Standard Infection Control Precautions Literature Review:
Personal Protective Equipment (PPE)
Gloves

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This literature review will be updated in real time if any significant changes are found in the professional literature or from national guidance/policy.

Version	Date	Summary of changes	Changes marked
3.0	July 2016	**Addition of New Recommendation – 'When should sterile or non-sterile gloves be worn?'** "Sterile gloves are not required for minor skin surgery, e.g. wound suturing and local skin excisions." (Grade B recommendation)	
2.0	April 2014	Defined as final	
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Version	Date Approved	Name	Job Title	Division
3.0	July 2016	NPGO Steering Group		
2.0	April 2014	Steering (Expert Advisory) Group for SICPs and TBPs		
1.0	January 2012	Steering (Expert Advisory) Group for SICPs and TBPs		

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Description:	This literature review examines the available professional literature on PPE (Gloves) in the hospital setting.
Purpose:	To inform the Standard Infection Control Precaution (SICP) section on PPE (Gloves) in the National Infection Prevention and Control Manual in order to facilitate the prevention and control of healthcare associated infections in NHSScotland healthcare settings.
Target audience:	All NHS staff involved in the prevention and control of infection in NHSScotland.
Circulation list:	Infection Control Managers, Infection Prevention and Control Teams, Public Health Teams
Update/review schedule:	Updated as new evidence emerges with changes made to recommendations as required.
Cross reference:	National Infection Prevention and Control Manual http://www.nipcm.hps.scot.nhs.uk/ SBAR – Use of gloves for environmental cleaning http://www.nipcm.hps.scot.nhs.uk/documents/sbar-use-of-gloves-for-environmental-cleaning/ SBAR – Immunisation and use of gloves http://www.nipcm.hps.scot.nhs.uk/documents/sbar-gloves-for-administering-immunisations-january-2014/
Update level:	Changes to practice – Minor changes to recommended use of sterile/non-sterile gloves Research – No significant changes

Contents

1. Objectives

The aim of this review is to examine the extant professional literature regarding the use of gloves as Personal Protective Equipment (PPE) for standard infection control purposes. The specific objectives of the review are to determine:

- Are there any legislative requirements for the use of gloves as PPE for infection control purposes?
- When should gloves be worn?
- When should sterile or non-sterile gloves be worn?
- What type of gloves should be worn based on material type, e.g. latex, nitrile, neoprene?
- When should non-sterile examination or surgical gloves be worn?
- Should specific gloves be worn for specific procedures?
- When should double gloving be adopted?
- How should double gloves be worn?
- When should gloves be changed or removed?
- How should gloves be donned (put on)?
- How should gloves be removed and disposed of?
- How should gloves be stored?
- What are the healthcare-associated infection risks of reusing gloves?
- What are the healthcare-associated infection risks of using alcohol-based hand rub on gloves, rather than changing gloves?

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 professional literature on gloves as PPE for standard infection control purposes.

Are there any legislative requirements for the use of gloves as PPE for infection control purposes?

There is no direct legislative requirement to wear gloves for the purposes of the prevention and control of infection; however the Health and Safety at Work Act (1974), Control of Substances Hazardous to Health (2002 as amended) regulations and Personal Protective Equipment at Work Regulations 1992 (as amended) legislate that employers (i.e. NHSScotland) must provide PPE which affords adequate protection against the risks associated with the task being undertaken. Employees (i.e. healthcare workers) have a responsibility to comply by ensuring that suitable PPE is worn correctly for the task being carried out.

The Health and Safety Executive (HSE) have issued specific UK guidance relating to the use of disposable latex gloves: It stipulates that their use must be based on a risk assessment which has deemed their use necessary, and that in such instances, disposable latex gloves must be low-protein and powder-free.

Specific standards relating to the quality and performance of gloves are outlined in **Appendix 1**.

When should gloves be worn?

The use of gloves should be based on an assessment of the risk of contact with blood, body fluids, secretions and/or excretions, non-intact skin, mucous membranes, hazardous drugs and chemicals, e.g. cleaning agents: Where such a risk exists, gloves should be worn to protect the healthcare worker and/or the patient.

