NHS National Services Scotland

Personal Protective Equipment (PPE): Aprons and Gowns Literature Review

Version 2.0

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Antimicrobial Resistance & Healthcare Associated Infection (ARHAI) Scotland
An NHS Scotland Assure Service

Version history

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
1.0	January 2021	This literature replaces the Standard Infection Prevention Control literature review on PPE: Aprons and Gowns, Version 3.0, April 2015. This literature review includes Transmission Based Precautions for PPE: Aprons and Gowns and has been updated using two-person systematic review methodology.
1.1	January 2022	How should aprons/gowns be donned? Update to recommendation under this reference based on Scottish expert opinion. 'When worn as part of contact precautions, an apron (or gown if excessive splash or spray is anticipated) should be donned for direct care delivery and contact with the patient's care environment.'
2.0	October 2025	Three-year update of the literature review • Updated using a new methodology as outlined in the development process. The question set was reviewed, and the previously separated SICPs and TBPs specific objectives were combined to focus on "use in health and care settings". • A new research question: How should reusable aprons/gowns be reprocessed? was added.

Version	Date	Summary of changes
		• The research question: When are reusable aprons/gowns appropriate? was removed and now covered under “What type(s) of aprons/gowns should be used in health and care settings?” The following questions were modified from the previous review. • Are there any legislative requirements for the use of aprons/gowns as PPE for infection control purposes? (Modification: The term ‘or standards (BS/EN/ISO)’ was added) • When/where should aprons/gowns be worn for SICPs? and TBPs? (Modification: These were combined, and the term ‘where’ was removed) • How should aprons/gowns be donned? (Modification: How and where should aprons/gowns be donned (put on)?) • How should aprons/gowns be doffed? (Modification: How and where should aprons/gowns be doffed (taken off)?) Databases were searched for evidence published between 2020 and 2024 for all questions except question 4 (newly added question) which search for evidence published between 2020 and 2024 was conducted for. • Search strategies added as Appendix 1.

Approvals

Version	Date Approved	Group/Individual
1.0	January 2021	Steering (Expert Advisory) Group for SICPs and TBPs
1.1	January 2022	
2.0	September 2025	National Policy, Guidance and Evidence (NPGE) Working Group Care Home Infection Prevention and Control (CHIPC) Oversight and Advisory Group

Key information

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Document information

Document information	Description
Description:	This literature review examines the available professional literature on PPE (Aprons and Gowns) in health and care settings.
Purpose:	To inform the sections on Personal Protective Equipment (PPE): Aprons and Gowns in the National Infection Prevention and Control Manual in order to facilitate the prevention and control of healthcare associated infections in NHSScotland health and care settings.
Target Audience:	All NHS staff involved in the prevention and control of infection in NHSScotland.
Update/review schedule:	Updated as new evidence emerges with changes made to recommendations as required. Review will be formally updated every 3 years with next review in 2027
Cross reference:	National Infection Prevention and Control Manual Care Home Infection Prevention and Control Manual
Update level:	Practice – No significant changes to practice. Research – Several areas of research require higher quality primary research to allow the formation of evidence-based recommendations regarding the use of aprons/gowns for IPC in health and care settings. In particular, the efficacy of aprons/gowns (reusable and disposable) for protection against different types of anticipated exposure.

Contact

ARHAI Scotland Infection Control team:

Telephone: 0141 300 1175

Email: NSS.ARHAIinfectioncontrol@nhs.scot

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1 Objective

The aim of this review is to examine the extant professional literature regarding the use of aprons/gowns as Personal Protective Equipment (PPE) for infection prevention and control purposes in health and care settings.

The specific research questions are provided below:

- Are there any legislative requirements or standards (BS/EN/ISO) for the use of aprons/gowns as PPE for infection control purposes?
- When should aprons/gowns be worn in health and care settings?
- What type(s) of aprons/gowns should be used in health and care settings?
- How should reusable aprons/gowns be reprocessed?
- How and where should aprons/gowns be donned (put on)?
- When should aprons/gowns be removed/changed?
- How and where should aprons/gowns be doffed (taken off)?
- How should aprons/gowns be disposed of?
- How should aprons/gowns be stored?

2 Methodology

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

A new research question; How should reusable aprons/gowns be reprocessed?, was added to this review update and a separate literature search was carried out for the new research question; any evidence identified relevant to existing research questions was considered for inclusion. The complete search strategy is provided in Appendix 1.

In addition to the exclusion criteria outlined in the NIPCM: Development Process, the following exclusion criteria were used in this review.

- This review did not assess the use of aprons/gowns as PPE for high consequence infectious diseases (HCIDs). A separate literature review that examines the extant professional literature regarding PPE for HCIDs is available.
- Additionally, this review did not include manikin/simulation studies or assess reprocessing of single use aprons/gowns.
- Occupational health issues, for example adverse effects of wearing aprons and gowns are not covered in this review.

Definitions for grades of evidence are provided in Appendix 2. A Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart, adapted from Moher et al.,[1] is presented in Appendix 3.

3 Discussion

3.1 Implications for practice

3.1.1 Are there any legislative requirements or standards (BS/EN/ISO) for the use of aprons/gowns as PPE for infection control purposes?

Six legislation documents and four British standards were included for this research question.[2-11] The six legislation documents were considered mandatory,[2-7] while the four British standards were graded SIGN50 level 4.[8-11] All the legislation documents included were published by the UK government.[2-7] Three of the included documents were identified in the current review update.[5-7]

No specific legislative requirements regarding the use of aprons or gowns as PPE for infection control purposes were identified. However, the legislations included are for the use of PPE for infection control purposes in health and care settings and are therefore applicable to aprons and gowns.

The Health and Safety at Work etc. 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.[2] This legislation mandates a duty on employers to ensure, as far as is reasonably practicable, the health, safety, and welfare of all employees at work.[2]

The Control of Substances Hazardous to Health (COSHH) Regulations 2002 (as amended) mandates that employers must prevent or adequately control employees' exposure to hazardous substances.[4] It requires employers to provide suitable PPE, including protective clothing, to achieve adequate control of exposure.[4]

The COSHH Regulations 2002 can be viewed as a detailed schedule of the Health and Safety at Work etc. Act, which would include infectious agents in health and care settings, and the use of appropriate PPE. 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 health and care settings.

