasping the sides and pulling up an away from the face
4. Switch off the respirator unit and unbuckle the respirator waist belt
5. Remove the non-sterile disposable gown by breaking the ties and pulling away from the neck and shoulder. Touching the inside of the gown only, turn the gown inside out by carefully rolling or folding into a bundle
6. Perform hand hygiene

(Good Practice Point (GPP))

How should a powered respirator be decontaminated?

- Single-use hoods must be disposed of after each care activity. Re-useable hoods must be disinfected after each care activity, unless an IDHC.
- Any re-useable components of powered respirators, such as belt and respirator, must be decontaminated after each care activity. Decontamination should follow the manufacturer's instructions and a record kept, unless an IDHC. Re-using components of powered respirators should always be based on an assessment of clinical risk, taking into consideration the infectious agent and presence of blood or body fluids.

(Good Practice Point (GPP))

When should a powered respirator filter be changed?

Powered respirator filters should be changed according to manufacturer's instructions or if damaged, visibly dirty, contaminated with blood or body fluids, when breathing resistance increases and after each use for patients with known or suspected IDHC.

(AGREE rating: Recommend)

Should an infectious patient wear an FFP3 respirator?

Infectious patients should never wear an FFP3 respirator.

(AGREE rating: Recommend)

When should a visitor wear a respirator?

The use of a respirator may be offered to those who wish to visit a patient known or suspected to be infected with a microorganism spread by the airborne (aerosol) route. This decision should be based on a risk assessment.

(Good Practice Point (GPP))

4. Discussion

4.1 Implications for practice

What is a respirator?

A respirator is a device designed to protect the wearer against inhalation of hazardous substances[2] and can be used by an individual to provide respiratory protection from infectious agents transmissible by the airborne (aerosol) route. Respirators can also be used to protect healthcare workers during aerosol generating procedures. In the healthcare setting the term respirator most commonly refers to the filtering half face piece (FFP). There are three categories of Filtering Face Piece (FFP): FFP1; FFP2 (roughly equivalent to a N95 respirator); and FFP3. The FFP3 respirator offers the highest level of protection and requires the wearer to be fit tested.[2] A powered respirator is the alternate of FFP3, these do not need fit tested and provide respiratory protection through complete enclosure of the wearers head. They comprise a powered respirator unit (belt mounted) and a respirator hood, the respirator confers protection against infectious agents by blowing filtered air into the hood. [2;3]

What is a 'fit test'?

Before an FFP3 respirator can be used, a fit test must be performed to ensure that an FFP3 mask can properly fit the wearers face shape, with no gaps between mask and face for air to pass unfiltered. [1]

There is no defined frequency for repeat fit testing, but every 2 years has been suggested as a baseline. [1] Fit testing also needs to be repeated when there are any changes to a wearers face including: weight gain/loss, if they have undergone significant dental work, or have developed facial imperfections such as scars or moles that impair the face seal.[1]

(AGREE rating: Recommend)

Powered respirator hoods do not need fit tested and provide respiratory protection through the complete enclosure of the wearers head, they comprise a powered respirator unit (belt mounted) and a respirator hood.

(Good Practice Point (GPP))

What type of respirator is recommended for use in UK healthcare settings?

FFP3 respirators are recommended for use in UK healthcare settings by the Health and Safety Executive (HSE) to protect healthcare workers from infectious aerosols.[2] HSE stipulate that FFP3 respirators must comply with British Standard BS EN149.[2]

(Mandatory)

Tight fitting respiratory protective equipment such as FFP3 respirators can only provide effective protection if the wearer is clean shaven. Beards, long moustaches and stubble may prevent an adequate seal being formed. Other types of respiratory protection that offer the same or greater level of protection (e.g. powered respirators) should be considered if a good fit cannot be achieved with an FFP3 respirator.[1;2]

(Mandatory)

The hood component of powered respirators must be fluid-resistant when protection against splash and spray is required and single-use disposable. Powered respirators must have an enclosed filter unit that can be wiped down with detergent and/or disinfectant. The belt component of powered respirators must be washable.

(Good Practice Point (GPP))

Are there any legislative requirements relating to the use of respirators by healthcare workers?

Although there is no direct legislative requirement for healthcare workers to wear a respirator when delivering care, UK legislation does require employers to provide PPE that affords adequate protection against the risks associated with the task being undertaken.