(Grade D recommendation)

It is not usually necessary to wear gloves for administering immunisations unless:

- It is anticipated that there may be exposure to blood or body fluids;
- The healthcare worker has non-intact skin on their hands; or
- The person receiving the immunisation has non-intact skin.

Gloves may also be worn to offer protection to healthcare workers where there is a risk of exposure to vaccination solutions when administering immunisations.

Gloves should be worn for administering immunisations where advocated by the vaccine manufacturer or by clinical consensus.

(AGREE rating: Recommend)

When should sterile or non-sterile gloves be worn?

Healthcare workers should assess the procedure which has to be undertaken, which will determine whether sterile or non-sterile gloves should be worn.

Sterile gloves should be worn:

- for most surgical procedures*;
- for invasive procedures, e.g. lumbar puncture;
- as part of an aseptic technique; and
- for the insertion of some invasive devices**, e.g. urinary catheter and central venous catheter.

Non-sterile gloves should be worn for:

- non-sterile procedures, e.g. patient examination; and
- communal care equipment and environmental cleaning.

(Grade D recommendation)

*Sterile gloves are not required for minor skin surgery, e.g. wound suturing and local skin excisions.

(Grade B recommendation)

**Sterile gloves are not required for the insertion of a peripheral venous catheter, for obtaining blood cultures or when a safety device/technique is used.

(Good Practice Point (GPP))

When indicated, non-sterile gloves should be used for administering immunisations.

(AGREE rating: recommend)

What type of gloves should be worn based on material type, e.g. latex, nitrile, neoprene?

Latex (including DPNRL) gloves should be worn when it is anticipated that there will be contact with blood or body fluids as they provide the best fit, dexterity and provide the greatest comfort as well as good barrier protection.

Where latex cannot be worn either nitrile or neoprene gloves are a suitable alternative, with nitrile gloves exhibiting good protection against lipids and bone cement. Manufacturers have recently developed 'next generation' nitrile gloves that claim to provide greater flexibility.

Vinyl gloves should not be worn when it is anticipated there will be contact with blood or body fluids or cytotoxic drugs.

The following gloves are **unsuitable** for clinical care and should not be used for clinical purposes:

- Polythene;
- Copolymer or ethylene-methyl methacrylate or EMA; and
- Polyvinyl chloride (PVC)

No glove material provides protection against all hazards which may be encountered in the hospital setting, where any doubt exists as to the barrier efficiency of a particular glove type, the manufacturer should be contacted for further information.

(Grade D recommendation)

Glove material and durability should be appropriate to the task, and gloves should fit correctly.

(AGREE rating: recommend)

Single-use disposable gloves that meet the standard EN374-2 (and EN374-3 if exposure to chemical agents is anticipated) should be worn for environmental cleaning. Re-usable household ('Marigold' type) gloves are not suitable for environmental cleaning tasks in healthcare settings due to the risk of cross-infection.

(Good Practice Point (GPP))

When should non-sterile examination or surgical gloves be worn?

Examination gloves:

Non-sterile examination gloves should normally be used during procedures that do not require sterile conditions, e.g. blood tests. Some of these gloves can also protect the wearer from harm caused by chemicals or pharmaceuticals.

(Good Practice Point (GPP))

Surgical gloves:

Surgical gloves have more precise sizing with better fit and tactility, and are generally made from thicker material. Their primary purpose is to act as a barrier to prevent the possible cross-transmission of diseases between healthcare professionals and patients during surgical procedures.

(Good Practice Point (GPP))

Should specific gloves be worn for specific procedures?

The gloves worn for a specific procedure should be informed by whether there is a need to maintain sterility and the protective qualities of specific glove materials.

(Good Practice Point (GPP))

When should double gloving be adopted?

It is recommended that double gloving, using an indicator glove, should be considered for Exposure Prone Procedures (EPPs) in the operating theatre setting, for example orthopaedic or gynaecological surgical procedures, and if appropriate, be adopted by all members of the scrub team, as it provides significantly increased barrier protection when compared to single gloving and allows for glove perforations to be more frequently and easily identified.

EPPs are outlined in more detail in Standard Infection Control Precautions Literature Review: Occupational exposure management (including sharps).