The Personal Protective Equipment at Work Regulations 1992 stipulates that employers must provide suitable PPE to employees who may be exposed to health

or safety risks at work, except where such risks have been adequately controlled by other means.[3] Employees must also be trained on how to use PPE effectively, and any PPE provided must be maintained, including being cleaned and replaced as necessary, to ensure it is in efficient working order and good repair.[3] The Personal Protective Equipment at Work (Amendment) Regulations 2022 extend this to all types of workers rather than just full-time employees alone.[6]

All the UK legislation and regulations outline the responsibilities of the employer and employee. It is a legal requirement that employers provide personal protective equipment for their employees where hazards of the workplace cannot be controlled by other means.[2-4]

Legislations outlines that PPE must be suitable for the task being undertaken, fit appropriately and, if being worn with other pieces of PPE, the employer shall make sure that the pieces are compatible with each other and in wearing them together, do not reduce the level of protection.[3, 4]

Employers must provide adequate instruction and information on how to correctly use PPE provided and employees in turn have a responsibility to comply, by ensuring that suitable PPE is worn correctly for the task being carried out.[3, 4]

Employers must ensure that PPE is maintained in good working order and in a clean condition. Employers must also ensure that PPE is properly stored in a designated area, checked at suitable intervals and, when discovered to be defective, repaired or replaced before further use.[3, 4]

The Regulation (EU) 2016/425 and the Personal Protective Equipment (Enforcement) Regulations 2018 outlines the essential health and safety requirements that must be met before PPE products can be placed on the GB market and provide a system for enforcement of the Regulation respectively.[5, 7] Regulation (EU) 2016/425 mandates all PPE placed on the UK market must have been manufactured to the required standard, passed the appropriate tests for the PPE type and intended use/purpose, and be CE (Conformité Européene or European Conformity marking) or UKCA (UK Conformity Assessed) marked.[7]

British Standards

The four British standards included provide requirements that aprons and gowns used as PPE in health and care settings must fulfil. These include performance requirements for surgical gowns,[8] specification of ergonomic requirements to allow optimisation of the balance between protection and usability,[11] and test methods for assessing a material's resistance to penetration of bacteria-carrying particles and liquids.[9, 10]

At the time of writing, these discussed standards were the most recent versions available. It should be noted, however, that these are subject to amendment and that the standards discussed here may not represent all standards which apply to aprons or gowns used as PPE in health and care settings.

The applicable British and European standards are outlined in Appendix 4.

3.1.2 What type(s) of aprons/gowns should be used in health and care settings?

Twenty-four pieces of evidence were included for this research question,[12-35] eight of these were identified in the current review update.[28-35] Twenty-one of the included evidence were SIGN50 Level 4 expert opinion guidance documents,[14-20, 22-35] and three guideline documents were graded as AGREE II 'recommend with modifications'.[12, 13, 21] Nine of the included evidence were from the UK,[12, 13, 15-17, 23, 29, 30, 35] seven were from the USA,[14, 19, 22, 24, 25, 27, 29] two were from Australia,[26, 34] and one from India.[18] Two European Centre for Disease Prevention and Control (ECDC) expert opinion guidance which are directly applicable to the UK were included,[31, 32] along with three World Health Organization (WHO) publications.[20, 21, 33]

According to Australian expert opinion guidance on prevention and control of infections in healthcare settings, the type of apron or gown required depends on the level of risk, including the anticipated degree of contact with infectious material and the potential for blood and body substances to penetrate through to clothes or skin.[34] Similarly, four expert opinion guidance from the USA advise that the type of gown should be selected based on the nature of patient interaction, including the anticipated degree of contact with infectious material and potential for blood and body fluid penetration.[19, 22, 25, 28]

Aprons

Two UK guidance, graded AGREE II 'recommend with modifications' and eight expert opinion guidance from the UK, the USA and Australia recommend that plastic aprons worn in health and care settings should be single use or disposable and fluid repellent or impervious.[12-17, 23, 29, 30, 34] UK expert opinion guidance further advise that disposable plastic aprons should be non-powdered vinyl/nitrile or latex-free and CE marked.[29, 30]

Gowns

Both reusable and disposable gowns are described in literature. A WHO guideline document, graded AGREE II 'recommend with modifications', explained that gowns worn in health and care settings could be disposable, made of synthetic fibre, or washable cloth.[21] An Australian expert opinion guidance on prevention and control of infections in healthcare settings advises strict use of disposable gowns in healthcare settings,[34] while expert opinion guidance from the American Academy of Ophthalmology suggest that a disposable gown is preferable and should be used where possible.[22] Conversely, a WHO expert opinion guidance for laboratory settings suggest that either a reusable or disposable gown is acceptable.[33]

A WHO guidance document, graded AGREE II 'recommend with modifications', recommends a disposable, long-sleeved, waterproof, cuffed gown for both standard and contact precautions.[21] Similarly, two UK guidance documents, graded AGREE II 'recommend with modifications', and seven expert opinion guidance from the UK and Australia recommend a full body, long sleeved, fluid-repellent gown.[12, 13, 15, 23, 26, 31, 32, 34, 35]

Furthermore, a WHO guidance, graded AGREE II 'recommend with modifications' recommends wearing a waterproof apron over non-fluid resistant gown if a fluid resistant gown is required but not available.[21] However, this is not applicable to Scottish health and care settings as UK legislation mandates employers to ensure that appropriate PPE is always provided.

Sterile gown

Four expert opinion guidance from ECDC, the UK, Australia, the USA, and India advise that a sterile gown is only required when invasive procedures requiring aseptic technique are undertaken.[15, 18, 24, 34]

Two expert opinion guidance from the Association of periOperative Registered Nurses (AORN) suggest that sterile gowns must wrap around the body completely and cover the back.[25, 28] However, the gown should not be so large that the material can unintentionally come in contact with unsterile items, and the sleeves of the gown should cover the arms down to the wrist comfortably so the cuffs of the gown will not pull out of the gloves.[25] Another expert opinion guidance from AORN recommends that materials used for sterile gowns should be: low-linting, resistant to tears, punctures, abrasions and penetration by blood and other body fluids, comfortable; and contribute to maintaining the wearer's desired body temperature.[27] In the context of NHSScotland PPE provision, most of these features would be met through the required adherence to British and European standards (see Appendix 4).

Conclusion

In summary, the evidence base, which largely consists of extant expert opinion guidance, was consistent that the type of apron or gown used in health and care settings should be selected based on the task being undertaken and the anticipated levels of body fluid exposure. Most of the included evidence consistently recommend a plastic, fluid repellent, disposable apron for routine care where there is a risk of uniform contamination, while a full body, long sleeved, fluid-repellent gown, which could be either disposable or reusable, is recommended where extensive splashing is expected. A sterile gown is only advised for invasive procedures.