In the UK, the Health and Safety at Work etc. Act (HSWA) requires a safe working environment and sets the precedent from which all other health and safety regulations follow.[4] The Management of Health and Safety at Work Regulations (MHSWR) place the legal responsibility for health and safety primarily with the employer.[5]

Under the Control of Substances Hazardous to Health (COSHH) Regulations, where it is not reasonably practicable to prevent exposure to a substance hazardous to health via elimination

or substitution (as is the case where healthcare workers are caring for individuals known, or suspected, to be infected with a microorganism spread by the airborne (aerosol) route), then the hazard must be adequately controlled by "applying protection measures appropriate to the activity and consistent with the risk assessment".[6]

This includes the following controls listed in order of priority:

1. "The design and use of appropriate work processes, systems and engineering controls and the provision and use of suitable work equipment and materials.
2. The control of exposure at source, including adequate ventilation systems and appropriate organisational measures; and
3. Where adequate control of exposure cannot be achieved by other means, the provision of suitable personal protective equipment".[6]

COSHH requires that employees use the control measures provided, including PPE, appropriately. Therefore all reasonable steps should be undertaken by employers to make sure that control measures are used. [6]

There is no direct legislative requirement for healthcare workers to wear a respirator when delivering care, however, UK legislation does require employers to provide PPE that affords adequate protection against the risks associated with the task being undertaken. Healthcare workers have a responsibility to ensure that suitable PPE is worn correctly for the task being undertaken.

(Mandatory)

It is also a legislative requirement that wearers of FFP3 respirators are fit tested prior to using and FFP3 respirator to ensure that there is an adequate fit to provide protection.[2]

(Mandatory)

When should a respirator be worn?

The requirement to wear a respirator is determined by a risk assessment based on the task being undertaken; the suspected or known infectious state of the patient; the presenting symptoms of the patient.[1]

(AGREE rating: Recommend)

There is consensus in the literature that healthcare workers should use an approved respirator when caring for patients known or suspected to be infected with certain microorganisms transmissible by the airborne (aerosol) route i.e. MDR-TB and XDR-TB and SARS, while the patient is considered infectious. [7-10] Recent evidence-based guidance on the use of respiratory and facial protection equipment published by the Healthcare Infection Society (HIS) states that a respirator should be worn when caring for patients with active respiratory TB until MDR or XDR disease has been excluded; HIS produced a flow-diagram to assist in the decision making process, this is available on Appendix 2. [1] This recommendation differs from recommendation in other UK guidance such as the recommendation by the National Institute for Health and Care Excellence (formerly the National Institute for Health and Clinical Excellence), that healthcare workers are only required to wear a mask [respirator] when caring for a patient with TB if MDR TB is suspected.[10] The Healthcare Infection Society guidance also differs from Scottish guidance published by the Health Protection Network which states that healthcare workers should wear a respirator when caring for a patient with TB if MDR TB is suspected, but outlines the additional requirement for healthcare workers to wear a respirator when: “intensive nursing intervention is required if the healthcare worker is likely to have close contact (equivalent to household contact) for a cumulative total for eight hours or more”.

The Healthcare Infection Society guidance has defined the microorganisms that require the use of respiratory protective equipment i.e. FFP3 respirator.[1]

The use of a respirator is recommended when carrying out “aerosol generating procedures” (AGPs). These procedures can generate an aerosol hazard from an infection that may otherwise be only transmissible by the droplet route.[1]

(Good Practice Point (GPP))

Eye protection such as safety goggles or visors must be worn when a risk of contamination of the eyes is anticipated i.e. from droplets or splashes including respiratory secretions. Eye protection is always required during potentially infectious AGPs.[1] Eye protection should ideally be disposable however if this is not possible then it should be decontaminated following use.[1]

Due to the fact that the infectious particles have the potential to disseminate beyond the immediate environment of the patient, the FFP3 respirator should be put on before entry into the room or area of a patient suspected or confirmed to be infectious.[9]

(AGREE rating: Recommend)

The rate of clearance of aerosols in an enclosed space (room) is dependent on the extent of ventilation: the greater the number of air changes per hour (ventilation rate), the faster any aerosols will be diluted.[1] The time required for dilution of aerosols, and thus the time after which the room can be entered without respiratory protection, can be determined following a risk assessment.[1] The risk assessment should take into account the number of air changes per hour (assuming perfect mixing, a single air change removes 63% of airborne contamination, each subsequent air change removes 63% of what remains; therefore five air changes reduces contamination to <1% of its former level, assuming dispersal has ceased). [1]

(AGREE rating: Recommend)

What is an aerosol generating procedure (AGP)?