(Grade A recommendation)

How should double gloves be worn?

There are variations of double gloving: i.e. smaller glove over larger glove; larger glove over smaller glove; the use of a glove liner; or the use of a steel weave outer glove. All of these double gloving combinations broadly afford a similar level of barrier protection however the indicator glove should always be the innermost glove. Clinicians should therefore determine which method of double gloving provides them with the greatest level of dexterity, tactile sensation and comfort.

(Good Practice Point (GPP))

When should gloves be changed or removed?

Gloves are a single-use item and should be changed after each use or upon completion of a task.

Gloves must never be decontaminated, for example with soap and water or alcohol based hand rub.

Gloves should be changed after patient contact and therefore must be changed between patients.

Gloves may need to be changed after the completion of a single aspect of patient care/treatment – even on the same patient – for example, gloves may be required to insert an invasive device, once the device has been inserted it may be necessary to change gloves before providing additional care.

Gloves should be changed if a perforation or puncture is suspected or identified.

Gloves must be changed upon completion of a task involving the use of cleaning chemicals as they may compromise the barrier integrity of the glove.

(Grade D recommendation)

How should gloves be donned (put on)?

Perform hand hygiene before applying gloves (sterile or non-sterile), ensuring hands are completely dry.

The procedure for donning sterile gloves should be as follows:

- The gloves package should be placed on a clean, dry and flat surface.
- The package should be opened ensuring that the exterior of the gloves is not touched.
- The package should be positioned so that the left glove is on the left side, the right glove on the right side and the fingers should point away from the body.
- The dominant hand should be gloved first. The glove should be picked up by the inside edge of the cuff using the thumb and index finger of the non-dominant hand.
- The fingers of the dominant hand should be slowly inserted into the glove, which should be pulled to the wrist. The cuff should not be un-folded at this stage.
- Using the gloved dominant hand, insert the fingers underneath the outside folded edge of the glove for the non-dominant hand.
- The fingers of the non-dominant hand should be slowly inserted and the glove pulled to the wrist.
- The cuff of the glove on the non-dominant hand should be rotated over the wrist. This process should be repeated for the cuff of the glove on the dominant hand.
- Gloves should then be adjusted to ensure a comfortable and correct fit – taking care to maintain sterility.
- An assessment should be made as to whether the glove was contaminated during the donning process.

(Grade D recommendation)

In the operating theatre environment, gloves should be put on as outlined above but when they are pulled to the wrist, the glove should fully cover the cuffs of a gown.

(Good Practice Point (GPP))

How should gloves be removed and disposed of?

The procedure for removing all gloves (sterile or non-sterile) should be as follows:

- Un-glove the dominant hand first. Using the index finger and thumb of the non-dominant hand, grip and lift the outside edge of the glove cuff of the dominant hand – taking care not to touch the skin of the wrist or the hand.
- Insert the middle finger under the outside edge of the glove and invert it (turn it inside out) as it is slowly peeled off using the gloved non-dominant hand.
- Hold the removed glove in the non-dominant (gloved) hand.
- Insert the index and fore fingers of the dominant hand inside the cuff of the non-dominant gloved hand.
- Peel the glove slowly off the hand so that it is inverted (turned inside out) and so that it covers the other glove (from the non dominant hand).
- Dispose of the gloves in the appropriate waste stream.
- Perform hand hygiene.

(Grade D recommendation)

How should gloves be stored?

Gloves should be stored in their original containers and should be stored away from direct sunlight, heat sources and liquids, including chemicals. The area should be clean and should protect the gloves from contamination.

(Good Practice Point (GPP))

4. Discussion

4.1 Implications for practice

Are there any legislative requirements for the use of gloves as PPE for infection control purposes?