3.1.3 When should aprons/gowns be worn in health and care settings?

Thirty-seven pieces of evidence were included for this research question,[12-26, 29-50] 16 of these were identified in the current review update.[29-38, 46-50] Thirty-three of the included evidence were graded SIGN50 Level 4 expert opinion guidance documents,[14-26, 29-40, 42-50] three guidelines were graded AGREE II 'recommend with

modifications',[12, 13, 21] and an observational study was graded SIGN50 Level 3 evidence.[41]

Eleven of the included evidence were from the UK,[12, 13, 15-17, 23, 29, 30, 35, 48, 49] 14 from the USA,[14, 19, 22, 24, 25, 36, 38, 40-46] three from Australia,[26, 34, 50] and one each were included from Canada,[47] Germany,[37] and India.[18] Two ECDC expert opinion guidance documents which are directly applicable to the UK were included,[31, 32] along with four WHO publications intended for a global audience.[20, 21, 33, 39]

There is consistency in three included guidelines and 17 expert opinion guidance that aprons or gowns should be worn in health and care settings when exposure to blood, body fluids, secretions or excretions, through close contact with patients or any activity or procedure, is anticipated.[12-17, 21, 22, 26, 29-32, 35-38, 48, 49]

Aprons

Nine expert opinion guidance advise wearing a disposable plastic apron as part of PPE ensembles for activities where a low risk of splashing or contamination with blood or bodily fluids is anticipated, including cleaning, handling dirty or infectious laundry, contact with non-intact skin and mucous membranes, and for aerosol generating procedures (AGPs) on persons without a suspected or confirmed infection.[15-17, 29, 30, 34, 35, 48, 49] This recommendation is consistent across a wide variety of settings, including children and young people settings, adult social care, care homes and hospitals.[15-17, 29, 30, 35, 48, 49]

Two UK guideline documents, graded AGREE II 'recommend with modifications', and three UK expert opinion guidance recommend wearing aprons when caring for individuals with a known or suspected infection, such as *Clostridioides difficile* infection (CDI) or acute respiratory infections (ARI), if risk assessment indicates contamination of uniforms or clothing with blood, body fluids, chemicals, or cleaning products is likely.[12, 13, 16, 23, 48] This includes when cleaning a patient's environment, handling bed pans, faeces and assisting with toileting and hygiene needs.[16, 48]

Three expert opinion guidance from Germany, Australia and the USA were not as specific. They suggest wearing either 'aprons or gowns' as part of standard precautions for patient contact activities,[37] during procedures likely to generate splashes of blood or other body fluids,[14, 26] when entering the room of patients with

CDI and for visitors assisting with patient care.[50] A COVID-19 specific ECDC expert opinion guidance, published in February 2021, suggests that aprons can be used instead of gowns when the risk of contact with body fluids is low.[31]

The Royal College of Nursing (RCN) advise that aprons should not be routinely worn, but should be 'reserved for when required'.[23]

Gowns

Risk assessment

A WHO guideline document, graded AGREE II 'recommend with modifications', and two WHO expert opinion guidance recommend that the decision of when to wear a gown should be based on an exposure risk assessment.[20, 21, 39] However, information on how risk should be assessed was not provided. RCN expert opinion guidance suggests that the decision of when to wear gowns may also be based on local policy for certain settings or situations.[23]

Exposure to splash or spray of blood or body fluids

Two UK guideline documents (Epic3 guidelines and NICE CG139, published in 2014 and 2012 respectfully) and a WHO guideline, all graded AGREE II 'recommend with modifications', recommend that fluid repellent gowns should be worn instead of aprons, if there is an extensive risk of splashing or contamination with blood or body fluids.[12, 13, 21] Six expert opinion guidance from the UK also advise this approach.[15, 23, 30, 35, 48, 49] Similarly, expert opinion guidance from international organisations recommend wearing a gown to prevent soiling of clothing and skin during procedures that are likely to generate splashes of blood and body fluids,[18, 36, 38, 47] including environmental cleaning and managing infectious waste.[22, 26, 31, 32, 38] They advise that gowns should be worn for procedures and patient care activities where contact with blood, body fluids, secretions, or excretions is anticipated, including potentially contaminated environmental surfaces and when handling patient care equipment that is visibly soiled or may have been in contact with blood or body fluids.[19, 20, 22, 24, 34, 40, 43-47]

An observational study, graded SIGN 50 level 3, evaluated the incidence of macroscopic blood contamination on gown surfaces of four dermatologists who

performed at least 100 dermatological excisional procedures. Visual blood contamination was seen on 42% (95% Confidence interval: 37.7–46.3) of the physicians' surgical gowns. There was no statistically significant difference between the splash incidence on the gowns (P-value = 0.9034) and the dermatologists were not aware of blood splashes at the time of contamination.[41] This study highlights that care procedures, in this case routine excisional dermatological procedures, can result in blood contamination which may go unnoticed by the operator.

Two WHO expert opinion guidance recommend wearing gowns and coveralls with a zip flap for protection against splashes when handling and processing specimens (with infectious agents) and performing diagnostic testing in laboratories.[20, 33]

Acute respiratory infections (ARI)

A 2014 WHO guideline for IPC of epidemic- and pandemic-prone acute respiratory infections graded AGREE II 'recommend with modifications' recommends the use of long-sleeved gowns as determined by risk assessment (risk associated with the suspected/confirmed pathogen) when providing care to patients with acute respiratory infection (ARI) syndromes.[21] ECDC expert opinion guidance advises wearing a long-sleeve gown when there is high risk of exposure to respiratory viruses and when caring for patients with respiratory syncytial virus (RSV) infection, particularly infants, young children, and immunocompromised adults.[32] American Association of Nurse Anaesthesiology (AANA) expert opinion guidance, published in 2015, recommends wearing a gown as part of transmission-based precautions upon entering the room of a patient with an infectious agent that can be transmitted by respiratory secretions through the droplet route (such as Influenza, Pertussis, Mumps, and Rubella) and the airborne route (such as measles, varicella, and TB).[24] RCN expert opinion guidance suggest that gowns may be required for high risk respiratory infections.[23] However, details or examples were not provided.

Aerosol generating procedures (AGPs)

Eleven expert opinion guidance from international organisations recommend that gowns should be worn as part of contact precautions during AGPs.[19, 20, 22, 24, 26, 31, 32, 40, 43-45] WHO guidance published in 2014 for IPC of epidemic- and pandemic-prone acute respiratory infections, graded AGREE II 'recommend with modifications',

recommends long-sleeved gowns during AGPs consistently associated with an increased risk of transmission of ARI.[21] ECDC, in guidance published in 2023, advise that everyone present in a room when performing AGPs on patients with respiratory viral infection should wear an impervious long-sleeved gown.[32]

Managing multidrug-resistant Organisms (MDROs)

Three expert opinion guidance documents recommend wearing gowns when caring for patients colonised or infected with MDROs.[23, 34, 46] Australian National Health and Medical Research Council (NHMRC) expert opinion guidance recommends that gowns must be worn when caring for patients colonised or infected with MDROs, especially if patient and/or environmental contact is anticipated.[34] CDC expert opinion guidance on preventing the spread of MDROs in nursing homes recommends using gowns as part of contact and enhanced barrier precautions when performing high-contact resident care activities (for example, dressing, bathing or showering, and providing hygiene) for all residents infected or colonised by MDROs and during care of wounds and/or indwelling medical devices (for example, feeding tube, tracheostomy or ventilator) regardless of MDRO colonisation status.[46] RCN expert opinion guidance also suggests that based on local policy, gowns may be required when caring for patients with MDROs.[23]