Aerosol generating procedures (AGPs) are medical and patient care procedures that result in the production of airborne particles (aerosols) and create the potential for airborne transmission of infections that may otherwise only be transmissible by the droplet route. AGPs can produce airborne particles <5 micrometres (µm) in size which can remain suspended in the air, travel over a distance and may cause infection if they are inhaled.

From the available literature [1;11] and incorporating UK expert opinion, the following procedures are currently considered to be AGPs:

- Intubation and extubation
- Manual ventilation
- Open suctioning
- Cardiopulmonary resuscitation
- Bronchoscopy
- Surgery and post-mortem procedures involving high-speed devices
- Some dental procedures (e.g. drilling)

- Non-invasive ventilation (NIV) e.g. Bi-level Positive Airway Pressure (BiPAP) and Continuous Positive Airway Pressure ventilation (CPAP)
- High-Frequency Oscillating Ventilation (HFOV)
- Induction of sputum

The current UK AGPs list is based on a 2007 systematic review by the World Health Organization (WHO), which ranked procedures according to the strength of available evidence.[12] The WHO 2007 list of AGPs did not include dental procedures or induction of sputum; it remains unclear what evidence was used to include these procedures on the UK list; it was likely these were based on expert opinion. The most recent assessment by the WHO (2014) stated that there was only consistent evidence for tracheal intubation, tracheotomy, non-invasive ventilation and manual ventilation before intubation as AGPs; this was based on the systematic review by Tran et al.[12;13]

The systematic review by Tran et al. of AGPs and risk of acute respiratory infection (ARI) transmission was published in 2012.[13] The review included ten studies (five case-control; five cohort), all of which investigated the protective measures or the risk factors for transmission of SARS from patients to healthcare workers in intensive care or other healthcare settings during the 2002-2003 SARS outbreaks.[13] The review found, based on the included studies, that the following procedures present an increased risk of transmission: tracheal intubation, non-invasive ventilation, tracheotomy and manual ventilation before intubation.[13] Other intubation associated procedures, endotracheal aspiration, suction of body fluids, bronchoscopy, nebulizer treatment, administration of oxygen, high flow oxygen, manipulation of oxygen mask or BiPAP mask, defibrillation, chest compressions, insertion of nasogastric tube, and collection of sputum were not significantly associated with and increased risk of transmission.[13] In conclusion the authors urge caution when interpreting the results, highlighting the lack of research this field and the low quality of the studies available.

In a 2009 review of the risks and disease transmission associated with AGPs, the authors noted that the evidence defining the relative risk of presumed AGPs was ‘insubstantial’. The authors concluded that while there is ‘compelling evidence’ that procedures such as bronchoscopes’ generate aerosols, the potential for aerosol generation from some procedures may have been overstated. They further concluded that the uncertainty surrounding AGPs makes it difficult to

construct effective infection control policy, and further research is required to definitively determine which procedures generate aerosols.[14]

The findings of the review, therefore, suggest that some procedures potentially capable of generating aerosols have been associated with increased risk of SARS transmission to healthcare workers, or were a risk factor for transmission, with the most consistent association across multiple studies indentified with tracheal intubation.[13]

The WHO list of AGPs did include nebulisation. There is now consistent evidence that nebulisation and oxygen therapy (pressurised humidified O2) do not result in an increased risk of aerosols from patients.[13;15] During nebulisation the aerosol derives from the fluid in the nebuliser chamber and not from the patient It should be noted that induction of sputum does not include chest physiotherapy. Chest physiotherapy may increase droplet production, however evidence indicates these particles are predominantly >10µm in size and precipitate within 1m of the patient, therefore droplet precautions are considered sufficient.[15]

The scientific evidence necessary to establish which procedures are associated with transmission of respiratory pathogens is generally limited and most studies lack quality. The majority of available studies were undertaken during SARS outbreaks; evidence of transmission risk/aerosol production that relate to one specific infection should be interpreted with caution and cannot be generalised to other respiratory infections.

Although there is an absence of strong evidence to support some of the procedures listed as AGPs in this document this does not mean that there is an absence of risk; at present there is insufficient evidence to alter this list of AGPs and a precautionary approach should be taken for all procedures listed above as potentially capable of generating infectious aerosols from patients suspected or known to have respiratory infections.