There are no specific legislative requirements regarding the use of gloves as PPE for infection control purposes, that is, to prevent the spread of healthcare associated infection. Although the wearing of PPE in the hospital setting is covered by the Health and Safety at Work Act (1974)[1], Control of Substances Hazardous to Health (2002 as amended) regulations[2], and the Personal Protective Equipment at Work Regulations 1992 (as amended).[3]

The Health and Safety at Work Act is the generic health and safety legislation for the UK and broadly covers the use of PPE and risk, but is not healthcare specific. The Control of Substances Hazardous to Health (COSHH) is more specific and provides details in relation to hazardous materials and the use of PPE; and can almost be viewed as a detailed schedule of the Health and Safety at Work Act, which would include pathogens in the hospital environment and the use of appropriate PPE – for example the use of gloves to protect against blood borne viruses during venepuncture. If an activity does not involve or is perceived not to involve contact with a hazardous material then the Personal Protective Equipment at Work Regulations 1992 provide general guidance on the use of PPE; in the hospital environment this could be the use of gloves to protect against glass fragments when cleaning up broken glass; however if the glass contained a laboratory sample then the activity would be covered by the Control of Substances Hazardous to Health.

All of the UK legislation and regulations outline the responsibilities of the employer and employee and also cover the unnecessary exposure to risk of service users.

The Health and Safety Executive (HSE) has issued specific UK guidance relating to the use of disposable latex gloves: It stipulates that their use must be based on a risk assessment which has deemed their use necessary, and that in such instances, disposable latex gloves must be low-protein and powder-free. The HSE acknowledges that when exposure to blood borne pathogens is likely, that disposable latex gloves are the safest choice.[4] Therefore, the use of disposable latex gloves across NHSScotland is endorsed by the HSE providing that the gloves

are – irrespective of whether they are sterile/non-sterile, examination/surgical – low-protein and powder-free.

Specific standards relating to gloves in the healthcare setting are outlined in Appendix 1 of this document.

When and where should gloves be worn?

There is a substantial volume of evidence published in the literature on glove use in the healthcare setting, which is largely in the form of expert opinion and consensus/practice guidelines which outline appropriate glove use in a variety of locations and situations. The literature examining double gloving is the most comprehensive with a high quality systematic review[5] and a number of high quality randomised controlled trials[6-8] and cohort studies[9;10] published on the subject.

There is consensus in the literature regarding why, when and where gloves should be worn in the hospital setting. It is consistently recommended that the decision to wear gloves for a specific task should be based on a risk assessment.[11-18] The assessment should consider whether there is a risk of contact with or exposure to: blood and/or body fluids; secretions and/or excretions; non-intact skin; mucous membranes; hazardous drugs or chemicals. Where it is deemed likely that such a risk exists it is recommended that gloves are worn in order to protect both the healthcare worker and/or the patient.[11-34]

(Grade D recommendation)

(AGREE rating: Recommend)

It is not usually necessary to wear gloves for administering immunisations unless:

- It is anticipated that there may be exposure to blood or body fluids;
- The healthcare worker has non-intact skin on their hands; or
- The person receiving the immunisation has non-intact skin.

Gloves may also be worn to offer protection to healthcare workers from exposure to vaccination solutions when administering immunisations; however delivery techniques such as the Z track injection technique may represent an effective alternative. Gloves should be worn where advocated by the vaccine manufacturer or by clinical consensus, for example as recommended by the CDC when administering smallpox vaccinations.[35]

(AGREE rating: Recommend)

When should sterile or non-sterile gloves be worn?

It is consistently recommended in the literature that the choice between wearing sterile or non-sterile gloves should be determined by the nature of the task being undertaken by the healthcare worker. There is consensus in the literature that sterile gloves should be worn: for most surgical procedures; for invasive procedures; as part of aseptic technique; for the insertion of some invasive devices; and for acute wound care. The literature also consistently states that non-sterile gloves should be worn for non-sterile procedures and chronic wound care.[11;14;16;17;20;26;29;36;37]

(Grade D recommendation)

However, there is accumulating evidence that the use of sterile gloves offers no additional benefits to the use of non-sterile gloves for minor skin surgery, e.g. wound suturing and local skin excisions.[38-40]

(Grade B recommendation)

When indicated, non-sterile gloves should be used for administering immunisations.[41]

(AGREE rating: Recommend)

What type of gloves should be worn based on material type, e.g. latex, nitrile, neoprene?