Source control

Seven expert opinion guidance documents advise the use of sterile gowns for source control to prevent contamination of a sterile field during invasive procedures or surgery.[15, 18, 24, 25, 34, 36, 42] NHMRC expert opinion guidance recommends that sterile gowns should be worn for procedures that require an aseptic field.[34] The Association of Anaesthetists of Great Britain and Ireland expert opinion guidance published in 2009 outlines a requirement of sterile gowns for all invasive surgical procedures, including insertion of central venous catheters, and spinal, epidural and caudal procedures.[15] The Society for Cardiovascular Angiography and Interventions (SCAI), recommends that cardiac catheterisation personnel should wear sterile gowns as part of aseptic technique, for insertion of central venous catheters or guidewire exchange.[36]

Three expert opinion guidance from the USA and India advise that every surgical team member should wear a sterile gown for surgical procedures.[18, 24, 25] However,

expert opinion from the American Spine Intervention Society's Patient Safety Committee highlights that evidence on the infection control benefits of wearing a surgical gown for routine spine pain interventional procedures is inconclusive and suggest that gowning should only be considered for procedures with consistently higher infection rates which often require lengthy access to the epidural space, such as spinal cord stimulation, intrathecal pump placement, or procedures that involve disc access such as discography.[42]

Two sources were consistent in their advice regarding the use of gowns for source control within high risk units, where patients are usually immunocompromised.[19, 37] Expert opinion guidance from the American Healthcare Infection Control Practices Advisory Committee (HICPAC) and the German Commission for Hospital Hygiene and Infection Prevention (KRINKO) advise that staff and visitors should not routinely don gowns on entrance to high-risk units, including intensive care units (ICUs) and hematopoietic stem-cell transplantation (HSCT) units, due to a lack of scientific evidence of IPC benefits.[19, 37] KRINKO further advise that staff and relatives should wear a gown when in close contact with very severely immunocompromised patients in protective isolation.[37]

Conclusion

In summary, the majority of the evidence for this research question consists of extant expert opinion guidance which is consistent in advising that aprons or gowns should be worn in health and care settings when a risk of contamination or splashing with blood or bodily fluids is anticipated. Although a standard means of assessing risk is not provided in the literature, the included evidence advises that aprons should be worn when there is a low risk of contamination from infectious agents or blood and bodily fluids, while gowns are advised when there is extensive splashing of blood and bodily fluids or high risk of contamination from infectious agents such as MDROs and ARIs. A source also advised that staff and relatives should wear a gown as source control when in close contact with immunocompromised patients. Sterile gowns are advised as source control for invasive procedures which require an aseptic field.

3.1.4 How and where should aprons/gowns be donned (put on)?

Fifteen pieces of evidence were included for this research question,[19-22, 24, 26-28, 34, 40, 43, 44, 46, 50, 51] five of these were identified in the current review update.[28, 34, 46, 50, 51] Fourteen documents were graded SIGN 50 Level 4 expert opinion guidance,[19, 20, 22, 24, 26-28, 34, 40, 43, 44, 46, 50, 51] and one guideline document was graded AGREE II 'recommend with modifications'.[21] There were no primary research studies included for this research question.

Of the included evidence, one is a UK expert opinion guidance,[51] nine were published in the USA,[19, 22, 24, 27, 28, 40, 43, 44, 46] and three were from Australia.[26, 34, 50] One expert opinion guidance and a guideline document graded AGREE II 'recommend with modifications', both published by the WHO.[20, 21]

Hand hygiene

Seven evidence sources consistently recommend that hand hygiene should be performed before donning aprons or gowns.[21, 22, 26, 28, 34, 43, 51] According to WHO guideline, graded AGREE II 'recommend with modifications',[21] and six expert opinion guidance from the UK,[51] USA,[22, 28, 43] and Australia,[26, 34] hand hygiene should be performed first prior to donning a gown. AORN expert opinion guidance recommends that surgical hand antisepsis should be performed before donning a sterile gown.[28]

Sequence of donning

Two expert opinion guidance documents and a WHO guideline document, graded AGREE II 'recommend with modifications', recommend that gowns should be donned first before other PPE.[19, 21, 43] WHO further advise that donning should be done in an order that ensures adequate placement of PPE items and prevents self-contamination and self-inoculation.[21] However, Australian expert opinion guidance on caring for patients with influenza-like illnesses advises that in high aerosol-risk settings, a gown should be donned following other PPE items in the sequence; particulate mask, eye protection, impervious long-sleeved gown, then gloves.[26] AORN expert opinion recommends that when donning a reprocessed gown, the materials should be visually inspected to determine their integrity before use.[27]

Method of donning

DHSC expert opinion guidance recommends that following hand hygiene, aprons should be put on and tied at the waist.[51]

Four expert opinion guidance propose different techniques for donning gowns.[20, 24, 28, 43] Expert opinion guidance from AANA recommend that both sterile and non-sterile gowns should be secured at the back of the neck and waist,[24] while CDC recommend that the gown should be secured at the back alone.[43] A WHO expert opinion guidance for public health emergencies recommends that a gown should be donned in such a way that it fully covers the torso from neck to knees, arms to end of wrists and wrap around the back, then fastened at back of neck and waist, and secured with duct tape.[20]

AORN expert opinion guidance recommends that sterile technique must be employed when donning a sterile gown and assistance from a team member is required.[28] They further suggest that healthcare workers should don a sterile gown with the gown cuffs remaining at or beyond the fingertips, then insert hands into gloves held open by a scrubbed team member, with the gown cuff touching only inside of the gloves.[28]

Where to don

Seven evidence sources, including a WHO guideline document graded AGREE II 'recommend with modifications' and six SIGN 50 level 4 expert opinion guidance documents advise that aprons and gowns should be donned before room entry [24, 34, 46, 50] or on entry to the room, cubicle or patient care area.[19, 21, 24, 44]

Conclusion

In summary, there is consistency in the evidence base that hand hygiene should be performed prior to donning an apron or gown in health and care settings. Seven sources (six expert opinion guidance and a guideline document) recommend that aprons and gowns should be donned "before" or "upon" room entry.[19, 21, 24, 34, 44, 46, 50] Three sources are consistent in advising that gowns should be donned first before other PPE.[19, 21, 43] There were inconsistencies in the evidence base on how to secure a gown at the back. This may be due to the nature of the expert opinion guidance

which are focused on pandemic or high-risk infections, and variations in gown design.