This is an area of active research and this list may be subject to change as new evidence emerges.

(AGREE rating: Recommend)

What is the correct procedure for putting an FFP3 respirator on?

Generic guidance produced by the Department of Health for putting on an FFP3 respirator is outlined below; however, specific manufacturer instructions should be followed.

1. Hold the respirator in one hand and separate the edges to fully open it with the other hand. Bend the nose wire (where present) at the top of the respirator to form a gentle curve.
2. Turn the respirator upside down to expose the two headbands, and then separate them using your index finger and thumb. Hold the headbands with your index finger and thumb and cup the respirator under your chin.
3. Position the upper headband on the crown of your head, above the ears, not over them. Position the lower strap at the back of your head below your ears.
4. Ensure that the respirator is flat against your cheeks.
5. Mould the nosepiece across the bridge of your nose by firmly pressing down with your fingers until you have a good facial fit. If a good fit cannot be achieved, try another size or design of FFP3.
6. A fit check should now be performed to ensure there are no leaks.[16]

(Good Practice Point (GPP))

What is a 'fit check' and how is an FFP3 respirator fit check carried out?

After putting the FFP3 respirator on, a 'fit check' must be performed to ensure a secure seal is formed between the mask and the wearers face; leaving no gaps where unfiltered air may pass.[1]

Guidance produced by the Healthcare Infection Society on the use of respiratory and facial protection equipment outlines how an FFP3 respirator fit check should be carried out:

1. Cover the front of the respirator with both hands, being careful not to disturb the position of the respirator on the face.
2. For an **unvalved** product – exhale sharply; for a **valved** product – inhale sharply.
3. If air flows around the nose, readjust the nosepiece; if air flows around the edges of the respirator, re-adjust the head bands.

4. A successful fit check is when there is no air leaking from the edges of the respirator. Always perform a fit check **before** entering the work area. [1]

(AGREE rating: Recommend)

What is the correct procedure for removing an FFP3 respirator?

Generic guidance produced by the Healthcare Infection Society for removing an FFP3 respirator is outlined below; however, specific manufacturer instructions should be followed

Before leaving the relevant work area:

- Gloves, gown/apron and eye protection should be removed (in that order, where worn) and disposed of as healthcare (including clinical) waste.
- On removal of eye protection, it should be handled by the headband or earpieces only.
- Where non-disposable eye protection has been used, appropriate measures for decontamination between uses need to be in place.
- Hand hygiene must be performed after removal and disposal.

After leaving the area:

- Respirators can be removed and disposed of as healthcare (including clinical) waste.
- Untie or break the bottom ties first, followed by top ties or elastic, and remove by handling ties only.
- Hand hygiene must be performed after disposal.[1]

(AGREE rating: Recommend)

When should an FFP3 respirator be changed?

FFP3 respirators are single use/disposable and should be changed after each use. Other indications that a change in respirator is required include: if breathing becomes difficult; if the respirator becomes damaged; or if the respirator becomes obviously contaminated with body fluids such as respiratory secretions. [1]

(Good Practice Point (GPP))

How should a powered respirator be put on?

Health Protection Scotland undertook an SBAR to determine the correct procedure for doffing, donning and decontaminating a powered respirator. Recommendations based on expert opinion and current were made however, specific manufacturer instructions should be followed.[3]

A powered respirator will be worn with a fluid-resistant, disposable gown; the procedure for donning the powered respirator ensemble is:

1. Apply a disposable, fluid-resistant gown
2. Apply the belt-mounted respirator unit to the waist and buckle securely and comfortably
3. Apply the respirator hood and attach the breathing tube
4. Switch on the respirator unit
5. Ensure the respirator hood is comfortable and secure.
6. Apply a fluid-resistant, disposable apron over the ensemble

(Good Practice Point (GPP))

How should a powered respirator be removed?

The procedure for doffing a powered respirator (including gown) is outlined below. Single use components should be immediately disposed of into the clinical waste stream, reusable components should be placed into a designated container marked for decontamination immediately as they are removed.[3]

1. Remove gloves and the fluid-resistant, disposable apron before leaving the clinical area
2. Detach the breathing tube from the respirator hood (a buddy may assist if needed)
3. Carefully remove the respirator hood by grasping the sides and pulling up an away from the face
4. Switch off the respirator unit and unbuckle the respirator waist belt
5. Remove the non-sterile disposable gown by breaking the ties and pulling away from the neck and shoulder. Touching the inside of the gown only, turn the gown inside out by carefully rolling or folding into a bundle

6. Perform hand hygiene

(Good Practice Point (GPP))

How should a powered respirator be decontaminated?