There is broad agreement across the literature concerning the appropriateness and suitability of specific materials in relation to exposure to specific hazards; and therefore their suitability for use in the clinical setting. In total 13 different glove materials were identified by this review:

- Latex or NRL (natural rubber latex).
- Vinyl or polyvinyl chloride platisols.
- Polythene.
- Copolymer or ethylene-methyl methacrylate or EMA.
- Elastyren.
- DPNRL latex with the majority of latex proteins removed.

- Nitrile or acrylonitrile-butadiene or NBR.
- Polyvinyl chloride (PVC).
- Neoprene or chloroprene or polychloroprene.
- Polyurethane.
- Polymers or block polymers.
- Polyisoprene.
- Tactylon.

It is not possible to make a recommendation in relation to several of these materials because there is insufficient coverage of them in the evidence identified by the review. Furthermore, not all of these materials are suitable for manufacturing gloves intended for the provision of clinical care and many are instead used to manufacture gloves intended for use in the preparation of food or when cleaning.

There is consensus in the literature that **latex (including DPNRL)** gloves should be worn when it is anticipated that there will be contact with blood or body fluids because gloves manufactured from latex provide the best fit, dexterity and afford the greatest comfort as well as good barrier protection. Where latex cannot be worn it is recommended that either **nitrile** or **neoprene** gloves are a suitable alternative, with **nitrile** gloves exhibiting good protection against lipids (e.g. oils and fats) and bone cement. Manufacturers have recently developed 'next generation' **nitrile** gloves that claim to provide greater flexibility and tactile sensitivity over traditional **nitrile** gloves. **Vinyl** gloves should not be worn when it is anticipated there will be contact with blood or body fluids or cytotoxic drugs. It is also recommended, by the literature, that the following gloves are unsuitable for clinical care and should not be used for clinical purposes:

- Polythene.
- Copolymer or ethylene-methyl methacrylate or EMA.
- Polyvinyl chloride (PVC).

There is also consensus that no one glove material provides protection against all hazards which may be encountered in the care setting, where any doubt exists as to the barrier

efficiency of a particular glove type, the manufacturer should be contacted for further information.[12;14;17;18;20;21;25;26;28;30;37;41-45]

(Grade D recommendation)

A CDC Guideline recommends that the durability of gloves, and thus the material type, should be appropriate to the task and that gloves should fit correctly.[31]

(AGREE rating: Recommend)

Single-use disposable gloves that meet the standard EN374-2 (and EN374-3 if exposure to chemical agents is anticipated) should be worn for communal care equipment and environmental cleaning tasks.[46] Re-usable household ('Marigold' type) gloves are not suitable for these tasks due to the risk of cross-infection.[46]

(Good Practice Point (GPP))

When should examination or surgical gloves be worn?

Insufficient evidence was identified by this review assessing when examination or surgical gloves should be worn to allow a graded recommendation to be made.[14;20;43;47]

Should specific gloves be worn for specific procedures?

A substantial body of evidence examining whether specific types of gloves should be worn for specific procedures was identified by this review, however there is no definitive consensus in the literature. This is principally because the articles are drawn from a disparate range of clinical specialties meaning that the same procedures are not universally assessed in relation to glove use.[14;16;17;20;21;23;24;29;37;41;47;48] Thus it is not possible to draw a graded recommendation on this aspect of glove use in the hospital setting. It is advisable that the gloves worn for a specific procedure should be informed by whether there is a need to maintain sterility and the protective qualities of specific glove materials.

(Good Practice Point (GPP))

When should double gloving be adopted?

This literature review identified a body of high quality evidence relating to the practice of double gloving. The literature consistently recommends the practice of double gloving during surgical procedures as a means of increasing the barrier protection offered by a single pair of gloves. Furthermore, the addition of an indicator glove is advised as this facilitates the easy identification of perforations, tears and breaches of the barrier integrity of a glove. There is also consensus advocating that all members of the scrub team should double glove, as there is evidence which suggests that not only is the principal surgeon at risk of glove perforation but that the assistant/second surgeon and scrub nurses are also exposed to this risk. The literature consistently identifies the glove of the surgeon's non-dominant hand as being the site most frequently perforated. The evidence also suggests that there is a direct link between length and complexity of surgery, the number of surgical instruments involved/required, whether the procedure is elective or emergency, and surgeon experience and the total number of glove perforations: Higher numbers of glove perforations occur in emergency surgery, or procedures which take a long time, or involve a large number of instruments, or where the surgeon has considerable experience. The impact on dexterity and tactile sensation is highlighted by the literature as being a potential disadvantage of double gloving and it is frequently cited by surgeons as being a factor which discourages them from double gloving.