3.1.5 When should aprons/gowns be removed/changed?

Twenty-two pieces of evidence were included for this research question,[13, 15, 16, 18-21, 23, 24, 28-32, 34, 35, 38-40, 43, 46, 50] ten of these were identified in the current review update.[28-32, 34, 35, 38, 46, 50] Twenty of the included evidence were SIGN 50 Level 4 expert opinion guidance,[13, 15, 16, 18-21, 23, 24, 28-32, 34, 35, 38-40, 43, 46, 50] and two guideline documents were graded as AGREE II 'recommend with modifications'.[13, 21] Seven of the included evidence were from the UK,[13, 15, 16, 23, 29, 30, 35] seven were from the USA,[19, 24, 28, 38, 40, 43, 46] and two were from Australia.[34, 50] Two expert opinion guidance were published by the ECDC,[31, 32] and three by the WHO.[20, 21, 39]

Removal after use

Two guideline documents (published by NICE and WHO) graded AGREE II 'recommend with modifications', along with eleven SIGN 50 level 4 guidance documents, published by ANNA, CDC, ECDC, SHEA, NHMRC, RCN, DHSC, UKHSA and the Department of Health and Health Protection Agency (DoH and HPA) recommend that aprons or gowns should be worn for only one procedure or episode of patient care, and changed or discarded when contaminated, after completion of care activity and between care for different patients. [13, 16, 21, 23, 24, 29-31, 34, 35, 40, 44, 46] Three SIGN 50 level 4 guidance documents (published by CDC, HICPAC and American Academy of Opthalmology) further advise that gowns should not be reused, even for repeated contacts with the same patient.[19, 22, 43]

Change during care activity or procedure

A WHO guideline, graded AGREE II 'recommend with modifications', and five expert opinion guidance documents recommend that soiled gowns should be removed, with care, as soon as possible.[15, 18, 20, 21, 28, 38] A CDC expert opinion guidance for dental settings recommends that protective clothing should be changed if visibly soiled and changed immediately or as soon as feasible if penetrated by blood or other potentially infectious fluids.[38] AORN expert opinion guidance for operating room settings suggests using clinical judgement to determine whether a sterile sleeve

should be worn to cover contaminated areas of a gown sleeve or if the gown should be removed, and a new sterile gown donned.[28]

Sessional use

A WHO guideline for epidemic and pandemic prone acute respiratory infections (ARIs), graded AGREE II 'recommend with modification', suggest that if a gown does not come into direct contact with any patient, then it can be worn during the care of more than one patient in a single cohort area.[21]

Conclusion

In summary, there was no primary research available for this research question. Extant expert opinion guidance and guidelines advise that aprons and gowns should be worn for one procedure or one episode of care and changed when contaminated, after the completion of the care activity, and between care of different people. Sessional use of gowns, where the same gown is worn during the care of more than one patient, was described by one guideline for care of patients with epidemic and pandemic prone ARIs.

3.1.6 How and where should aprons/gowns be doffed (taken off)?

Thirteen pieces of evidence were included for this research question,[19-22, 24, 26, 33, 34, 43, 44, 46, 47, 51] five of these were identified in the current review update.[33, 34, 46, 47, 51] Twelve of the included evidence were SIGN 50 Level 4 expert opinion guidance,[19, 20, 22, 24, 26, 33, 34, 43, 44, 46, 47, 51] and one guideline document, published by the WHO, was graded AGREE II 'recommend with modifications'.[21]

Alongside two WHO [20, 33] expert opinion guidance documents, other SIGN 50 level 4 guidance was included from the UK,[51] the USA,[19, 22, 24, 43, 44, 46] Australia,[26, 34] and Canada.[47] There were no primary research studies included for this research question.

How to doff/remove

Seven sources (six SIGN 50 level 4 expert opinion guidance and one AGREE II 'recommend with modifications' guideline) advise that aprons and gowns should be

removed in such a way as to avoid contact with the contaminated outer surface and therefore self-contamination.[19-21, 26, 34, 43, 51]

A WHO expert opinion guidance advise that disposable aprons should be removed following the sequence; “untie or break the fastening at the neck and roll the apron down to contain the contaminated front of apron, untie or break the fastening at the back of the waist, and roll the apron further without contaminating the hands”.[33]

Six expert opinion guidance (published by AANA, CDC, HICPAC, NHMRC, and WHO) describe the following steps for gown removal: unfasten ties in back of neck and waist; pull away from neck and shoulders to avoid touching the outer ‘contaminated’ side of the gown; turn gown inside out; and fold or roll into a bundle, then discard into appropriate receptacle.[19, 20, 24, 33, 34, 43]

Hand hygiene during removal

A WHO guideline document graded AGREE II ‘Recommend with modifications’, and two expert opinion guidance documents from DHSC and ASID recommend that hand hygiene should be performed before removal of aprons and gowns.[21, 26, 51]

A WHO guideline document, graded AGREE II ‘Recommend with modifications’, and five expert opinion guidance documents from Australia, the USA and the UK recommend that hand hygiene should be performed following the removal of aprons and gowns.[19, 21, 22, 34, 43, 51]

Where to doff/remove

Seven expert opinion guidance advise that aprons or gowns should be removed before leaving the patient room or care area to prevent possible contamination of the environment outside the patient’s room.[19, 22, 34, 43, 44, 46, 47] WHO guidelines recommend that PPE should be removed in the anteroom, if available.[21]

Conclusion

In summary, there was no primary research available for this research question. The evidence base, which largely consists of extant expert opinion guidance, was consistent in advising hand hygiene prior to and after removing an apron or gown, and removal where the care episode took place, before leaving the patient care area or room. During removal, contact with the contaminated front area of aprons or

gowns should be avoided to prevent self-contamination or spread of infectious agents.

3.1.7 How should reusable aprons/gowns be reprocessed?

This is a new research question for this version of the review. Two pieces of evidence were included, a guideline document (the UK Epic3 guidelines published 2014) graded AGREE II 'Recommend with modifications',[12] and a SIGN 50 Level 4 expert opinion guidance document published by the USA Association of periOperative Registered Nurses (AORN).[27] No primary research studies were included.

Epic3 guidelines recommend that non-disposable protective clothing should be sent for laundering after use.[12] However, a detailed reprocessing method was not provided.

The AORN recommend that reprocessing instructions, including the suggested number of processing and useful life of barrier materials, which should be provided by the manufacturer, must be followed.[27] They further explain that repeated processing will ultimately diminish the protective barrier ability of reusable textiles. Therefore, tracking the number of reprocessing cycles and monitoring the quality of reusable surgical gowns to detect any form of deterioration in protective quality is recommended.[27] However, reusable textiles should continue to meet the original barrier quality level throughout the manufacturer-recommended life cycle.[27]

Conclusion

In summary, very limited evidence was identified for this research question, with no primary research studies included, making it difficult to assess consistency or inform the development of evidence-based recommendations. Moreover, no reprocessing methods were described in the literature.