Any re-useable components of powered respirators, such as hoods, belts and battery packs must be decontaminated after each care activity. Decontamination should follow the manufacturer's instructions and a record must be kept.[3]

(Good Practice Point (GPP))

When should powered respirator filters be changed?

Powered respirator filters should be changed according to manufacturer's instructions or if visibly damaged, visibly dirty, contaminated with blood or body fluids, when breathing resistance increases and after each use for patients with known or suspected IDHC.[3]

(Good Practice Point (GPP))

Should an infectious patient wear an FFP3 respirator?

Due to the nature of the FFP3 respirator filtration, which filters incoming air and not expelled air, it is not suitable for an infectious patient to wear an FFP3 respirator.[8]

Infectious patients should never wear an FFP3 respirator.

(AGREE rating: Recommend)

When should a visitor wear a respirator?

There is very little scientific evidence on the use of PPE, including respirators, by visitors.[9] It is therefore not possible to make evidence-based recommendations on this issue.

The use of a respirator may be offered to those who wish to visit a patient known or suspected to be infected with a microorganisms spread by the airborne (aerosol) route based on a risk assessment.

(Good Practice Point (GPP))

4.2 Implications for research

There is greater emphasis in the literature on N95 respirators, with relatively few studies of FFP3 respirators or powered hoods. More research on FFP3 respirators and powered hoods, which are recommended for use in the UK, would be beneficial to strengthen the evidence base. [17-19]

A recent review concluded that although a number of procedures are currently categorised as aerosol generating procedures, for some there is insufficient evidence to confirm that they actually do produce aerosols.[14] Further research in this area may be warranted.

The evidence base supporting the aerosol transmission of influenza is building and is now stronger than it was before the last pandemic.[20-23] The Public Health England (PHE) NERVTAG subcommittee have recommended that during an influenza pandemic all persons (staff and visitors) present in an Intensive Care Unit (ICU) housing pandemic influenza patients should be issued with FFP3 respirators at all times (unless patients are isolated in a negative pressure side room, where only staff entering the room need wear a respirator). All general ward staff, community, ambulance and social care staff should wear surgical masks for close patient contact, unless performing an AGP, when a respirator should be worn.[24]

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Appendix 1: Recommended air-change rates [25]

Application	Ventilation	ac/Hour	Pressure (Pascals)	Supply Filter	Noise (NR)	Temp (°C)	Comments For further information see Section 6
General ward	S / N	6	-	G4	30	18-28	
Communal ward toilet	E	10	-ve	-	40	-	
Single room	S / E / N	6	0 or –ve	G4	30	18-28	
Single room WC	E	3	-ve	-	40	-	
Clean utility	S	6	+ve	G4	40	18-28	
Dirty utility	E	6	-ve	-	40	-	
Ward Isolation room	-	-	-	-	-	-	See SHPN 4; Supplement 1
Infectious disease Iso room	E	10	-5	G4	30	18-28	Extract filtration may be required
Neutropenic patient ward	S	10	+10	H12	30	18-28	
Critical Care Areas	S	10	+10	F7	30	*18-25*	Isolation room may be –ve press
Birthing Room	S & E	15	-ve	G4	40	*18-25*	Provide clean air-flow path
SCBU	S	6	+ve	F7	30	*18-25*	Isolation room may be –ve press
Preparation room (Lay-up)	S	>25	35	F7*	40	*18-25*	*H12 if a lay-up for a UCV Theatre
Preparation room / bay sterile pack store	S	10	25	F7	40	*18-25*	*50NR if a bay in a UCV Theatre
Operating theatre	S	25	25	F7	40	*18-25*	
UCV Operating theatre	S	25*	25	H12	40	*18-25*	Fresh air rate; excludes re-circulation
Anaesthetic room	S & E	15	>10	F7	40	*18-25*	Provide clean air-flow path
Theatre Sluice/dirty utility	E	>20	-5	-	40	-	
Recovery room	S & E	15	0	F7	35	*18-25*	Provide clean air-flow path

Appendix 2: Flow diagram for the selection of respiratory and facial protection [1]