It is therefore recommended that double gloving, using an indicator glove, should be considered for Exposure Prone Procedures (EPPs) in the operating theatre setting, for example orthopaedic or gynaecological surgical procedures, and if appropriate, be adopted by all members of the scrub team, as it provides significantly increased barrier protection when compared to single gloving and allows for glove perforations to be more frequently and easily identified.[5-10;14;19;28;42;44;45;49-56]

EPPs are outlined in more detail in Standard Infection Control Precautions Literature Review: Occupational exposure management (including sharps).

(Grade A recommendation)

How should double gloves be worn?

Despite the high quality of the evidence relating to the practice of double gloving, there is a lack of evidence on how double gloves should be worn, specifically whether a different sized glove

should be worn over or under another glove. There was no consensus in the four articles identified that addressed this issue, so it is not possible to make a graded evidence-based recommendation.[28;45;51;55]

When should gloves be changed or removed?

This review identified a substantial volume of literature which, irrespective of setting, glove type, clinical specialty, or procedure is consistent in its recommendations relating to when gloves should be changed or removed. Specifically, there is consensus which can be summarised thus:

- Gloves are a single-use item and should be changed after each use or upon completion of a task.
- Gloves must **never** be decontaminated, for example with soap and water or alcohol based hand rub.
- Gloves should be changed after patient contact and must be changed between patients.
- Gloves may need to be changed after the completion of a single aspect of patient care/treatment – even on the same patient – for example, gloves may be required to insert an invasive device, once the device has been inserted it may be necessary to change gloves before providing additional care.
- Gloves must be changed if a perforation or puncture is suspected or identified.
- Gloves must be changed after contact with cleaning chemicals which may compromise the barrier integrity of the glove.[11;12;16;19;20;26;28;29;31-34;36;37;42;44;45;51;57;58]

(Grade D recommendation)

(AGREE rating: recommend)

How should gloves be donned (put on)?

The literature is also consistent in its recommendations for the procedure for putting on sterile gloves. A recurring message from the literature is the importance of preserving the sterility of sterile gloves whilst putting them on and before commencing a sterile task. It is recommended that hand hygiene should be performed before putting on any gloves, either sterile or non-

sterile, in the clinical setting. This review failed to identify any evidence regarding the procedure for putting on non-sterile gloves, meaning that it is not possible to determine a graded recommendation. There is however agreement across the literature that sterile gloves should be donned as follows:

- Perform hand hygiene before applying gloves (sterile or non-sterile), ensuring they are completely dry.
- The gloves package should be placed on a clean, dry and flat surface.
- The package should be opened ensuring that the exterior of the gloves is not touched.
- The package should be positioned so that the left glove is on the left side, the right glove on the right side and the fingers should point away from the body.
- The dominant hand should be gloved first. The glove should be picked up by the inside edge of the cuff using the thumb and index finger of the non-dominant hand.
- The fingers of the dominant hand should be slowly inserted into the glove, which should be pulled to the wrist. The cuff should not be un-folded at this stage.
- Using the gloved dominant hand, insert the fingers underneath the outside folded edge of the glove for the non-dominant hand.
- The fingers of the non-dominant hand should be slowly inserted and the glove pulled to the wrist.
- The cuff of the glove on the non-dominant hand should be rotated over the wrist. This process should be repeated for the cuff of the glove on the dominant hand.
- Gloves should then be adjusted to ensure a comfortable and correct fit – taking care to maintain sterility.
- An assessment should be made as to whether the glove was contaminated during the donning process.[12;14;16;20;27;28;33;34;59;60]

(Grade D recommendation)

(AGREE rating: recommend)

How should gloves be removed and disposed of?