3.1.8 How should aprons/gowns be disposed of?

Eight pieces of evidence were included for this research question,[12, 16, 19-21, 23, 24, 36] one of these was identified in the current review update.[36] Six of the included evidence were SIGN 50 Level 4 expert opinion guidance,[16, 19, 20, 23, 24, 36] and two guideline documents (2014 Epic3 guidelines and 2014 WHO epidemic and pandemic

prone ARI guidelines) were graded AGREE II 'recommend with modifications'.[12, 21] Three of the included evidence were published in the UK,[12, 16, 23] three were published in the USA,[19, 24, 36] and two by the WHO.[20, 21] No primary research studies were included.

Epic3 and a WHO guideline along with six expert opinion guidance from AANA, CDC,RCN, WHO, and DoH and HPA advise that disposable aprons and gowns should be disposed of immediately after use, into an appropriate waste stream in accordance with local waste policies.[12, 16, 19-21, 23, 24, 36]

The NIPCM literature review that examines the extant literature regarding the safe disposal and management of waste provides more information on disposal of PPE.

The WHO recommend that hand hygiene should be performed following disposal of PPE.[21]

Conclusion

In summary, included evidence was consistent in advising that disposable aprons and gowns be disposed in a designated healthcare waste receptable, in accordance with local waste policies.

3.1.9 How should aprons/gowns be stored?

Four pieces of evidence were included for this research question,[3, 4, 16, 52] one of these was identified in the current review update.[52] Two of the included evidence are mandatory legislation,[3, 4] and two were graded SIGN 50 Level 4 expert opinion guidance.[16, 52] All evidence was published in the UK.[3, 4, 16, 52]

The Control of Substances Hazardous to Health Regulations 2002 and the Personal Protective Equipment at Work Regulations 1992 mandates the employer to ensure that PPE, including protective clothing, is properly stored in a well-defined place.[3, 4] These UK legislations also mandate employers to ensure that PPE "is maintained in an efficient state, in efficient working order, in good repair and in a clean condition".[3, 4] The Regulation (EU) 2016/425 (as incorporated into UK law) states that PPE sold on the market must be supplied with relevant information on storage.[52]

Expert opinion guidance published by the UK Health and Safety Executive (HSE) emphasises the need for employers to provide suitable accommodation for PPE

when not being used and advise that storage should “prevent damage from chemicals, sunlight, high humidity, heat and accidental knocks; prevent contamination from dirt and harmful substances; reduce the possibility of losing the PPE; and enable the sufficient drying of PPE to ensure its effectiveness is maintained”.[52] Expert opinion guidance published in 2013 by the DoH and HPA recommends that aprons should be stored in a manner that ensures that they do not accumulate dust, which may act as a reservoir for micro-organisms.[16]

Conclusion

In summary, the evidence was consistent that employers must make provision to store PPE in such a way that prevents damage and exposure to contaminants. However, only limited evidence was available for this research question, and three out of four included evidence is focused on PPE in general rather than being specific to storage of aprons and gowns.

3.2 Implications for research

There is limited rigorous primary and scientific evidence on the use of aprons and gowns in health and care settings. However, there is, for the most part, consistency in expert opinion. The studies described in this section have not been used to inform final recommendations but are described below as they may indicate prudent avenues for further research.

There may be a need to clarify or expand legislation relating to the use of aprons and gowns as PPE in health and care settings. At present, much of the legislation are either generic or relate to handling and management of dangerous substances and/or chemicals with no specific regulation for infectious agents in a non-laboratory clinical environment.

Most primary studies that assess the effectiveness of PPE in preventing infection transmission, which could have provided evidence of when aprons or gowns should be worn in health and care settings, reported bundled outcome measures, making it difficult to deduce the effect of aprons and gowns.[53-60] Further primary research that is focused on the effectiveness of aprons and gowns solely would strengthen the evidence base.

This literature review failed to identify rigorous evidence regarding the use and reprocessing of reusable aprons and gowns in health and care settings. Future research should look to assess the use of reusable aprons and gowns in health and care settings, including their efficacy compared to disposable aprons and gowns, as well as detailed methods of reprocessing. However, it is acknowledged that manufacturers may be best placed to describe appropriate laundering and reprocessing procedures.

A limited number of controlled trials have been conducted using surgical gowns and drape materials coated with antibacterial substances. These trials show promise but are currently limited by small sample sizes and indirect measures of SSI risk and/or nosocomial infection.[61, 62] It has been demonstrated that the glove gown interface could be a potential source of surgical site contamination therefore indicating that further research may be needed into mitigating this risk.[63] One UK expert opinion source stated that sterile adhesive tape could be placed circumferentially around the proximal end of gloves, covering the non-waterproof cuff and adhering to the waterproof sleeve of the gown.[64] Authors state that this is to avoid the risk of contamination from non-waterproof cuffs which anecdotally become contaminated with sweat.[64] Specific designs of gowns have been explored in a limited way with a suggestion that gowns with tighter wrists and more wrist/hand coverage may result in less wrist and hand contamination during doffing, however, further research in this area is needed.[65]

There is insufficient evidence to support the wearing of cover gowns over surgical attire to prevent transmission when theatre staff leave the theatre area temporarily,[66] and further investigation is needed into whether changing of gowns mid-way through long surgeries may influence SSI rates.[67] Moreover, there is a multitude of studies on transference of bacteria from colonised patients to PPE but a lack of studies or evidence for gown contamination being transferred to patients from HCW PPE.

A list of all studies excluded from the review after critical appraisal, based on their limitations, is provided in Appendix 5.

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Appendix 1: Literature Review Search Strategies

For all questions except Question 4

MEDLINE and Embase

Search 2020 to Current

1	Gown*.ti,ab,kf.
2	Apron*.ti,ab,kf.
3	(Overgown* or Over gown*).ti,ab,kf.
4	Coverall*.ti,ab,kf.
5	*Protective Clothing/
6	1 or 2 or 3 or 4 or 5
7	exp Health Facilities/ or (health care facilit* or healthcare facilit* or health facilit*).ti,ab,kf.
8	hospital*.ti,ab,kf.
9	exp Infections/ or infection*.ti,ab,kf.
10	exp Infection Control/
11	exp cross infection/
12	exp Disease Transmission, Infectious/
13	exp Universal Precautions/ or universal precaution*.ti,ab,kf.
14	(Don* or doff* or remov*).ti,ab,kf.
15	(Dispos* or waste).ti,ab,kf.
16	(Store* or storing or storage).ti,ab,kf.
17	7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16
18	6 and 17
19	limit 18 to (English language and yr="2020"-current)

CINAHL

Search 2020 to Current

S15 S3 AND S14

S14 S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13

S13 TI (store* or storing or storage) OR AB (store* or storing or storage) OR SU (store* or storing or storage)

S12 TI (dispos* or waste) OR AB (dispos* or waste) OR SU (dispos* or waste)

S11 TI (don* or doff* or remov*) OR AB (don* or doff* or remov*) OR SU (don* or doff* or remov*)

S10 (MH "Disease Transmission+")

S9 (MH "Cross Infection")

S8 (MH "Infection Control+")

S7 TI (infection* OR universal precaution*) OR AB (infection* OR universal precaution*) OR SU (infection* OR universal precaution*)

S6 (MH "Infection+")

S5 TI (health care facilit* or healthcare facilit* or health facilit* or hospital) OR AB (health care facilit* or healthcare facilit* or health facilit* or hospital) OR SU (health care facilit* or healthcare facilit* or health facilit* or hospital)

S4 (MH "Health Facilities+")

S3 S1 OR S2

S2 (MH "Protective Clothing")

S1 TI (gown* or apron* or overgown* or over gown*or coverall*) OR AB (gown* or apron* or overgown* or over gown*or coverall*) OR SU (gown* or apron* or overgown* or over gown*or coverall*)

For Question 4 (new question)

MEDLINE and Embase

Search 2000 to Current

1	Gown*.ti,ab,kf.
2	Apron*.ti,ab,kf.
3	(Overgown* or over gown*).ti,ab,kf.
4	Coverall*.ti,ab,kf.
5	*Protective Clothing/
6	1 or 2 or 3 or 4 or 5
7	(health care facilit* or healthcare facilit* or health facilit* or hospital*).ti,ab,kf.
8	exp Health Facilities/
9	exp Infections/ or infection*.ti,ab,kf.
10	exp Infection Control/
11	exp cross infection/
12	exp Disease Transmission, Infectious/
13	exp Universal Precautions/ or universal precaution*.ti,ab,kf.
14	7 or 8 or 9 or 10 or 11 or 12 or 13
15	(Reprocess* or re-process*).ti,ab,kf.
16	(Clean* or disinfect* or Steriliz* or sterilis* or decontamin*).ti,ab,kf.
17	15 or 16
18	6 and 14 and 17
19	limit 18 to english language
20	limit 19 to yr="2000 -Current"

CINAHL

Search 2000 to Current.

S15 S3 AND S11 AND S14

S14 S12 OR S13

S13 TI (Clean* or disinfect* or Steriliz* or sterilis* or decontamin*) OR AB (Clean* or disinfect* or Steriliz* or sterilis* or decontamin*) OR SU (Clean* or disinfect* or Steriliz* or sterilis* or decontamin*)

S12 TI (Reprocess* or re-process*) OR AB (Reprocess* or re-process*) OR SU (Reprocess* or re-process*)

S11 S4 OR S5 OR S6 OR S7 OR S8 OR S9 OR S10

S10 (MH "Disease Transmission+")

S9 (MH "Cross Infection")

S8 (MH "Infection Control+")

S7 TI (infection* OR universal precaution*) OR AB (infection* OR universal precaution*) OR SU (infection* OR universal precaution*)

S6 (MH "Infection+")

S5 TI (health care facilit* or healthcare facilit* or health facilit* or hospital) OR AB (health care facilit* or healthcare facilit* or health facilit* or hospital) OR SU (health care facilit* or healthcare facilit* or health facilit* or hospital)

S4 (MH "Health Facilities+")

S3 S1 OR S2

S2 (MH "Protective Clothing")

S1 TI (gown* or apron* or overgown* or over gown* or coverall*) OR AB gown* or apron* or overgown* or over gown* or coverall*) OR SU (gown* or apron* or overgown* or over gown* or coverall*)

Appendix 2: Evidence gradings

SIGN 50 Evidence levels

The SIGN 50 methodology was used to appraise and grade primary studies and expert opinion guidance documents.

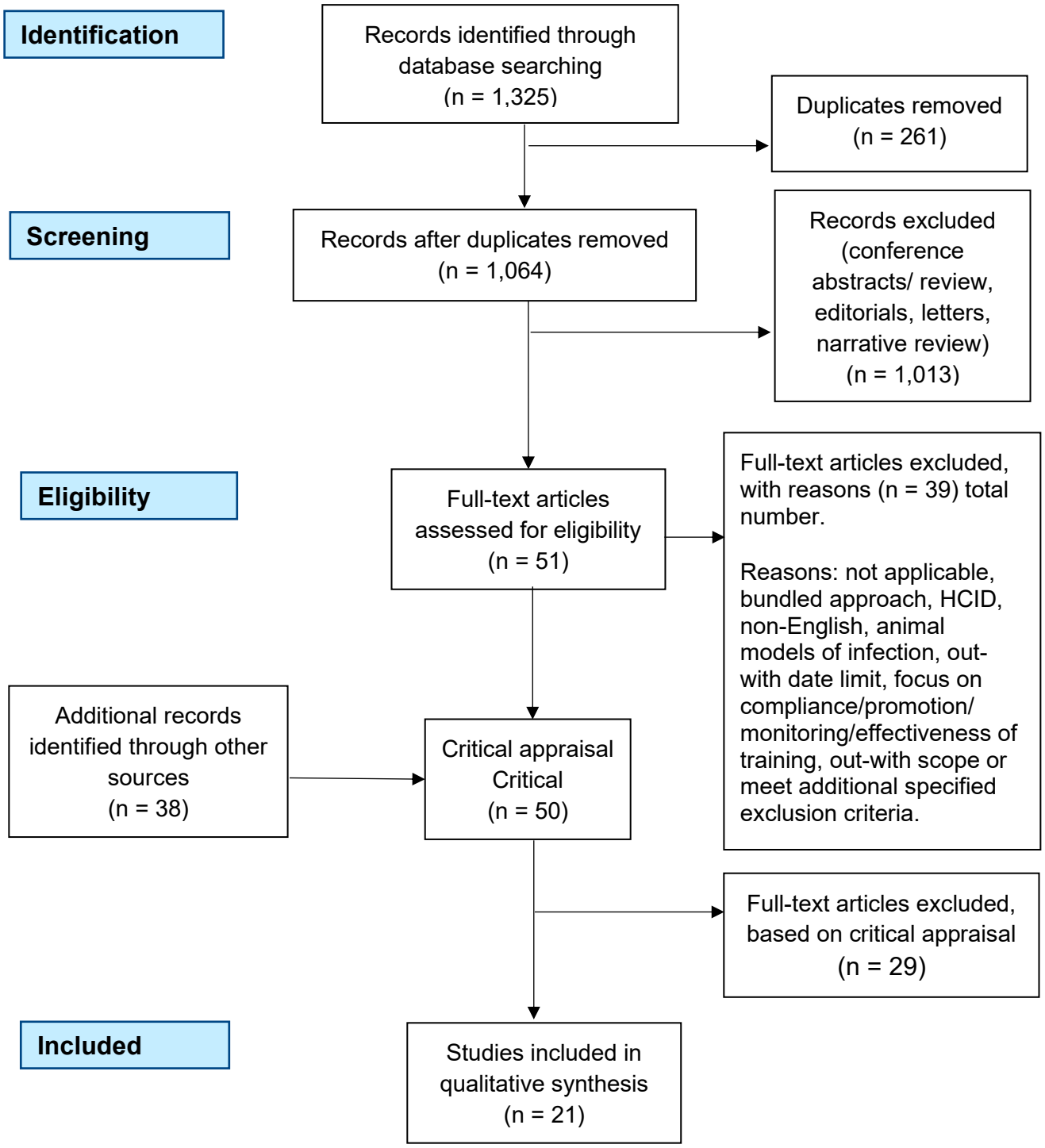
Grade	Description
1++	High-quality meta-analyses, systematic reviews of RCTs, or RCTs with a very low risk of bias
1+	Well-conducted meta-analyses, systematic reviews of RCTs, or RCTs with a low risk of bias.
1-	Meta-analyses, systematic reviews of RCTs, or RCTs with a high risk of bias
2++	High-quality systematic reviews of case-control or cohort studies. High-quality case-control or cohort studies with a very low risk of confounding, bias, or chance and a high probability that the relationship is causal
2+	Well-conducted case-control or cohort studies with a low risk of confounding, bias, or chance and a moderate probability that the relationship is causal
2-	Case-control or cohort studies with a high risk of confounding, bias, or chance and a significant risk that the relationship is not causal
3	Non-analytic studies, for example, case reports, case series
4	Expert opinion