There is broad consensus in the evidence, identified by this literature review, regarding the correct procedure for removing gloves in the clinical setting. Despite this consensus, different levels of detail are provided by different articles – with some outlining a step by step process for glove removal and others instead choosing to highlight the importance of preventing the potential unnecessary risks associated with inappropriate glove removal. Based on the available evidence the procedure for removing gloves in the hospital setting should be as follows:

- Un-glove the dominant hand first. Using the index finger and thumb of the non-dominant hand, grip and lift the outside edge of the glove cuff of the dominant hand – taking care not to touch the skin of the wrist or the hand.
- Insert the middle finger under the outside edge of the glove and invert it (turn it inside out) as it is slowly peeled off using the gloved non-dominant hand.
- Hold the removed glove in the non-dominant (gloved) hand.
- Insert the index and forefingers of the dominant hand inside the cuff of the non-dominant gloved hand.
- Peel the glove slowly off the hand so that it is inverted (turned inside out) and so that it covers the other glove (from the non-dominant hand).
- Dispose of the gloves in the appropriate waste stream.
- Perform hand hygiene.[11;12;14;16;20-22;27;33;34;44;45;60;61]

(Grade D recommendation)

(AGREE rating: recommend)

How should gloves be stored?

Insufficient evidence was identified by this literature review to allow a graded evidence-based recommendation to be made on the correct storage of gloves.

What are the healthcare-associated infection risks of reusing gloves?

Items of personal protective equipment (PPE), including gloves, are able to act as fomites with the potential for cross-transmission of nosocomial pathogens in healthcare settings.[62-64] It is therefore recommended that items of PPE should be replaced every time the wearer comes into contact with a new patient or a new patient's surroundings.

What are the healthcare-associated infection risks of using alcohol-based hand rub on gloves, rather than changing gloves?

The World Health Organisation provides clear recommendations that gloves "should not be washed, decontaminated, or reprocessed for any reuse purpose"; the concern being that decontamination practices may damage the material integrity of gloves and impair their protective function.[65] In particular, it is noted that "cleansing plastic-gloved hands with an alcohol-based formulation leads to early dissolving of the plastic material".[65] Although the use of alcohol-based hand rub on double gloves has been applied within the context of a SARS outbreak, it is not recommended for routine use.[66]

4.2 Implications for research

There is an extensive body of literature which examines glove use. Much of this literature is in the form of expert opinion and consequently, when assessed, yields a low level of evidence and graded recommendation. Gloves have been in use for a considerable period of time in the healthcare setting and their appropriate use formed the basis of barrier, enteric and universal precautions. Therefore this may explain why the evidence identified by this review is in the form of practice guidelines, consensus statements and non-systematic reviews as more detailed research is deemed unnecessary. Ethical considerations make it difficult to conduct higher quality studies as it would be likely that these would place either healthcare workers or patients at unnecessary risk.

Future research should seek to assess the most suitable way to double glove and should specifically seek to determine which combination of gloves provides the maximum level of comfort and best fit. Given the proven effectiveness of double gloving in the literature, coupled with healthcare workers concerns relating to inhibited tactile sensation and dexterity, this aspect should be addressed as a matter of urgency. There may also be a need for further research

which assesses how gloves should be changed intra-operatively. One article was identified by this review which compared the closed versus open technique of glove changing during surgery, suggesting that the closed technique minimises the risk of cross contamination.[67] A randomised controlled trial has since been conducted, confirming that the closed technique is more effective at reducing contamination of clothing, as indicated by a non-microbial proxy measure.[68] Furthermore, at present double gloving is predominantly recommended for the theatre setting. This review identified one paper, arguing that double gloving should be adopted for resuscitation.[69] Future research should seek to assess whether it is practical and appropriate for double gloving to be adopted outwith the operating theatre environment.

This literature review identified one study[70] which argues that the current CDC algorithm for the removal of PPE, including gloves, is not effective in preventing the contamination of the skin and/or clothing of healthcare workers; meaning that there is a risk for the transmission of pathogens. In contrast, two more recent studies have proposed that the CDC algorithm can be effective.[71;72] The use of double gloving, PPE impregnated with antimicrobial agents or the adoption of USA surgical PPE removal methods are all proposed as alternatives which may mitigate against this cross transmission risk. Given that current UK PPE removal methods are broadly similar to those outlined by the CDC; the significance of these studies should not be underestimated. Further research is required in order to accurately assess the risks associated with the extant UK PPE removal method and to determine strategies which alleviate any risk of pathogen transmission.

Finally, there may be a need to clarify or expand legislation relating to the use of appropriate PPE. At present much of the legislation relates to the handling and management of dangerous substances and/or chemicals with no specific regulation for pathogens in a non-laboratory clinical environment.

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Appendix 1

Standards pertaining to gloves as PPE			
Standard	**Title**	**Description**	**Publication date**
10/30217663 DC	BS ISO 11193-1 AMD1. Single-use medical examination gloves. Part 1. Specification for gloves made from rubber latex or rubber solution.	Draft version of specifications and requirements of single use medical grade examination gloves.	March 2010.
ISO11193-2 : 2006 EDTN1	ISO11193-2: 2006 Single-use medical examination gloves. Part 2: Specification for gloves made from poly(vinyl chloride).	This standard outlines the specifications and requirements for vinyl medical gloves.	November 2006.
BS EN 455-1:2000	Medical gloves for single use. Requirements and testing for freedom from holes.	This standard outlines Leak tests, Watertightness tests, Performance testing, and Quality control of **ALL** medical gloves.	December 2000.
BS EN 455-2:2009	Medical gloves for single use. Requirements and testing for physical properties.	This standard outlines the requirements and gives test methods for the physical properties of single use medical gloves (i.e. surgical gloves and examination/procedure gloves) in order to ensure that they provide and maintain in use an adequate level of protection from cross contamination for both patient and user. This standard also includes an annex which outlines the relationship with Essential Requirements of EU Directive 93/42/EEC concerning medical devices.	November 2009.

BS EN 455-3:2006	Medical gloves for single use. Requirements and testing for biological evaluation.	This standard outlines the Biochemical methods and Biological analysis and testing for Natural rubber and Synthetic rubber medical gloves. Marking, Packaging, Immunology, Antigens, Proteins, Allergies, are included.	January 2007.
BS EN 455-4:2009	Medical gloves for single use. Requirements and testing for shelf life determination.	This standard outlines the durability, endurance and storage of gloves – specifically in terms of their "shelf life".	August 2009.
BS EN 13921:2007	Personal protective equipment. Ergonomic principles.	This standard provides guidance on the generic ergonomic characteristics related to personal protective equipment (PPE) – it does not however cover the requirements which relate to specific hazards that PPE may be designed.	September 2007.
EN 374-2:2003	Protective gloves against chemicals and micro-organisms - Part 2: Determination of resistance to penetration	This is the reference test specified by the European Standard for the assessment of glove quality. Gloves must pass this test in order to prove that they are an effective barrier against liquids and micro-organisms.	October 2005
EN 374-3:2003	Protective gloves against chemicals and micro-organisms – Part 3: Determination of resistance to permeation by chemicals	This reference test specifies the determination of the resistance of protective glove materials to permeation by potentially hazardous non-gaseous chemicals under the conditions of continuous contact. Gloves are classified according to the breakthrough time of the chemical through the glove material.	October 2005
Statutory Instrument 2002 No. 1144	Health and Safety – Personal Protective Equipment Regulations 2002	This instrument sets out the standards for PPE in the UK. Schedule 4 sets out the standards for conformity across the UK (and the EU) and requires that **all** PPE is **CE marked**. CE marking demonstrates that an item has been manufactured to a particular standard and passed the appropriate tests for the PPE type and intended use/purpose.	May 2002.

Legend:

BS = British Standards produced by the British Standard Institution (www.bsigroup.co.uk)

EN = European Standards (European Norm) produced by the European Committee for Standardisation (www.cen.eu)

ISO = International Standards produced by the International Standards Organization (www.iso.org)

EN standards are gradually being replaced by ISO standards – when these are adopted in the UK they are prefixed with BS (e.g. BS EN … or BS EN … or BS EN ISO …). This is usually to accommodate UK legislative or technical differences or to allow for the inclusion of a UK annex or foreword.