AGREE II Evidence levels

The AGREE II tool was used to appraise guidelines which were based on a systematic review of evidence, and experts have formulated the recommendations/ statements.

Grade	Description
AGREE II 'Recommend'	This indicates that the guideline has a high overall quality and that it can be considered for use in practice without modifications.
AGREE II 'Recommend with modifications'	This indicates that the guideline has a moderate overall quality. This could be due to insufficient or lacking information in the guideline for some items. If modifications are made the guideline could still be considered for use in practice, when no other guidelines on the same topic are available.
AGREE II 'Do not Recommend'	This indicates that the guideline has a low overall quality and serious shortcomings. Therefore, it should not be recommended for use in practice.

Appendix 3: PRISMA flow diagram



Appendix 4: Specific standards relating to the use, quality, and performance of aprons and gowns in health and care settings.

Standard	Title	Description	Publication Date
BS EN 13795-1:2019	Surgical clothing and drapes. Requirements and test methods - Surgical drapes and gowns.	This standard sets out the general requirements and tests for disposable and reusable surgical drapes and gowns including water-resistance tests, microbiological resistance tests, burst tests and tensile tests.	April 2019.
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.
BS EN ISO 22610:2006	Surgical drapes, gowns, and clean air suits, used as medical devices, for patients, clinical staff and equipment - Test method to determine the resistance to wet bacterial penetration.	This standard sets out the test method to determine the resistance of surgical drapes, gowns and clean air suits to wet bacterial penetration.	January 2007.

Standard	Title	Description	Publication Date
BS EN ISO 22612:2005	Clothing for protection against infectious agents - Test method for resistance to dry microbial penetration.	This standard describes a test method, with the associated equipment, that may be used to determine a material's resistance to dry penetration of bacteria on particles in the size range most typical for human skin scales.	March 2005.

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; BS EN; 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.

Appendix 5: Studies excluded following critical appraisal.

The following primary studies were excluded during critical appraisal based on their limitations:

- Byrd WA, Kavolus JJ, Penrose CT et al. Donning Gloves Before Surgical Gown Eliminates Sleeve Contamination. Journal of Arthroplasty 2019; 34. 6: 1184-1188.
- Ciavattini A, Delli Carpini G, Giannella L, et al. Expert consensus from the Italian Society for Colposcopy and Cervico-Vaginal Pathology (SICPCV) for colposcopy and outpatient surgery of the lower genital tract during the COVID-19 pandemic. International Journal of Gynecology & Obstetrics. 2020 Jun;149(3):269-72.
- Hafiani EM, Cassier P, Aho S, et al. Guidelines for clothing in the operating theatre, 2021. Anaesthesia Critical Care & Pain Medicine. 2022 Jun 1;41(3):101084.
- Hajar Z, Mana TSC, Cadnum JL, et al. Dispersal of gram-negative bacilli from contaminated sink drains to cover gowns and hands during hand washing. Infection Control & Hospital Epidemiology 2019; 40. 4: 460-462. 46.
- Ishihama K, Iida S, Koizumi H, et al. High incidence of blood exposure due to imperceptible contaminated splatters during oral surgery. Journal of Oral & Maxillofacial Surgery (02782391) 2008; 66. 4: 704-710.
- Jayasena H, Abeynayake D, De Silva A, et al. The use of personal protective equipment in endoscopy: what should the endoscopist wear during a pandemic?. Expert Review of Gastroenterology & Hepatology. 2021 Dec 2;15(12):1349-59.
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- Lai MY, Cheng PK and Lim WW. Survival of severe acute respiratory syndrome coronavirus. Clinical Infectious Diseases 2005; 41. 7: e67-71.
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- McQuerry M, Easter E, Cao A. Disposable versus reusable medical gowns: a performance comparison. American journal of infection control. 2021 May 1;49(5):563-70.
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- Pineles L, Morgan DJ, Lydecker A, et al. Transmission of methicillin-resistant Staphylococcus aureus to health care worker gowns and gloves during care of residents in Veterans Affairs nursing homes. American Journal of Infection Control 2017; 45. 9: 947-953.
- Pottier FG, Briche C, Haraczaj G, et al. Personal protective equipment and doffing procedures in out-of-hospital practice: assessment with a contamination simulation. International Journal of Emergency Medicine 2021; 14: 35. DOI: https://dx.doi.org/10.1186/s12245-021-00362-9.
- Puzniak LA, Leet T, Mayfield J, et al. To gown or not to gown: the effect on acquisition of vancomycin-resistant enterococci. Clinical Infectious Diseases 2002; 35. 1: 18-25.
- Siddiqui NT, Davies S, McGeer A, et al. The effect of gowning on labor epidural catheter colonization rate: a randomized controlled trial. Regional Anesthesia & Pain Medicine. 2014 Nov 1;39(6):520-4.
- Sundet A, Nelms NJ, Michelson JD. Donning Gloves Before Surgical Gown Cross-contaminates the Assistant. Arthroplasty Today. 2022 Oct 1;17:142-4.

- Tanabe F, Uchida Y, Arakawa S et al. Increased adhesion of methicillin-resistant Staphylococcus aureus to the surface of personal protective clothing damaged by friction during nursing action. American Journal of Infection Control 2020; 48. 4: 416-419.
- Verbeek JH, Rajamaki B, Ijaz S, et al. Personal protective equipment for preventing highly infectious diseases due to exposure to contaminated body fluids in healthcare staff. Cochrane Database of Systematic Reviews 2020; 4. CD011621.
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